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Scientific, Technical and Economic Committee for Fisheries (STECF)

International dimension (STECF-12-11)

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SCIENTIFIC, TECHNICAL AND ECONOMIC COMMITTEE FOR FISHERIES (STECF)

International dimension (STECF-12-11)

THIS REPORT WAS REVIEWED DURING THE PLENARY MEETING HELD IN COPENHAGEN, DENMARK, 9-13 JULY 2012

Background

Considering that Fisheries Partnership Agreements (FPAs) signed between the EU and third countries shall be based on the best available scientific advice and following the UNCLOS, particularly its articles 61, 62 and 63, the Commission will have to request, on a regular basis, assessment, advice and management recommendations related to the "surplus" likely available to EU fleets on stocks and in waters covered by FPAs.

However, even if the concept of "surplus" may be considered as quite well described in Article 62 of the UNCLOS, no agreed method has been yet made available to allow calculations, particularly in case of lack of management objectives and strategies clearly expressed by the coastal State the fish stocks are distributed in water of. Difficulties faces are even worst when assessing possible "surplus" levels in the case of stocks shared at a sub-regional geographical level among several coastal States and in absence of common and constraining management framework initiated and supported, for instance, by an Regional Fisheries Organisation.

In addition some difficulties may also appear when assessing "transitional" time periods, considering paths from an initial situation to a situation where the exploitation patterns would finally be compatible with stocks delivering MSY.

In the past, STECF was already asked to deliver recommendations on "surplus" levels in the context of Western African fisheries. Nevertheless, no agreement has been reached till yet on methodologies to be applied.

That's why the Commission would like to entrust the STECF with a discussion and possible recommendations leading to a endorsed methodology, sufficiently robust to address difficulties already indentified and to allow later calculations.

Request to the STECF

STECF was requested:

1) To discuss the concept of "surplus", based on the definition given in UNCLOS texts and taking into account the specific context of
   a) shared stocks (*e.g.* small pelagic species on the Western African coast);
   b) transitional periods of time, before having reached reference management points (e.g; how to consider the surplus if indicators of a specific fishery are still not at the management reference values agreed by fisheries policy makers and managers ?);

2) To discuss assessment models, indicators and management references points used for stocks of small pelagic and demersal species distributed in Western African Waters or in Waters of the Gulf of Guinea;
3) To suggest possible methods to evaluate surplus values, depending on
   a) the type of data available
   b) the type of assessment models used (*e.g.* such methods should distinguish between poor-data stocks and stocks where assessment would have been delivered using surplus production models or analytical models).
4) To deliver some first calculations, particularly for mixed FPAs of the Western African area.

STECF observations

The report of STECF EWG 12-04 is available here https://stecf.jrc.ec.europa.eu/reports/strategic-issues.

The EWG-12-04 has provided a qualitative and quantitative analysis of the concept of "surplus" (*sensu* UNCLOS) as used in FPAs between EU and Western Africa countries for stocks of small pelagic and demersal species distributed in Western African Waters or in Waters of the Gulf of Guinea. The EWG-12-04 has also evaluated assessment models, indicators and management references points to be used for the assessment and management of these stocks and proposed methods to calculate surplus values, including estimation of associated uncertainty.

STECF conclusions

STECF draws the following conclusions from the STECF EWG-12-04 report:

1. STECF notes that the concept of "surplus" defined in UNCLOS is somehow misleading due to the general meaning of the word “surplus”. There is a risk to consider “*surplus of the allowable catch*” as a fraction of the biomass that can be taken without any negative impact on the local fisheries or on the other parts of the ecosystem, which is obviously not true.

Computing surplus (**S**) relies on two elements, the stock’s potential (sustainable) catch (**Y**) and the coastal State potential catch (**C**):

S = Y - C

Although the definition of “surplus” seems to be simple from a theoretical point of view and all conditions for its implementation taken into account by UNCLOS, in practice it is based on two quantities, which are not simple to estimate and combine. It requires reliable fisheries statistics to estimate the coastal State potential catches and a quantitative stock assessment to estimate the stock’s potential (sustainable) catch.

2. STECF considers that the ICES framework (i.e. SISAM 2012, Introduction to Advice 2012; www.ices.dk) provides a useful basis for classifying stocks based on available information to identify suitable assessment methods. CECAF may wish to consider adopting that framework for its assessment working groups.

