# ICES WKFREQ REPORT 2012

ICES ADVISORY COMMITTEE

ICES CM 2012/ACOM:34

# Report of the Workshop on Frequency of Assessments (WKFREQ)

6–8 March 2012

By Correspondence

ICES International Council for the Exploration of the Sea

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Recommended format for purposes of citation:

ICES. 2012. Report of the Workshop on Frequency of Assessments (WKFREQ), 6–8 March 2012, By Correspondence. ICES CM 2012/ACOM:34. 29 pp.

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## Executive summary

The first WKFREQ meeting was intended to have taken place in 2010, but was postponed to 2011 (and then further to 2012) due to lack of participants. The 2012 meeting was similarly understaffed. The three participants met by correspondence and were successful in making a degree of progress, but could not address all of the ToRs to the extent that would have been expected with a larger group.

With the resources available, WKFREQ were able to review past ICES work on the issue of assessment and advice frequency, to consider approaches to the question in other parts of the world, to conduct an evaluation of the potential risk of switching to multiannual quotas for one particular case (the proposed EU-Russia management plan for Rockall haddock), and to reach the following series of (essentially) qualitative conclusions.

WKFREQ suggests that multiannual management approaches can only be considered for a limited subset of ICES stocks, namely those with robust assessments and modest exploitation, those with a limited amount of new information each year, those with very noisy data, those in which management is only weakly directed by assessments, and those in which individuals are very long lived and exploitation is (again) modest. Stocks in any other circumstances are unlikely to be suitable for a multiannual approach.

Even in suitable cases, the risk of changing to a multiannual system needs to be evaluated using a quantitative approach such as an MSE. Such an evaluation needs to consider the assessment model used and its uncertainty, survey and recruitment variability, the initial state and trajectory of the stock, the management approach used, how well the fishery performs economically, and more qualitative aspects such as political sensitivity. An evaluation that ignores one or more of these aspects in determining suitability may well reach the wrong conclusion, with potentially damaging consequences.

Multiannual procedures should be introduced only after a discussion with Stakeholders and Clients as the assessment frequency is also important for the credibility of the advice.

# 1 Introduction

## 1.1 Terms of Reference (ToRs)

The Workshop on Frequency of Assessments (WKFREQ), chaired by Coby Needle, UK, met by correspondence during 6–8 March 2012 to:

a ) Evaluate the effectiveness of current advisory frequency for annual / biennial advice, including examples of both analytical and non-analytical assessments;

b ) Compile an overview of decision making processes in assessment frequency (annual, bi- or triennial) outside the ICES environment

c ) Evaluate the factors that determine the most suitable frequency for advice;

d ) Establish a statistical basis for determining the desirable frequency of fish stock assessments;

e ) Put forward a framework for determining the advisory frequency for different categories of stocks assessed by ICES.

WKFREQ reported by 29 March 2012 for the attention of ACOM.

## 1.2 Report structure

The report structure largely follows the order of the ToRs. One working paper was submitted to WKFREQ, and this is discussed in Section 2. Section 3 covers the findings of the 1999 meeting of SGMAP, which is relevant to our ToRs c) and e). ToRs a) to d) are then covered in Sections 4 to 6, with conclusions in Section 7.

# 2 Working papers

One working paper was submitted to WKFREQ. Maurice Clark (Marine Institute, Galway, Ireland) suggested the following pragmatic approach, which is based principally on what data are available:

| | Current situation | Advice frequency | Assessment frequency |
|---|---|---|---|
| Tier A | Annual assessment and forecast | Consider in Benchmark WKs | |
| Tier B | Data incomplete, trends based advice | Pragmatic approach to advice frequency | Await developments from EGs |
| Tier C | Data insufficient for ass., advice, based on expert judgment, or no advice given | Pragmatic approach<br>3-yearly cycle for demersals | Develop decision tree protocol for expert judgment |

Maurice Clark was unfortunately unable to participate in the WKFREQ meeting but as discussed in Section 7 (Conclusions), WKFREQ concluded that **there are several factors in addition to data availability that should be taken into account,** such as the status of the stock (see Section 5 for a discussion), variability in recruitment and productivity (discussed by SGMAP (ICES, 1999)), and the political sensitivities asso-

ciated with the stock. All these issues including the data situation need to be considered when determining the assessment frequency.

The working document also includes a concrete proposal for stocks assessed by the Working Group for the Celtic Seas Ecoregion (WGCSE). WKFREQ suggests that WGCSE consider this proposal in detail.

# 3 Advisory frequency framework

## 3.1 Historical development

The question of frequency of advice or frequency of assessment has already been the object of discussions within ICES. A study group (ICES Study Group on Multiannual Assessment Procedures (SGMAP) was held in 1999 to address the question of multi-annual assessment procedures (MAP). Although the terms of references of SGMAP were different to those of WKFREQ, being more focused on how to provide annual advice if an assessment was not carried out every year, SGMAP did consider advice in terms of proposed TACs which would be valid for several years ahead, as well as other forms of multiyear advice. It is therefore worth recalling and commenting on their findings and recommendations.

## 3.2 The objectives and context of SGMAP

SGMAP noted that multiyear advice has long been seen as desirable by the fishing industry and by fishery management agencies. Under current assessment and fishery management practices, providing multiyear TAC advice (where the TAC in each year is expected to track changes in stock size while keeping or bringing the stock within safe biological limits) would require knowledge of actual catches in the coming years, relatively precise knowledge of incoming recruitment and future biological parameters.

In line with the objective of WKFREQ, SGMAP noted that [ACOM's] overall objective was "to provide the advice necessary to maintain viable fisheries within sustainable ecosystems," and that this could not be simply equated with TAC advice and point estimates. It was thus consistent with the precautionary approach (PA) to deliver a type of advice which would be less dependent on the occasional ups and downs in the fishery or vagaries in the latest VPA, and would be more focused on medium-term risks.

SGMAP also noted that they were seeking a mechanism whereby more robust advice would be provided, in the sense that advice would be less sensitive to the availability and/or quality of particular data. At the same time this would respond to concerns of stability, consistency, credibility, and workload across the advisory system. Moving to a multi-annual scheme has implications in terms of the frequency of assessment, the time horizon of advice, methodological and logistical considerations, but all of these are closely linked to the character or content of the advice that ICES intends to provide. One may ask whether tracking the ups and downs of stocks just at the boundaries of so-called safe biological limits is the best service science can provide to customers of advice and other interested parties.

It is worth noting that in 1999, SGMAP expressed a concern that the amount and quality of assessment work was getting harder to maintain, due to staff and budget reductions imposed on most laboratories. This was reflected in reduced expertise available in assessment working groups, and in difficulties in maintaining the basic

data collection programmes (sampling, surveys, etc.) required to provide reliable foundations for advice. WKFREQ considers that very little has changed in the intervening 13 years.

## 3.3 Conclusions and recommendations from SGMAP

Regarding the request to investigate and propose simplified methodology and procedures which may be used to provide management advice (such as TACs) in years when a full assessment was not performed, SGMAP concluded that

- So-called "short cut" methods (as opposed to a full assessment) were not necessarily simple. Assessment or forecasting methods that rely on estimating few parameters make correspondingly stronger structural assumptions and there is a greater risk that the assumptions shall be violated and strong biases in catch forecasts introduced thereby. Additionally, methods that rely on treating the most recent survey observation as precise may introduce unacceptable variability in catch forecasts unless some constraining assumption is applied.
- The costs and benefits of applying the "short cut" methods should be evaluated.
- The choice of appropriate methods is likely to be highly case-specific.
- It was considered undesirable in principle to use different models in forecasts; alternating between complex age-structured stock projections and simpler forecast methods in different years was deemed unappealing.
- Due to the hidden complexities and potential pitfalls of the simpler forecasting methods, and the requirement for extensive testing to address these issues, attempts to introduce such models are likely to increase rather than decrease the workload on assessment working groups, at least in the short term.

In addition, SGMAP expressed the view that, in any case, the development of the stock would have to be monitored, and that ICES would have to be prepared to change the policy on short notice if there was strong evidence that the development of the stock was not as assumed when the advice was given – that is, there needs to be a contingency plan in place for when stock dynamics deviate from expected trajectories. Important criteria that should guide the choice included

- Criteria relating to stock dynamics. Short-lived species and shoaling pelagic species will require more frequent monitoring. Stocks where there are reasons to suspect a regime shift in biological parameters (natural mortality, maturation and growth) pose special problems. Stocks where very large year classes appear occasionally would demand specific management regime
- Criteria relating to the fishery. If the exploitation rate is high, so that the catch is to a large extent driven by the recruitment, delays in recognising a decline in stock abundance may rapidly lead to a severe depletion of the stock. More frequent adjustments will be needed if trends in the exploitation rate are suspected. Shifts in the exploitation pattern, e.g., by change in regulations or in market conditions or in the behaviour of the fishery for other reasons, may call for revision of the advice.

- Criteria relating to assessments. Stocks where the assessment is known to have been problematic or misleading, or where the biological data are being revised, are not good candidates for an MAP. The best cases for multi-annual assessment are the stocks where the information available is such that the assessment and predictions are robust to the applied methodology.
- Criteria relating to decisions. The extent to which the assessments effectively influence the final management decisions should be considered.

In conclusion, SGMAP categorised the stocks for which a MAP could be considered:

1 ) Stocks where the information available is such that the assessment and predictions are robust to the applied methodology, the stock is relatively stable and the exploitation rate is modest, are the most likely candidates for considering a time frame beyond one year for advice in terms of TAC proposals.

2 ) Stocks where only a limited amount of information is added in most of the years. A typical example is the NEA mackerel, where the only data supplied every year are new catch at age data, except in every 3rd year, when there is a new SSB estimate from an egg survey. The possibility that the assessment could be substituted by an annual forward projection in which the actual catches are taken into account, should be investigated.

3 ) Stocks which are borderline with respect to signal/noise ratio in assessment data i.e. the value of new stock assessment calculations may be small because the information content of new data is low with respect to the management decision-taking. In other cases, assessment variability may be dominated by noisy survey information, such that short-term management responses to frequent new assessments would be inappropriate

4 ) Stocks where the annual assessment is of minor importance to the final management decisions.

5 ) Very long lived species, where the exploitation is modest and there is no reason to expect major changes in the state of the stock from one year to the next.