3. STECF notes that MSE simulations were developed to explore problems associated with the underestimation of catches, abundance index quality, lags between assessments, over-catch, alternative assessment models, and alternative management procedures based on catches and abundance observations. Most scenarios showed a large uncertainty regarding the estimation of the assessment model parameters and the related MSY reference points. The effect of the underestimation of catches was not so clear due to technical limitation about the relationship between underreporting and implementation error. The alternative management procedures may deliver stability of biomass and catches at a level that is not dangerous for the stock, but further investigation is required to fully understand the risks associated with each.

Three methods were developed to compute the coastal State potential catches, (i) maintain the fishing effort of the coastal State at a constant level, (ii) maintain the proportion of catches of the coastal State constant, or (iii) maintain a constant catch for the coastal State. Additionally, if the coastal State plans to develop its own fisheries, surplus catches must be computed on a case-by-case basis. This of course, requires that any development plans by the coastal state need to be made available.

The methods were tested using two examples based on *S.aurita* population dynamics, one over-exploited and another under-exploited, in an attempt to better understand the characteristics of the proposed estimators. When the stock is over-exploited by the coastal state alone, the harvest rate of the coastal state will have to decrease to achieve the management target and surplus is zero. Applying method (ii) to the over-exploited stock results in a lower harvest rate by the coastal state and there is a correspondingly higher surplus. However this results in a lower yield for the coastal state than when method (i) is applied. When the stock is under-exploited there is less of contrast between applying method 1 and method 2. Method 1 is able to maintain the harvest rate of the coastal state at the current level whereas under method 2 the harvest rate is slightly higher. The surplus is higher under method 1 and the yield of the coastal state is higher under method 2. In all of the above cases, the results are different depending on the status of the stock.

4. STECF notes that the methods to estimate surplus were tested on three real case studies, *S.aurita* in West Africa, *T.trecae* in West Africa and *P.longirostris* in Mauritania, to provide preliminary estimates of surplus. These stocks were assessed by CECAF and estimates of F_{MSY} and MSY based on a Biodyn model were used in the exercise. For *S.aurita* a MCMC methodology was applied to compute the variability of the model parameters and project it throughout surplus computations, showing the large uncertainty associated with these estimates. The results obtained and presented in the EWG report must be considered preliminary and require further in-depth assessment of their uncertainty before being used for management.

STECF notes that estimating surplus values is a complex process, and frequently produces estimates that are highly uncertain. Furthermore, the robustness of the estimates of MSY and coastal State potential catches to uncertainty in underlying factors is poor, resulting in a potential lack of robustness of the surplus estimates.

STECF recommendations

STECF recommends that FPAs be based on management plans, which should include management objectives, harvest control rules, TAC or effort allocation keys and should be supported by data collection programs, scientific advice and monitoring.

For practical purposes STECF recommends that in the context of FPAs, the estimated surplus should be used to allocate the EU fleet's share of a TAC or effort arising from a management plan.

REPORT TO THE STECF

EXPERT WORKING GROUP ON INTERNATIONAL DIMENSION (EWG-12-04)

Varese, Italy, 4-8 June 2012

1 EXECUTIVE SUMMARY

Fisheries Partnership Agreements (FPAs) signed between the EU and third countries shall be based on the best available scientific advice and following UNCLOS (1982), particularly articles 61, 62 and 63. To achieve such objective the European Commission (EC) will have to request, on a regular basis, assessment, advice and management recommendations related to the available "surplus" to European Union (EU) fleets on stocks and in waters covered by FPAs.

STECF was requested to provide scientific advice to the EC on this subject and set up the Expert Working Group on the International Dimension of the Common Fisheries Policy (EWG 12-04), which was asked to (i) discuss the UNCLOS concept of "surplus", (ii) discuss assessment models, indicators and management references points used for stocks of small pelagic and demersal species distributed in Western African Waters or in Waters of the Gulf of Guinea, (iii) suggest possible methods to evaluate surplus values, and (iv) deliver some first calculations for *S.aurita* and *T.trecae*.