**WKFREQ concurs with and endorses these conclusions**.

# 4 Current ICES advisory frequency (ToR a)

In October 2007, the ICES Council established ACOM and implemented an advisory structure that employs **Benchmark Workshops** to assemble data and lay down a reviewed or new assessment methodology in a Stock Annex. Benchmark Workshops review the assessment model and corresponding data. A Benchmark Workshop should include experts and stakeholders from outside the ICES community to broaden the idea and data pool, in order to improve assessment quality and enhance credibility. The result is a manual (called the **Stock Annex**) that describes the adopted assessment procedure for a specific stock. This procedure can be an analytical assessment, but can also be non-analytical, and could for instance be based on trends in a survey-based assessment or in a selected set of (survey) indicators, with or without forecasts. The result will be the "best available" method that ICES advice can be based on.

**Expert Groups** compile data and perform data analyses which are the basis for the formulation of advice. The expert groups provide two principal inputs: an estimate of the current status of the fish stock and its environment, and a projection of this status in the short and long term under various fisheries scenarios. This is the technical basis for the advice formulation. The analyses to be carried out by an Expert Group are stipulated in the relevant Stock Annexes.

The result of the Experts Groups are taken forward through a quality check in **Review Groups** (RG) to provide an independent review of the technical text, and in **Advice Drafting Groups** (ADG) to draft the advice for consideration by the **Advisory Committee** (ACOM). ACOM adopts the advice and is responsible for communication to the client.

There is no formal multiannual schedule established by ICES. ACOM works on an annual schedule that is adopted at the autumn ACOM meeting as a rolling plan that is modified where necessary throughout the year. The Advisory Report is published each year and includes (if only as a reference to earlier assessments) advice for all stocks that are on the recurrent list.

The assessment method for each stock is supposed to be benchmarked every 3–5 years. Furthermore, ICES has adopted an **Inter Benchmark Protocol** that allows the organisation to look into parts of the stock assessment in a written procedure. This is under the sole control of ACOM. However, political agendas (both within and outwith ICES) and substantial changes in stocks or fisheries have led to many examples of stocks where the scheduled time between benchmarks has been shortened.

Full assessments based on the stock annexes will be conducted every 1–2 years depending on exploitation and political pressure.

For stocks under a biennial schedule, the in-between (non-assessment) years are restricted to checking key stock parameters for signals of dramatic changes. The advice will often be rolled over (SALY; Same Advice as Last Year) or will be truly biennial advice. The reader is referred to analyses in Section 4.1 below on the life time of advice for the Celtic Sea stocks (which averages at about 3 years).

There are also stocks for which data are restricted to catch information only, and for which data do not allow for a numerical projection of stock status. These are included in the table below, which summarises the assessments carried out for 198 ICES stocks in 2011.

| No of stocks 2011 | Benchmark | Annual assessment | Biennial assessment |
|---|---|---|---|
| 198 | 6 | 144 (among which 26 were new assessments) | 48 |

WKFREQ has not been able to perform a thorough quantitative analysis of the efficiency and utility of this system. However, WKFREQ has reached the following conclusions through extensive discussion:

a ) The ICES timing system is under considerable political influence and for stocks that are politically sensitive (e.g. deep water stocks, elasmobranches, cod), the assessment frequency is higher than would be required on purely scientific grounds.

b ) The required assessment frequency strongly depends on the status and in particular the trends of the stock. This is illustrated by the two simulations that are presented for Rockall haddock in Section 6 below: the conclusions about the sustainability of the management plan are very different, depending on whether simulations start in 2001 (upward stock trend) or in 2010 (downward stock trend).

c ) The economic savings of reduced assessment frequency are limited, as the major costs are associated with monitoring which is assumed to continue on an annual basis. However, expertise might be better used.

d ) Experiences from the Expert Groups suggest the savings by a biennial procedure including a check on stock trend in in-between years will be limited. The issue is not only the formal change to be introduced by ACOM but rather a change in the culture of fish stock assessments better accepting the use of simple update procedures.

## 4.1 Life time of advice for the Celtic Seas stocks

When reflecting on a multi-annual advice, it may be informative to evaluate how stable the advice has been in the past. Based on 641 advices given for 33 stocks in the Celtic Seas ecoregion, it is notable that the wording of the advice is identical on average for a period of more than 2 years, and this reaches almost 4 years when selecting only those advices that are duplicated at least once (see Figure 4.1) The archetype of same wording every year are the *Nephrops* stocks, especially in Functional Units (FUs) 11, 12, and 13 where the advice was constantly to "Maintain current effort" without TAC constraints from 1992 to late in the 2000's. For plaice VIIbc, the advice was "Reduce catch to recent average landings" for 8 years. Cod Irish Sea and West of Scotland had a "zero catch" advice for 10 years. It is clear that for a number of stocks ICES seems keen to repeat the advice if the fisheries and stock indicators are similar. The result here is also in line with SGMAP conclusions (Section 6) that stock with stable status were good candidates for multi-year advices.

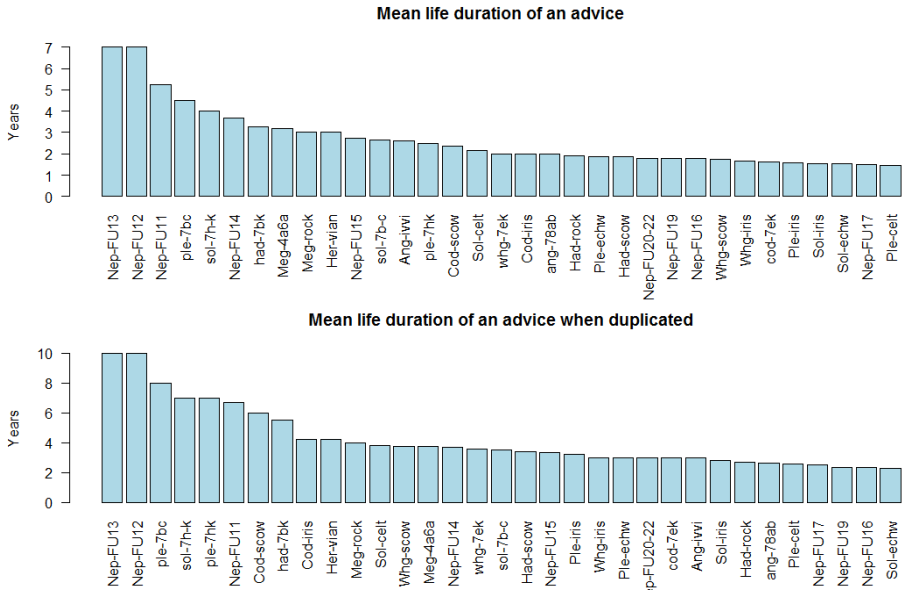


**Figure 4.1 – Upper panel: Mean life duration (consecutive years) of advices per stock. Lower panel: Same statistics when filtering out the singleton advices (including the very last advice).**

# 5 Frequency of assessment and advice around the world (ToR b)

## 5.1 NAFO timetable

The NAFO Scientific Council (NAFO 2009) concluded that the time period between full assessments could be extended for certain stocks based on a combination of their biological capacity for the rate of change of stock status and on current or anticipated fishing pressure (see table below). Interim monitoring would be undertaken every year for all stocks that were not receiving a full assessment. Any changes to the status quo would be addressed immediately by Scientific Council and, if necessary, revisions would be made to the advice previously given to Fisheries Commission. These proposals became effective from 2009. Recently, contributing organisations such as the US National Marine Fisheries Service (NMFS) have been exploring the resource implications of moving to annual assessments (Liz Brooks, NMFS Woods Hole, *pers. comm.*), although without yet reaching a final conclusion (see Section 5.3 below).

| One year basis | Two year basis | Three year basis |
|---|---|---|
| Northern Shrimp SA 0+1 | American plaice in Div. 3LNO | American plaice in Div. 3M |
| Shrimp Div. 3LNO | Capelin in Div. 3NO | Cod in Div. 3NO |
| Shrimp 3M | Redfish in Div. 3M | Cod in Div. 3M |
| Northern Shrimp in Denmark Strait | Thorny skate in Div. 3LNOPs | Northern shortfin squid in SA 3+4 |
| Greenland Halibut SA 2+Div 3KLMNO | White hake in Div. 3NOPs | Redfish in Div 3LN |
| Greenland halibut SA 0+1(offshore) & Div 1B-F | Yellowtail flounder in Div. 3LNO | Redfish in Div. 3O |
| | | Witch flounder in Div. 2J+3KL |
| | | Witch flounder in Div. 3NO |

## 5.2 ICCAT timetable

ICCAT has not formally adopted a protocol; it is up to the Commission to schedule the assessments. Nevertheless, the ICCAT SCRS (in particular the Bluefin Species Group, see ICCAT (2010, page 266)) has recommended several times to fix a minimum of a three-to-four year period between assessments. For stocks other than bluefin, this recommendation is often followed, but in the case of bluefin the Commission has been requesting assessments every two years.

In addition, the SCRS evaluated this question as part of a Management Strategy Evaluation (MSE; see Kell *et al*., 2003). This document showed that choice of reference points was more important than the assessment frequency.

## 5.3 New England experiences

Most groundfish assessments were conducted in 2008 using data current through 2007 for management (TAC targets) in 2009 and forecasts from the 2008 assessments (or 2007 data) were used to set target TACs for 2010 and 2011 as well. There was also a target TAC set for 2012 although the plan was to revisit it in 2011. This "experiment" has met with significant problems putting the credibility of the science at serious risk. When assessments were compared to survey data in the summer of 2011, it

was obvious that the projections from the 2008 assessments were not defensible. When one of the cod assessments was updated in late 2011, advice from 2008 was so dramatically changed that managers declared an "emergency" in terms of their management approach and the credibility of the science suffered dramatically. Other groundfish assessments are now (2012) being updated for the first time since the 2008 assessments, under the expectation that the cod situation will be replicated for several additional stocks.

# 6 Determining the most suitable frequency for advice (ToRs c and d)

## 6.1 Introduction

WKFREQ explored the possibilities of using a management strategy evaluation (MSE) approach to determine whether additional risk (of biomass falling below $B_{pa}$, for example) would be engendered by switching from an annual to a multi-annual approach. Pressure of time meant that an existing MSE had to be adapted for this purpose, and WKFREQ used the MSE code developed during 2011 for the evaluation of a proposed EU-Russia management plan for Rockall haddock. This was presented first in Needle and Mosqueira (2011), and subsequently in Needle (2012). The background to the MSE is summarised below, but the reader is referred to the two cited documents for full details. WKFREQ considers in any case that the particular specification of this MSE is relatively unimportant in this context: our focus here is on the relative change in risk as assessment frequency is increased, and the demonstration of a more widely applicable methodology.