The EWG convened in Varese, Italy, between the 4th and 8th of June. The first ToR was addressed from a wide perspective starting from UNCLOS (1982) text and discussing the implications it may have on CFP implementation and FPA negotiations. For the second ToR the group built on the recent work produced by ICES on assessment methods and data requirements and adapted to the CECAF's framework, followed by an exercise with CECAF's stocks under FPA. The third ToR built on the achievements of ToR 1) with relation to the computation of surplus and developed in two paths, one dealing with uncertainty on the estimation of MSY and another where distinct methods to compute the coastal State catches are described. The EWG used Management Strategy Evaluation (MSE) and *S. aurita* dynamics to test by simulation the definitions suggested. At last, a first attempt to apply the methods developed in ToR 3) was carried out using *Sardinella aurita* in West Africa, *Trachurus trecae* in West Africa and *Parapenaeus longirostris* in Mauritania, followed by an analysis of the variability associated with the computation of surplus using MCMC and stochastic projections.

The EWG considered the concept defined in UNCLOS misleading due to the general meaning of the word "surplus". There is a risk to consider "*surplus of the allowable catch*" as a fraction of the biomass that can be taken without any negative impact on the local fisheries or on the other parts of the ecosystem, which is obviously not true, *e.g.*it will have an impact on the coastal State CPUE, it may induce habitat destruction, etc.

As defined by UNCLOS, the surplus catch is the stock's annual potential catch minus the potential catch of the national fleet according to its "*capacity to harvest the entire allowable catch*", which STECF interprets as "*the total fishing effort (defined by the fleet capacity and its potential activity) the coastal country is able to apply for the exploitation of its EEZ resources*" (STECF, 37th plenary meeting, July 2011). As a matter of fact, the catch surplus (**S**) is obtained by removing the coastal State potential catch (**C**) of the stock's potential (sustainable) catch (**Y**), **S = Y – C**.

Although the definition of "catch surplus" seems to be simple from a theoretical point of view and all conditions for its implementation taken into account by UNCLOS, in practice it is based on two quantities, total allowable catches or effort and coastal State capacity to harvest the stock, which are not simple to estimate and combine. It requires reliable fisheries statistics to estimate the coastal State potential catches and a quantitative stock assessment to estimate the stock's potential. In fact, the EWG's understanding is that implementing the surplus concept requires the existence of formal fisheries management and monitoring systems, which is rarely the case for Western African stocks.

When transition periods are required to bring the stocks to maximum sustainable levels of exploitation, these should be treated as a different problem from surplus. During the transition period surplus and the coastal State potential catches are computed using a reference catch which is above MSY, following the decision made about the trajectory to get to MSY or other long term management objective.

The EWG categorized stocks within the CECAF area that are subject to FPA, according to the amounts and/or types of data available using the ICES framework and successively linked to a given methodology to provide quantitative advice. This framework defines assessment and advice methodologies taking into account the available data. It should be considered as a general framework and thus not linked with any specific area or management body. The classification suggested is useful for organizing information about available approaches and subsequently providing a guide helpful for the assessment working group in the selection of the most appropriate approaches to consider for stock assessment. The stocks considered don't have ageing information and those assessed use biomass dynamic models with several abundance indices.

MSE simulations were designed to give insights about the computation of surplus by looking at the factors that could have an impact on the estimation of MSY. A set of management scenarios were developed to test the effect of underestimation of catches, abundance index low quality, lags between assessments, over-catch and alternative assessment models. Furthermore, two alternative management procedures based on catches and abundance observations were tested to evaluate the possibility of managing the stocks without having a stock assessment. Most scenarios showed a large impact on the estimation of MSY. The effect of underreporting was not so clear due to technical limitations about the relationship between underreporting and implementation error. The alternative management procedures may deliver stability of biomass and catches at a level that is not dangerous for the stock, but further investigation is required to fully understand the risks associated.

Three options to compute the coastal State potential catches were developed, (1) maintain the proportion of fishing effort of the coastal State constant, (2) maintain the proportion of catches of the coastal State constant, or (3) maintain a constant catch for the coastal State. Additionally, if the coastal State is willing to develop its own fisheries surplus catches must be computed in a case-by-case basis as long as the development plans of the coastal state are available. These methods have distinct results depending on the status of the stock. When the stock is over-exploited by the coastal state alone, the harvest rate of the coastal state will have to decrease to achieve the management target and surplus is zero. Applying method 2 to the over-exploited stock results in a lower harvest rate by the coastal state and there is a correspondingly higher surplus. However this results in a lower yield for the coastal state than when method 1 is applied. When the stock is under-exploited there is less of contrast between applying method 1 and method 2. Method 1 is able to maintain the harvest rate of the coastal state at the current level whereas under method 2 the harvest rate is slightly higher. The surplus is higher under method 1 and the yield of the coastal state is higher under method 2.