## 6.2 Background

Discussions between the European Union (EU) and the Russian Federation (RF) on possible joint management measures for the Rockall haddock fishery have been progressing for over ten years. Changes in the shape of the EU Exclusive Economic Zone in 1999 led to the renewal of the RF Rockall haddock fishery, and as this fishery has quite different characteristics from the (predominantly) Scottish and Irish fisheries already present in the area, it was clear that joint management would be both necessary and potentially difficult to implement. Meetings involving both scientists and fisheries managers from the EU and the RF have been held on an almost annual basis since 2001 to determine what is known about these fisheries, and how such information can best be used to develop a productive and sustainable management system.

Building on the history of Rockall fisheries and the supporting scientific work presented by Newton *et al.* (2008), the EU-RF Working Group on Rockall haddock met four times during 2008–2010 and produced a state-of-the-art review of available data and scientific analyses pertaining to Rockall haddock (European Commission and Russian Federation, 2009). At the fourth of these meetings, in Edinburgh during September 2010, a proposal for a joint EU-RF management plan for Rockall haddock was drafted. Following further refinements, a final version was presented to the appropriate North East Atlantic Fisheries Commission (NEAFC) plenary meeting towards the end of 2010. The decision was taken there to forward the proposal to ICES for evaluation.

Although the request was received by ICES towards the end of 2010, technical difficulties with the evaluation and pressure of other work meant that the response to the request could not be included as part of the June 2011 advice release. Needle and

Mosqueira (2011) subsequently provided a quantitative risk-based evaluation of the likely performance of the proposed management plan, although they did not cover all relevant issues as yet. Remaining problems were highlighted in the text and will be dealt with during any future revisions of the management plan (if implemented). The evaluation was implemented in the R programming system (R Development Core Team, 2011, version 2.13.0), using the most recently-available versions of the FLR libraries (FLR Team, 2006, Kell *et al.*, 2007, Hillary, 2009, http://flr-project.org/).

## 6.3 Evaluating risk as a function of assessment frequency

WKFREQ extended the analyses presented in Needle and Mosqueira (2011) to cover the following cases:

- Recruitment CV = 0.3 or 1.0;
- Number of years with fixed quotas = 1 (annual) or 5.
- Starting year = 2001 (increasing stock) or 2010 (decreasing stock).

The target F was 0.3 in all cases. The survey CV was assumed to by 0.3 for all runs, although though this could also be modified and represents the uncertainty in the assessment itself. Each of the eight resultant combinations was used in an MSE run with 500 iterations for 20 years. Historical characterising analyses which were carried out for each of the runs for which the starting year was 2001 ("a" plots) and 2010 ("b" plots) are summarised in Figures 6.1 (XSA assessment), 6.2 (XSA tuning residuals), 6.3 (survey log catchability models), 6.4 (bootstrapped historical assessments) and 6.5 (bootstrapped survey indices). Full details on bootstrap and MSE methods can be found in Needle and Mosqueira (2011).

Figure 6.6 gives summary plots for one iteration of simulations with recruitment CV set to 1.0, the starting year at 2010, and years for fixed quota set at 1 (Figure 6.6a) or 5 (Figure 6.6b). In the example with annual quotas (Figure 6.6a), biomass falls to a low point in 2019, before rising again following some reasonable year-classes, and quotas are able to track the stock changes closely. With multiannual quotas (Figure 6.6b), the TAC is probably held at too high a level for the first five years, which leads to a steep decline in biomass initially. Subsequent five-year quotas are probably too low for the stock size, leading to greater expansion of biomass at the expense of foregone yield.

Note that the stochastic recruitment time-series cannot be the same for these two simulations, so they are difficult to compare directly. Figures 6.7a and 6.7b show the distributions of simulated values over 500 iterations of these two runs, from which we see that the median SSB falls to a lower level with multiannual quotas than with annual quotas, before rebounding to a higher level with multiannual than annual quotas. The stock response to multiannual quotas in this particular case, in other words, is to switch between extreme values which do not generally arise with annual quotas.

The histograms in Figure 6.8 summarise the risk of spawning stock biomass B falling below the precautionary level $B_{pa}$. For each iteration $i$, we sum the number of years $n_i$ out of the 22-year simulation period in which $B < B_{pa}$. The histogram then presents the distribution of the $n_i$ values, while the legend gives the mean of the $n_i$ values, along with what that mean represents as a fraction of the total simulation time-period. The fractions are 39.3% for annual quotas and 48.1% for multiannual quotas. Thus, all else being equal and over 500 simulated future recruitment time series, the annual quotas lead to considerably less risk of $B < B_{pa}$.

WKFREQ carried out such comparative runs for all eight combination of the factors starting year, recruitment CV, and number of years for fixed quotas. The results, calculated as a risk fraction as above, are as follows:

| Starting year | Recruitment CV | Number of years for fixed quotas | Percentage B < Bpa |
|---|---|---|---|
| 2001 | 0.3 | 1 | 0.0% |
| 2001 | 0.3 | 5 | 0.1% |
| 2001 | 1.0 | 1 | 5.7% |
| 2001 | 1.0 | 5 | 4.4% |
| 2010 | 0.3 | 1 | 19.5% |
| 2010 | 0.3 | 5 | 43.0% |
| 2010 | 1.0 | 1 | 39.3% |
| 2010 | 1.0 | 5 | 48.1% |

The factor-based mean percentages are:

| Factor | Value | Mean P% B < Bpa |
|---|---|---|
| Starting year | 2001 | 2.55% |
| | 2010 | 37.48% |
| Recruitment CV | 0.3 | 15.65% |
| | 1.0 | 24.38% |
| Number of years for fixed quotas | 1 | 16.13% |
| | 5 | 23.90% |

The strongest influence on risk in this analysis was the starting year. If the initial stock trend is positive, then risk over the next 20 years will be low no matter what other assumptions are made, while a negative initial stock trend will nearly always result in a higher risk. The variability in recruitment and the number of years for fixed quotas do have an effect, although weaker, and the latter is slightly weaker still than the former. So we can conclude that a switch from annual to multiannual quotas for this particular stock would lead to an increase in the risk of SSB falling below $B_{pa}$, although the influence of this switch is less than the two other factors that were explored.