The methods to estimate surplus were tested on three real case studies, *S.aurita* in West Africa, *T.trecae* in West Africa and *P.longirostris* in Mauritania, to provide preliminary estimates of surplus. These stocks were assessed by CECAF and estimates of Fmsy and MSY based on a Biodyn model were used in the exercise. The results obtained must be considered preliminary and require a more detailed assessment of their uncertainty before being used for management. The EWG used statistical methods to estimate the uncertainty of surplus in two examples based on *S.aurita* population dynamics, one over-exploited and another under-exploited. The exercise aimed at a better understanding of the characteristics of the estimators being proposed, show the kind of uncertainty one should expect for the estimation of surplus and describe a methodology to estimate surplus uncertainty.

The EWG highlighted the following suggestions to STECF:

- The EWG suggests that the methods described to compute surplus catches are used simultaneously and fully explored to understand exactly the implications of exploiting the stocks integrated in FPA.
- The EWG suggests assessment uncertainty to be carried over into surplus computations to identify the full range of surplus values.
- The EWG encourage the coastal states to monitor and reduce IUU to decrease uncertainty on surplus computation.

- The EWG suggests that fishing protocols associated with FPA consider intermediate revisions of surplus catches, to integrate the most updated scientific information and avoid exploiting stocks at levels not consistent with EU policies.
- The EWG notes that not having clear and formalized management plans makes it very difficult to compute surplus and guarantee that EU fleets are not contributing to unsustainable exploitation.
- The EWG notes that if a coastal State or states have specific fisheries development plans, where forecasts of fleet development are described, it is possible to compute surplus taking into account the coastal State development objectives.
- The EWG suggests CECAF to coordinate with ICES on the development of assessment and advice methodologies, to take advantage of the recent work done by ICES.
- The EWG encourage the transboundary co-management of migratory coastal species or shared stocks,

- The EWG suggests MSE analysis to be run for stocks to be taken into account by FPA, to have an in-depth view of the EU fleets' impacts considering as much uncertainty as possible.

2 CONCLUSIONS OF THE EXPERT WORKING GROUP

The concept defined in UNCLOS is somehow misleading due to the general meaning of the word "surplus". There is a risk to consider "*surplus of the allowable catch*" as a fraction of the biomass that can be taken without any negative impact on the local fisheries or on the other parts of the ecosystem, which is obviously not true, *e.g.* lower CPUE, discards, habitat destruction, etc.

Computing surplus (**S**) relies on two elements, the stock's potential (sustainable) catch (**Y**)and the coastal State potential catch (**C**).

$$\mathbf{S = Y - C}$$

Although the definition of "catch surplus" seems to be simple from a theoretical point of view and all conditions for its implementation taken into account by UNCLOS, in practice it is based on two quantities, which are not simple to estimate and combine. It requires reliable fisheries statistics to estimate the coastal State potential catches and a quantitative stock assessment to estimate the stock's potential.

The EWG notes that the implementation of the surplus concept requires the existence of formal fisheries management and monitoring systems which is rarely the case for Western African stocks.

The classification based on the ICES framework suggested for stocks within the CECAF area that are subject to FPA, is useful for organizing information about available approaches and subsequently providing a guide helpful for the assessment working group in the selection of the most appropriate approaches to consider for stock assessment. The stocks considered don't have ageing information and those assessed use biomass dynamic models with several abundance indices.

MSE simulations were developed to test common problems with stocks under FPAs, in particular underestimation of catches, abundance index quality, lags between assessments, over-catch, alternative assessment models, and alternative management procedures based on catches and abundance observations. Most scenarios showed a large impact on the estimation of MSY. The effect of underreporting was not so clear due to technical limitation about the relationship between underreporting and implementation error. The alternative management procedures may deliver stability of biomass and catches at a level that is not dangerous for the stock, but further investigation is required to fully understand the risks associated.