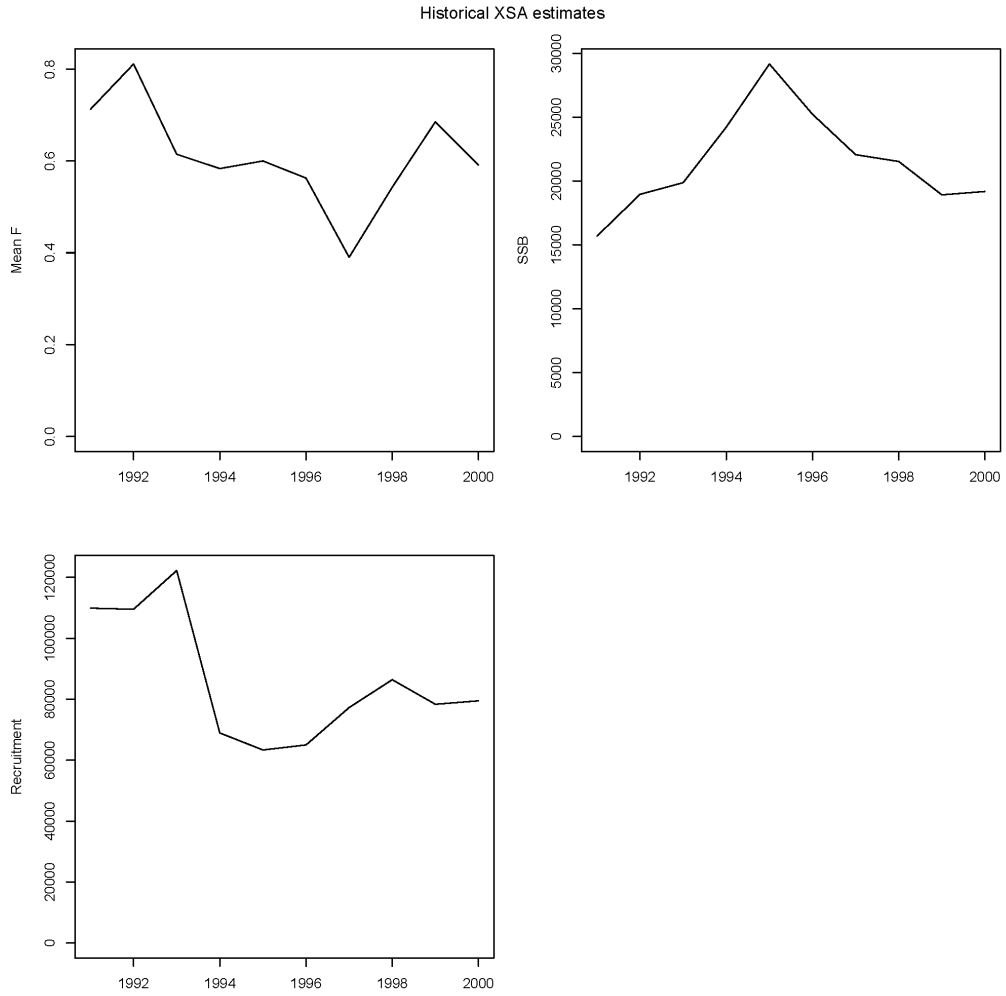


**Figure 6.1.a. Rockall haddock: historical XSA assessment summary for MSEs starting in 2001.**

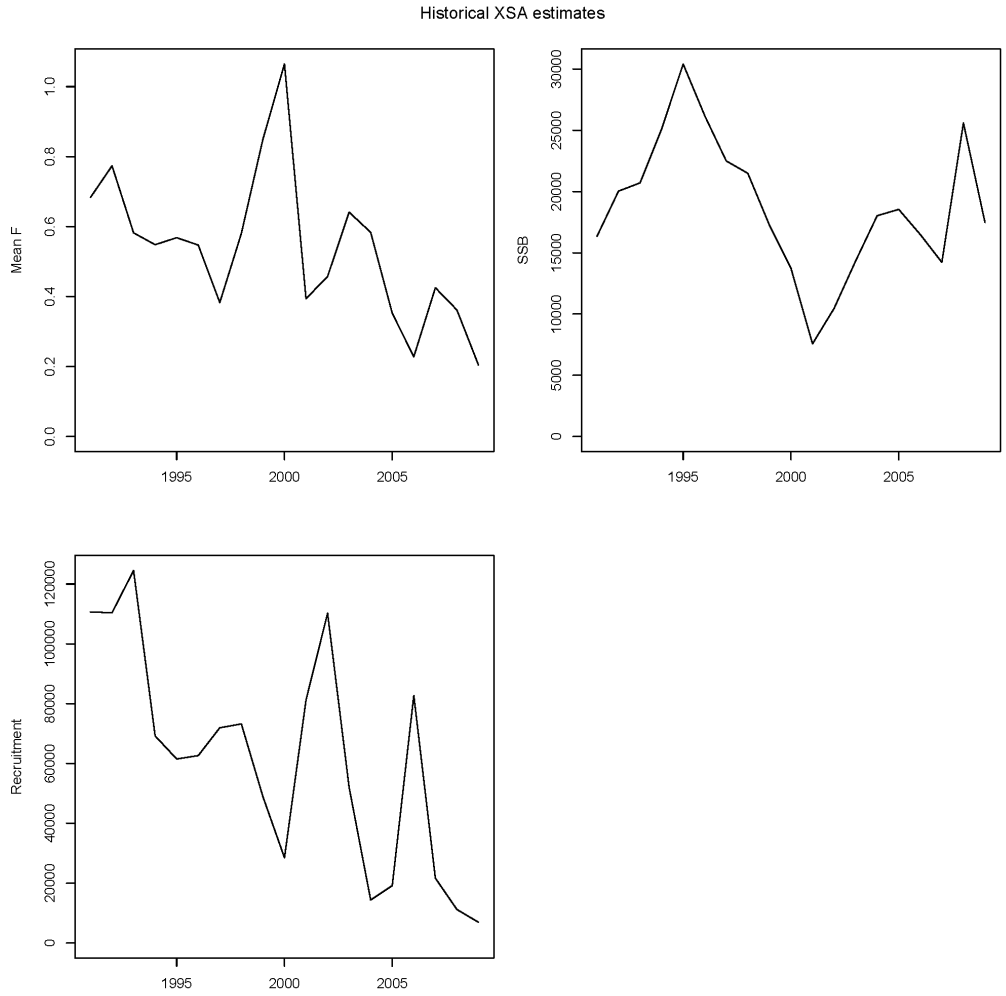


**Figure 6.1.b. Rockall haddock: historical XSA assessment summary for MSEs starting in 2010.**

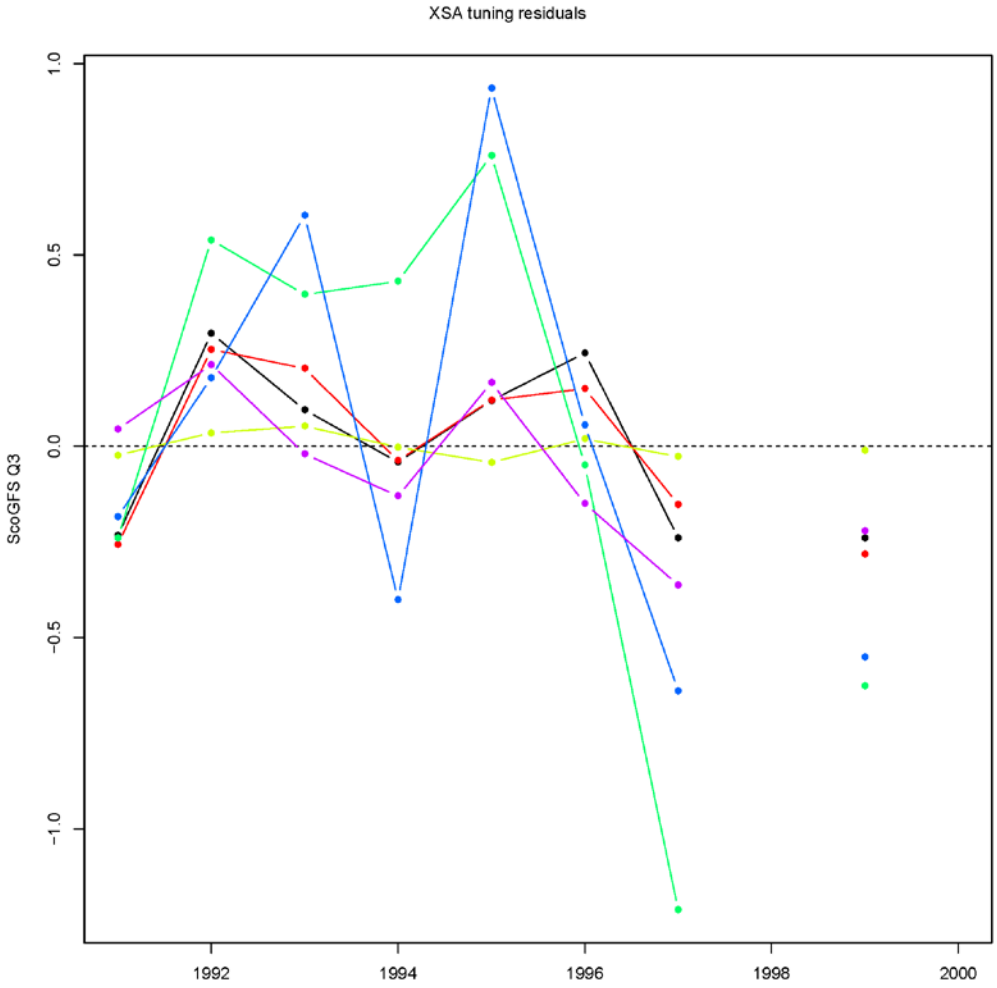


**Figure 6.2.a. Rockall haddock: historical XSA tuning residuals for MSEs starting in 2001. Each colour indicates an age-class.**

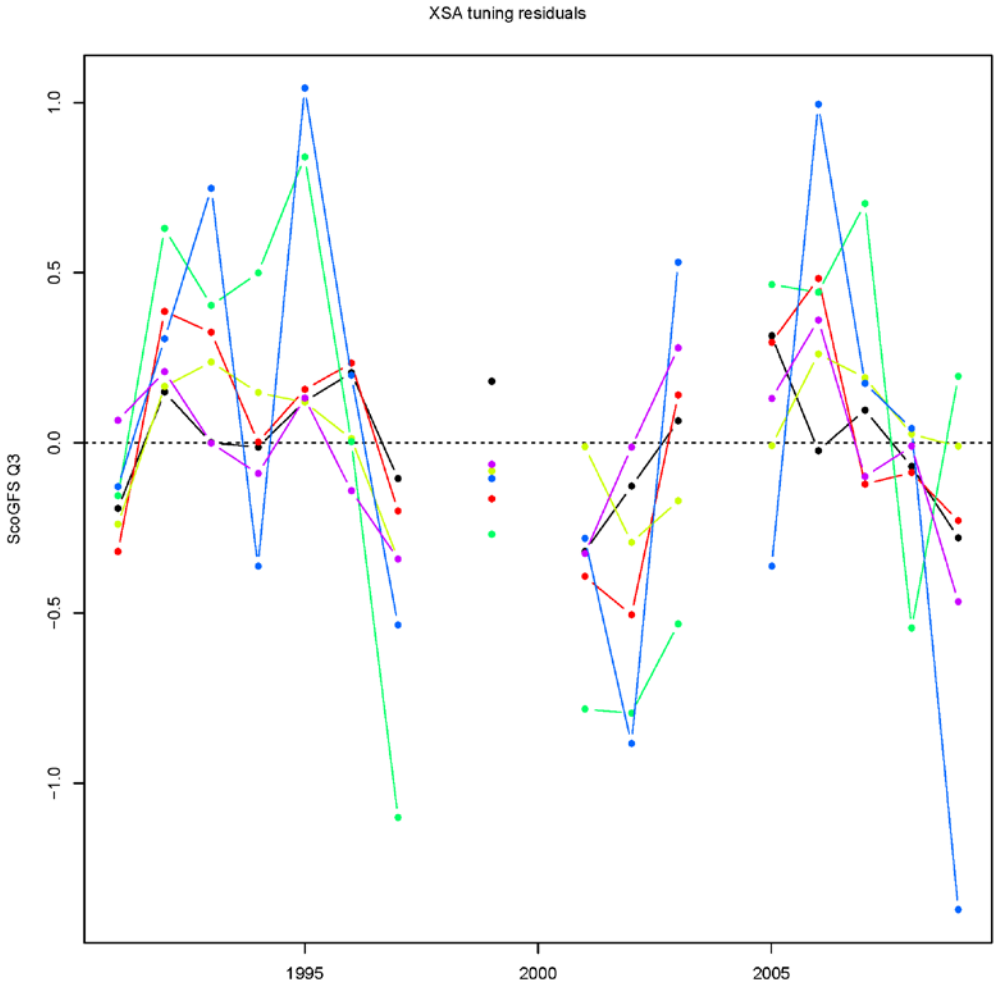


**Figure 6.2.b. Rockall haddock: historical XSA tuning residuals for MSEs starting in 2010. Each colour indicates an age-class.**

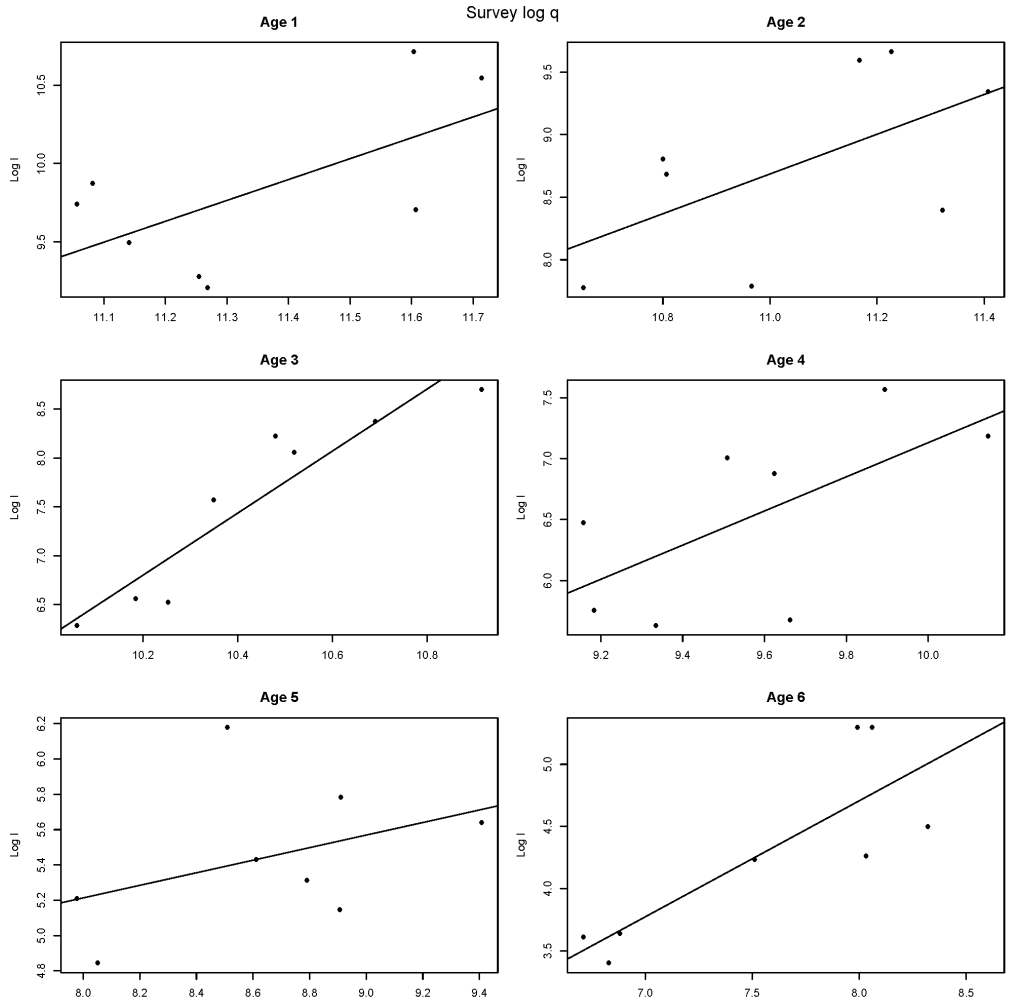


**Figure 6.3.a. Rockall haddock: log catchability models for survey ages 1-6 for MSEs starting in 2001. *x*-axis gives log stock abundance ln*N*, *y*-axis gives log survey abundance ln*I*, and the line gives best linear relationship ln$I = \alpha + \beta \ln N$.**

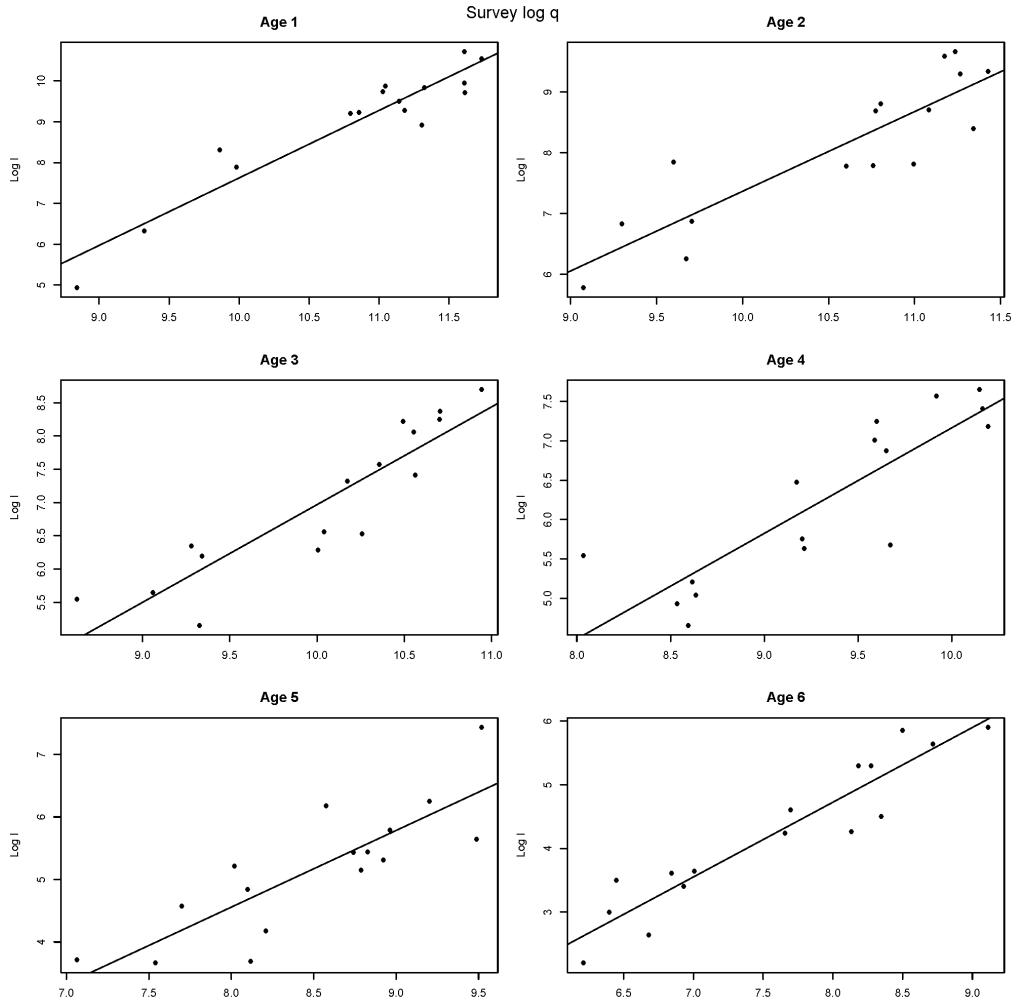


**Figure 6.3.b. Rockall haddock: log catchability models for survey ages 1-6 for MSEs starting in 2010. *x*-axis gives log stock abundance ln*N*, *y*-axis gives log survey abundance ln*I*, and the line gives best linear relationship ln$I = \alpha + \beta \ln N$.**

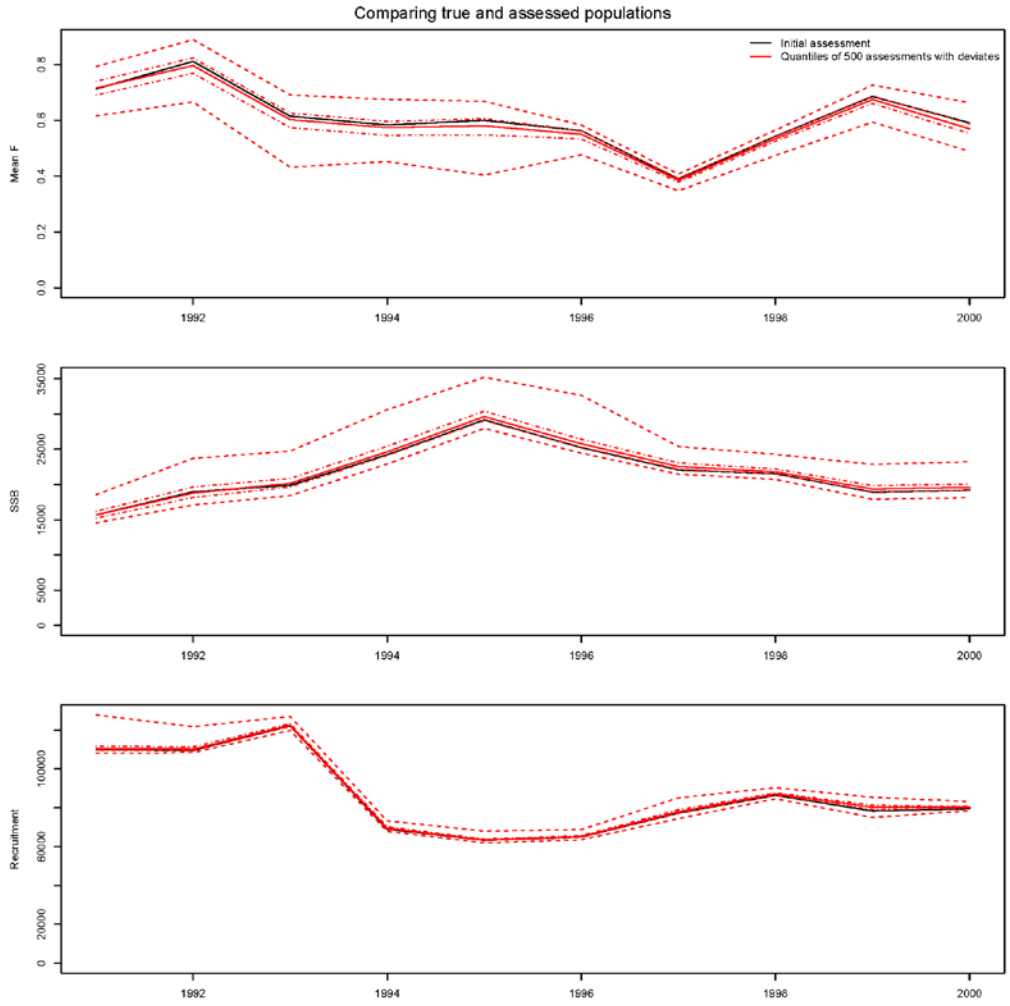


**Figure 6.4.a. Rockall haddock: bootstrapped historical XSA assessments for MSEs starting in 2001. Red lines give 10%, 25%, 50%, 75% and 90% quantiles.**

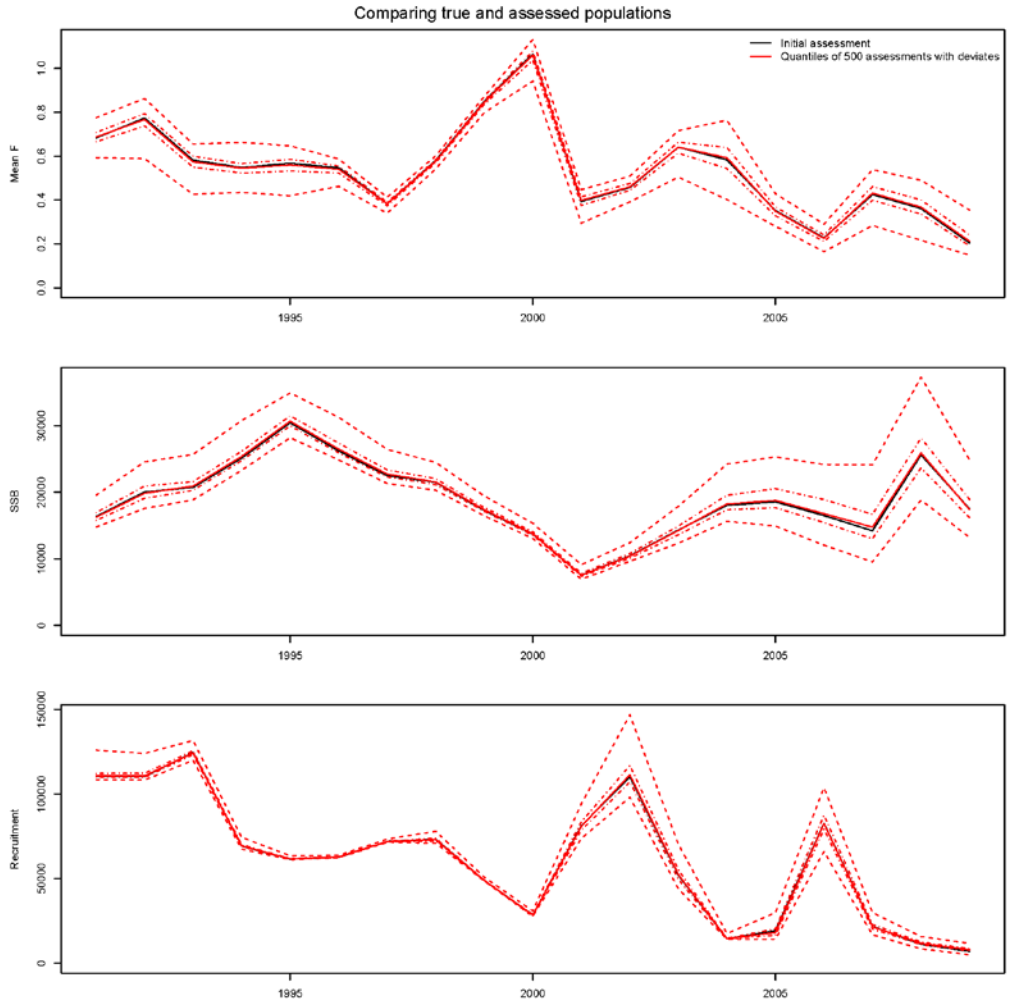


**Figure 6.4.b. Rockall haddock: bootstrapped historical XSA assessments for MSEs starting in 2010. Red lines give 10%, 25%, 50%, 75% and 90% quantiles.**