Three options to compute the coastal State potential catches were developed, (i) maintain the proportion of fishing effort of the coastal State constant, (ii) maintain the proportion of catches of the coastal State constant, or (iii) maintain a constant catch for the coastal State. Additionally, if the coastal State is willing to develop its own fisheries surplus catches must be computed in a case-by-case basis as long as the development plans of the coastal state are available. These methods have distinct results depending on the status of the stock. When the stock is over-exploited by the coastal state alone, the harvest rate of the coastal state will have to decrease to achieve the management target and surplus is zero. Applying method (ii) to the over-exploited stock results in a lower harvest rate by the coastal state and there is a correspondingly higher surplus. However this results in a lower yield for the coastal state than when method (i) is applied. When the stock is under-exploited there is less of contrast between applying method 1 and method 2. Method 1 is able to maintain the harvest rate of the coastal state at the current level whereas under method 2 the harvest rate is slightly higher. The surplus is higher under method 1 and the yield of the coastal state is higher under method 2.

The methods to estimate surplus were tested on three real case studies, *S.aurita* in West Africa, *T.trecae* in West Africa and *P.longirostris* in Mauritania, to provide preliminary estimates of surplus. These stocks were assessed by CECAF and estimates of Fmsy and MSY based on a Biodyn model were used in the exercise. The results obtained must be considered preliminary and require a more in depth assessment of their uncertainty before being used for management.

Statistical methods were used to estimate the uncertainty of surplus in two examples based on *S.aurita* population dynamics, one over-exploited and another under-exploited. The exercise aimed at a better understanding of the characteristics of the estimators being proposed, show the kind of uncertainty one should expect for the estimation of surplus and describe one possible methodology to estimate surplus uncertainty.

3 RECOMMENDATIONS OF THE EXPERT WORKING GROUP

- The EWG suggests that the methods described to compute surplus catches are used simultaneously and fully explored to understand exactly the implications of exploiting the stocks integrated in FPA.
- The EWG suggests assessment uncertainty to be carried over into surplus computations to identify the full range of surplus values.
- The EWG encourage the coastal states to monitor and reduce IUU to decrease uncertainty on surplus computation.
- The EWG suggests that fishing protocols associated with FPA consider intermediate revisions of surplus catches, to integrate the most updated scientific information and avoid exploiting stocks at levels not consistent with EU policies.
- The EWG notes that not having clear and formalized management plans makes it very difficult to compute surplus and guarantee that EU fleets are not contributing to unsustainable exploitation.
- The EWG notes that if a coastal State or states have specific fisheries development plans, where forecasts of fleet development are described, it is possible to compute surplus taking into account the coastal State development objectives.
- The EWG suggests CECAF to coordinate with ICES on the development of assessment and advice methodologies, to take advantage of the recent work done by ICES.
- The EWG encourage the transboundary co-management of migratory coastal species or shared stocks,
- The EWG suggests MSE analysis to be run for stocks to be taken into account by FPA, to have an in-depth view of the EU fleets' impacts considering as much uncertainty as possible.

4 INTRODUCTION AND TERMS OF REFERENCES

4.1 Introduction

The EWG was held in Varese, between the 4th and 8th of June to deal with several issues related with the international dimensions of the CFP. The ToR given were discussed and the EWG decided to take the following approach to deal with the request made.

ToR 1) was addressed from a wide perspective starting from UNCLOS (1982) text and discussing the implications it may have on CFP implementation and FPA negotiations. The group avoided linking the discussion to any particular case as much as possible.

With regards to ToR 2) the group built on the recent work produced by ICES on assessment methods and data requirements and adapted to the CECAF's framework. An exercise of application of the ICES framework to the stocks assessed by CECAF which are under FPA was performed.

ToR 3) built on the achievements of ToR 1) with relation to the computation of surplus and developed in two paths, one dealing with uncertainty on the estimation of MSY considering the most likely factors to affect the stocks subject to FPA, and another where distinct methods to compute the coastal State catches are described. The EWG used Management Strategies Evaluation to run simulation testing and using *S.aurita* dynamics to condition the operating model. Successively, the methods were applied to 2 simulated stocks with different levels of exploitation to illustrate the characteristics of the methods developed.

For ToR 4) a first attempt to apply the methods developed in ToR 3) to a set of real stocks was carried out, followed by an analysis of the variability associated with the computation of surplus using MCMC and stochastic projections.