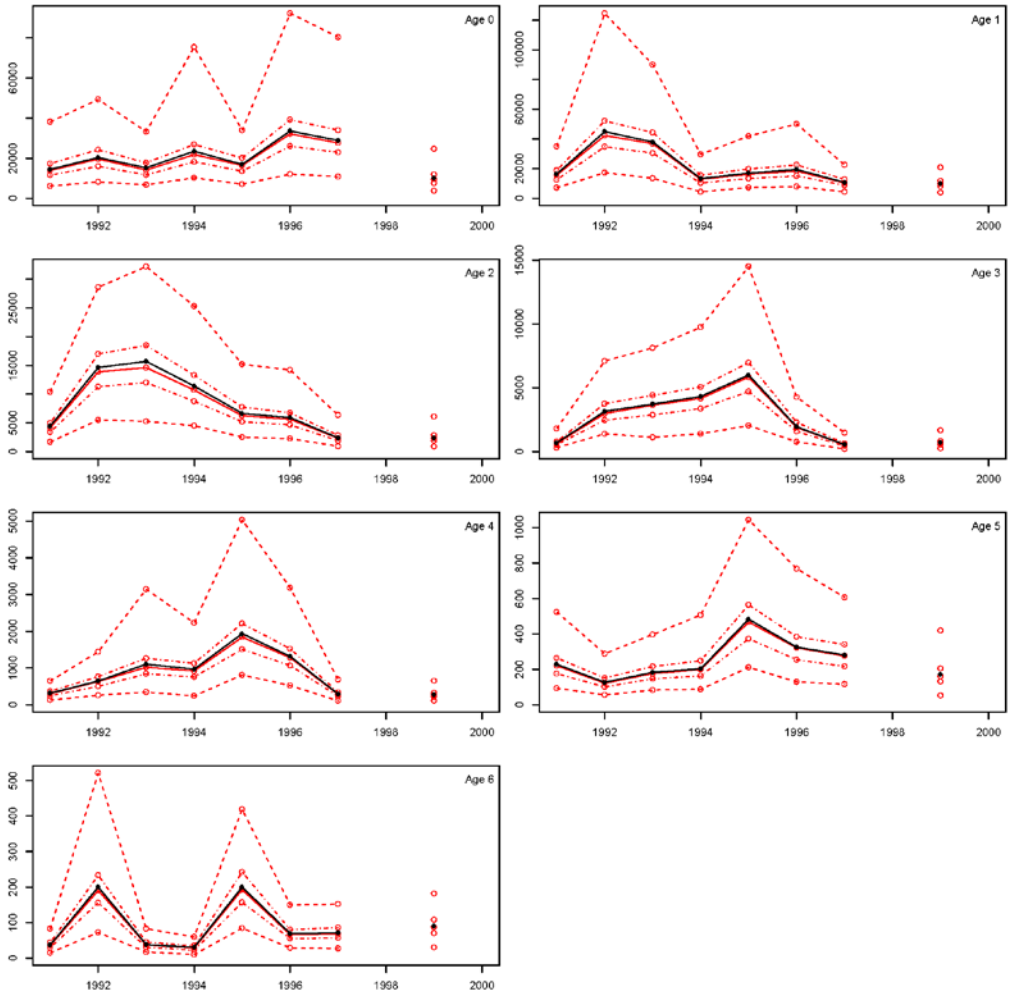


**Figure 6.5.a. Rockall haddock: bootstrapped historical survey indices for MSEs starting in 2001. Red lines give 10%, 25%, 50%, 75% and 90% quantiles.**

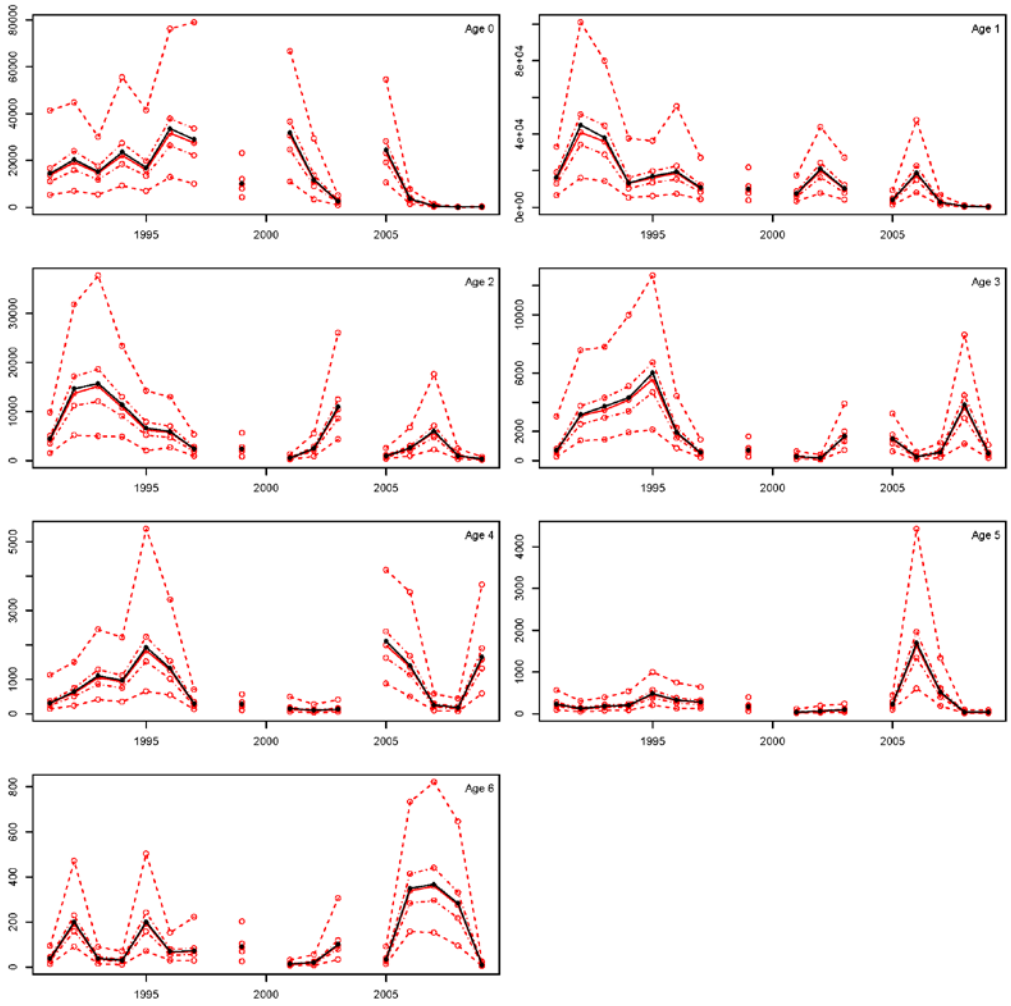


**Figure 6.5.b. Rockall haddock: bootstrapped historical survey indices for MSEs starting in 2010. Red lines give 10%, 25%, 50%, 75% and 90% quantiles.**

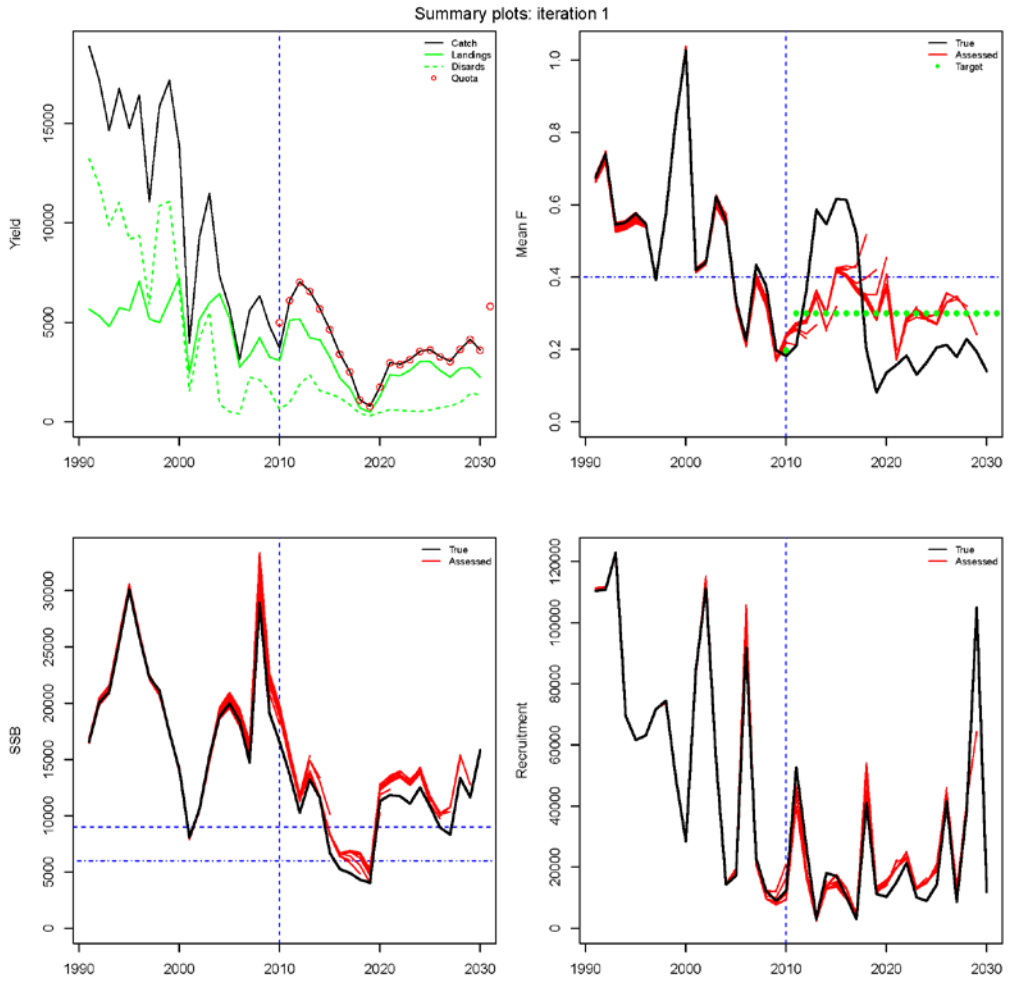


**Figure 6.6.a. Summary plots for one iteration of the Rockall haddock MSE. Recruitment CV was set to 1.0, the starting year to 2010, and years for fixed quota to 1. For all plots, the vertical blue line denotes the last historical year. Top left: total catch (black solid line). landings (green solid line) and discards (green dashed line). Red circles show the intended TAC for each year. Top right: time series of mean F, with true values in black while the assessed values from each year of the forward simulation are shown in red. Green dots indicate the intended mean F. The horizontal blue line shows the value of Fpa. The same colour scheme is used for SSB (bottom left; horizontal lines show Bpa and Blim) and recruitment (bottom right).**

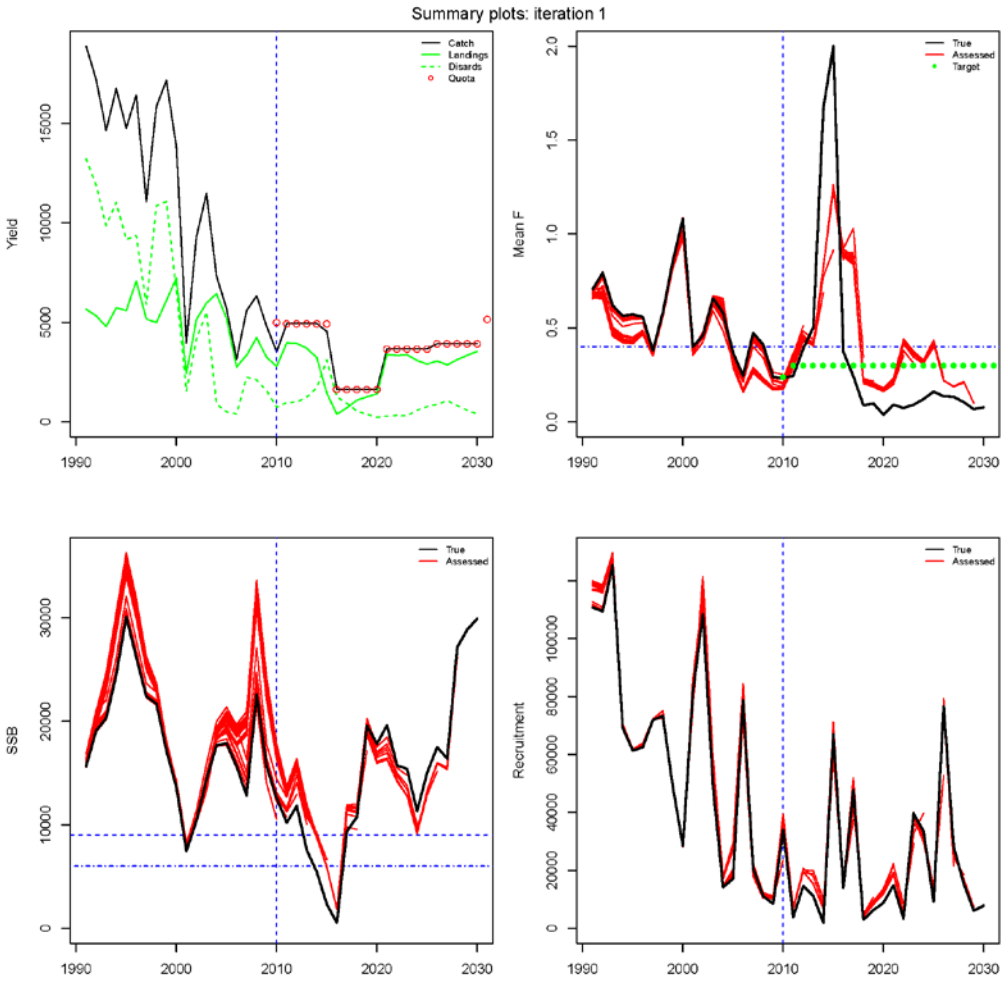


**Figure 6.6.b. Summary plots for one iteration of the Rockall haddock MSE. Recruitment CV was set to 1.0, the starting year to 2010, and years for fixed quota to 5. For all plots, the vertical blue line denotes the last historical year. Top left: total catch (black solid line). landings (green solid line) and discards (green dashed line). Red circles show the intended TAC for each year. Top right: time series of mean F, with true values in black while the assessed values from each year of the forward simulation are shown in red. Green dots indicate the intended mean F. The horizontal blue line shows the value of Fpa. The same colour scheme is used for SSB (bottom left; horizontal lines show Bpa and Blim) and recruitment (bottom right).**

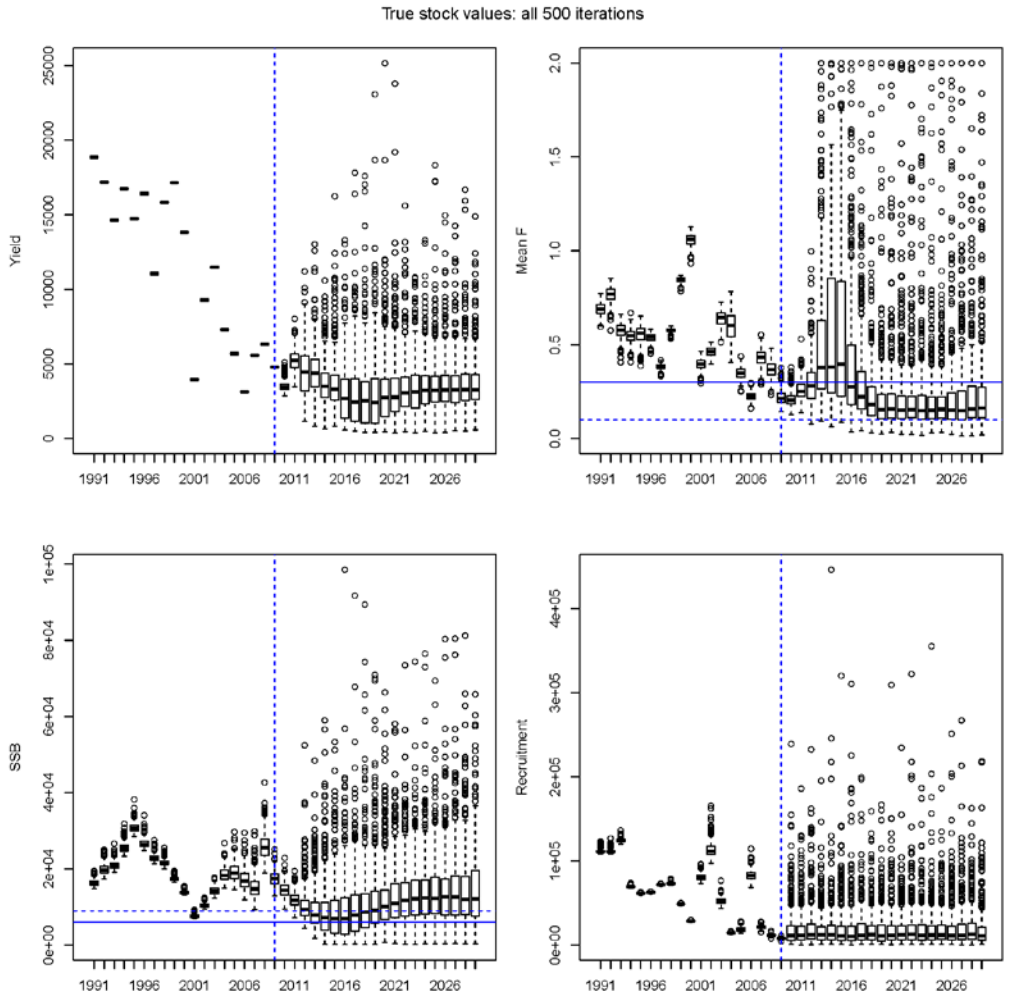


**Figure 6.7.a. True population values from the 500 simulation iterations. Recruitment CV was set to 1.0, the starting year to 2010, and years for fixed quota to 1. The short horizontal lines indicate the medians, and the boxes the quartiles (25%ile and 75%ile). The lower whisker gives the value of 25%ile–(1.5×(75%ile–25%ile)) and the upper gives 75%ile+(1.5×(75%ile–25%ile)). Outliers beyond this range are shown by open circles. The lines on the top-right plot show the target F (upper) and F =0.1 (lower), while those on the bottom-left plot show Bpa (upper) and Blim (lower). Vertical dashed blue lines show the last historical year.**

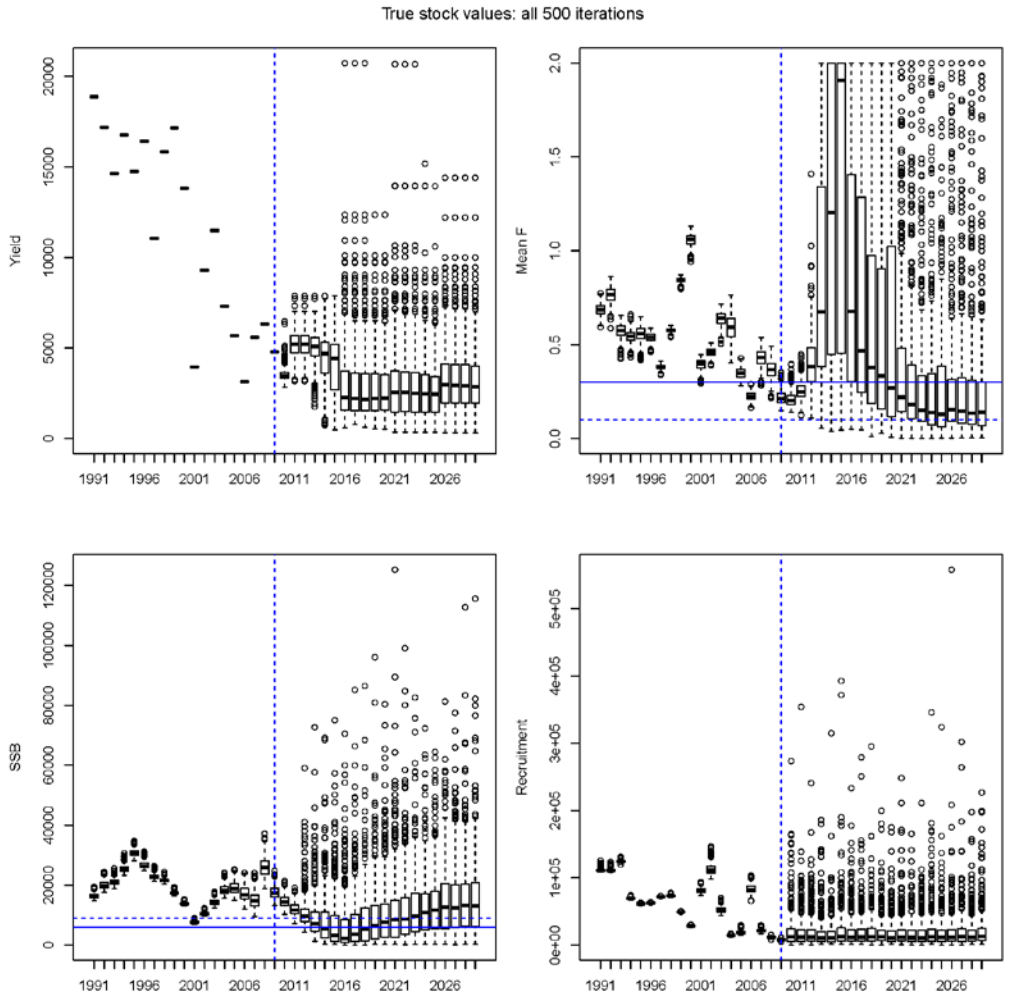


**Figure 6.7.b. True population values from the 500 simulation iterations. Recruitment CV was set to 1.0, the starting year to 2010, and years for fixed quota to 5. The short horizontal lines indicate the medians, and the boxes the quartiles (25%ile and 75%ile). The lower whisker gives the value of 25%ile–(1.5×(75%ile–25%ile)) and the upper gives 75%ile+(1.5×(75%ile–25%ile)). Outliers beyond this range are shown by open circles. The lines on the top-right plot show the target F (upper) and F =0.1 (lower), while those on the bottom-left plot show Bpa (upper) and Blim (lower). Vertical dashed blue lines show the last historical year.**

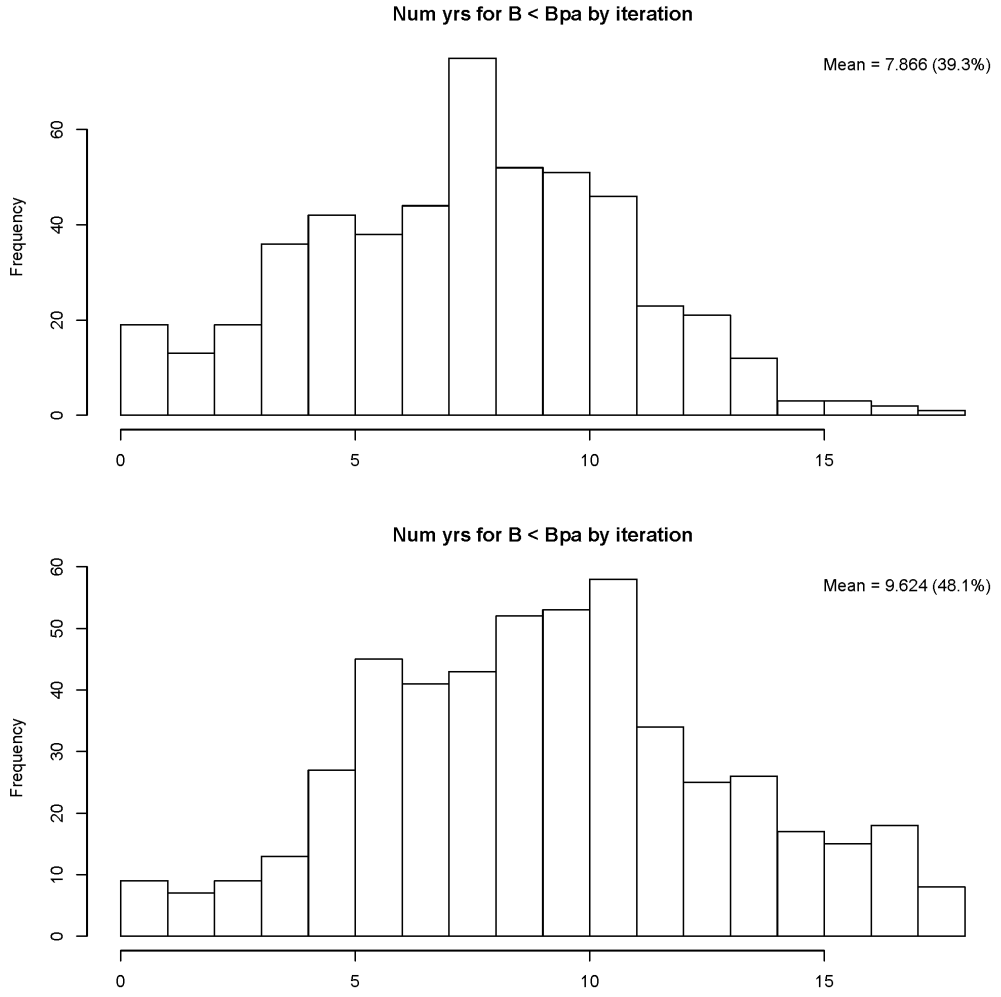


**Figure 6.8. Histograms of the number of years within each iteration (recruitment CV = 1.0, starting year 2010, and years for fixed quota = 1 (upper) or 5 (lower) in which SSB B < Bpa. The average number of years (out of a maximum total of 20) is given for each case, also expressed as a percentage of the total.**

## 6.4 Conclusions

The management strategy evaluations presented in this Section are intended to outline the basis of a methodology that could be used to determine the likely risk of changing from an annual to a multiannual quota system. This particular Rockall haddock MSE is still in an interim developmental stage, with further work planned for the WKROCKHAD meeting in May 2012 following ICES reviews in 2011, so it would not be appropriate to reach firm conclusions about the proposed Rockall haddock management on the basis of the results presented here. However, it is clear that any decision to change the frequency of advice or assessment is a management decision, and any potential consequences should be evaluated in a suitable management –oriented framework (such as an MSE). **WKFREQ concludes that, without quantitative evaluations of risk such as those presented here, it is difficult to see what decisions on assessment and advice frequency could be based on**.

# 7 Conclusions: Timetable and Frequency of Assessments

Defining the timetable and frequency of assessment involves a number of different considerations. Some of these are related to the assessments themselves, while others are related to the use of the assessments in the advisory process. While the price for a multiannual procedure can be defined in (for example) lost yield when compared to an annual assessment procedure, the political costs are less easy to specify but will generally become manifest as emergency procedures for a change midterm in the regulation; for example, strong pressure to reopen the decision process on the basis of (potentially) spurious observations of a stock increase.

The general model within which WKFREQ discussed the required frequency involves a multiannual decision, e.g. a multiannual TAC combined with an annual review of the decision. This review implies that stock monitoring remains annual and the possible savings from using a multiannual advisory/decision procedure therefore arise largely from the better use of the expertise and easing of the burden on the political decision system. However, the major costs associated with the advisory system are related to the monitoring, and these would remain under a system of multiannual decisions.

WKFREQ finds that careful consideration should be given to the design of a system that continuously monitors data, but only reopens assessments and advice when a signal is detected (i.e. somewhat of a "floating" schedule). The approach is analogous to sequential sampling, a methodology which is probably widely applicable to assessments.

An assessment has two main functions: to inform on the status of the stock and to provide a basis for advice on fisheries management. A depleted stock under a recovery plan would (from a biological conservation point of view) require more attention that would a stock at a high level. The political sensitivity could be related to ongoing negotiations and in that context perhaps the NEA mackerel might be a useful case: political sensitivity of course can be and often is related to depleted stocks. Industry may be more or less sensitive to the argument that you are putting the fish in the bank should your TAC be on the conservative side for a year, depending on the economic situation in the fishery. That is, the political pressure to take the last fish within sustainable limits or to meet the argument that because of hard times biological sustainability should have a lower priority than the economic status of the fisheries – perhaps the Barents Sea cod in recent years might be a useful example.

In conclusion: the desirable frequency of assessments depends initially on the ratio between the minimum change in stock status that should be detected and the uncertainty of the assessment. Therefore, WKFREQ considers that important parameters to be considered in determining assessment and advice frequency include the following:

1 ) The assessment model used and its uncertainty

2 ) Survey uncertainty

In order to provide guidance on the expected variability in the stock WKFREQ considered:

3 ) Recruitment variability

4 ) Initial state of the stock

Assessment scientists are still struggling to produce useful estimates of uncertainty (confidence limits) on stock estimates linked with our choice of assessment models.

Prediction are based on assumptions and one particular case is how best to estimate the recruiting year class. Predictions could include predictions of survey observations (with corresponding confidence limits), and an observation falling too far from the predicted could be used as a trigger to reopen the assessment. To investigate this further, we would need a long series of simulations to see how such a criterion would work given some of the issues that we are struggling with (catchability trends, biased catch at age matrix and so on). WKFREQ presented a case study based on Rockall haddock as an example on how such simulations based on the MSE framework could be constructed, and recommends that a quantitative evaluation process should be an essential element of any considerations on changing assessment and advice frequency.

5 ) The management approach

However, the usefulness of advice is also strongly related to the management approach. There may well be stocks where management is only considered if the stock becomes severely depleted. This is the thinking behind effort management where a constant fishing mortality rate of (for example) $F_{msy}$ could be applied as long as the stock productivity remains unchanged (there are other problems with this approach in particular in the definition of a standardised effort and in mixed fisheries).

Advisory Clients will evaluate the desirable frequency based on their needs. These needs are defined based on the political pressure to discuss the regulations and this involves

6 ) How well the fishery performs economically

7 ) Political sensitivity and how close NGOs and industry pay attention to TACs

This last point in particular relates very much to soft data that call for political judgement, and is definitely outside the quantitative analysis that can be made as part of an assessment procedure. However, these all remain real considerations. Clearly, Client input is central in discussion of the advisory frequency for a specific stock. An example where the political sensitivity calls for relative frequent assessment updates is sharks. These are under an FAO agreed action plan and the recurrent assessments – that repeat the deplorable status of many shark populations – are a part of maintaining these populations on the political agenda.

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