4.2 Terms of Reference for EWG-12-04

STECF was requested:

1) To discuss the concept of "surplus", based on the definition given in UNCLOS texts and taking into account the specific context of
   a) shared stocks (*e.g.* small pelagic species on the Western African coast);
   b) transitional periods of time, before having reached reference management points (e.g; how to consider the surplus if indicators of a specific fishery are still not at the management reference values agreed by fisheries policy makers and managers ?);
2) To discuss assessment models, indicators and management references points used for stocks of small pelagic and demersal species distributed in Western African Waters or in Waters of the Gulf of Guinea;
3) To suggest possible methods to evaluate surplus values, depending on
   a) the type of data available
   b) the type of assessment models used (*e.g.* such methods should distinguish between poor-data stocks and stocks where assessment would have been delivered using surplus production models or analytical models).
4) To deliver some first calculations, particularly for mixed FPAs of the Western African area.

5 DEFINITION OF "SURPLUS" BASED ON THE UN CONVENTION ON THE LAW OF THE SEA(UNCLOS, 1982)

The EWG was requested to discuss the concept of "surplus", based on the definition given by the UN Convention on the Law of the Sea (UNCLOS, 1982) and taking into account the specific context of: a) shared stocks (*e.g.* small pelagic species on the Western African coast), and b) transitional periods of time, before having reached reference management points (e.g; how to consider the surplus if indicators of a specific fishery are still not at the management reference values agreed by fisheries policy makers and managers).

The concept of surplus is defined by Art. 62.2 of the UN Convention on the Law of the Sea (UNCLOS, 1982) as:

The coastal states shall determine their capacity to harvest the living resources of the Exclusive Economic Zone (EEZ). Where the coastal states do not have the capacity to harvest the entire allowable catch, it shall, through agreements or other arrangements and pursuant to certain terms, conditions, laws and regulations [⋯], give other states access to the surplus of the allowable catch [⋯].

The concept defined in UNCLOS is somehow misleading due to the general meaning of the word "surplus". There is a risk to consider "*surplus of the allowable catch*" as a fraction of the biomass that can be taken without any negative impact on the local fisheries or on the other parts of the ecosystem, which is obviously not true, *e.g.* lower CPUE, discards, habitat destruction, etc.

In all fisheries, interactions between fleets exploiting the same stock do exist. Thus accepting a foreign fishery in a given EEZ necessarily affects the abundance of the stock and thus the CPUE of the coastal fleets exploiting the same stock. This will likely affect the profitability of the coastal fleet segment, with negative economic and social consequences.

Furthermore, each stock is part of the ecosystem and any catch may induce some changes in the ecosystem functioning (see also STECF, 38th plenary meeting, November 2011). These aspects are currently poorly understood and its quantification is complex. Nevertheless ecosystem approaches have been encouraged, with the long term objective of assessing the whole consequences of any fisheries management that includes harvesting the surplus.

UNCLOS (1982) Art. 61 is strongly related to Art. 62, where surplus is defined. In points 61.1.and 61.2 it allocates the responsibility for a sustainable management of the stocks in light of the best scientific evidence to the coastal State, by stating that "*The coastal State shall determine the allowable catch of the living resources in its exclusive economic zone*" and "*The coastal State, taking into account the best scientific evidence available to it, shall ensure through proper conservation and management measures that the maintenance of the living resources in the exclusive economic zone is not endangered by over-exploitation [...].*"In point 61.3 the Convention defines fisheries management objectives, stating that the coastal State should "*maintain or restore populations of harvested species at levels which can produce the maximum sustainable yield, as qualified by relevant environmental and economic factors*". Later agreements[1] (Nagoya 2010) set 2020 as the deadline to achieve MSY. At last, point 61.5 states that data and scientific information must be exchanged under the remit of competent international organizations through "*available scientific information, catch and fishing effort statistics, and other data relevant to the conservation of fish stocks shall be contributed and exchanged on a regular basis through competent international organizations [...]*".

Art. 62 also defines that when giving access rights to other States, the coastal State shall take into account economic situation, fishing history and research efforts of states, by stating that "*[...] the coastal State shall take into account all relevant factors, including, [...] the requirements of developing States in the subregion or region in harvesting part of the surplus and the need to minimize economic dislocation in States whose nationals have habitually fished in the zone or which have made substantial efforts in research and identification of stocks*".

[1]Decision adopted by the Conference of the Parties to the Convention on Biological Diversity at its Thenth Meeting, The Strategic Plan for Biodiversity 2011-2020 and the Aichi Biodiversity Targets. Nagoya, Japan, 18-29 October 2010

As defined by UNCLOS, the surplus catch is the stock's annual potential catch minus the potential catch of the national fleet according to its "*capacity to harvest the entire allowable catch*", which STECF interprets as "*the total fishing effort (defined by the fleet capacity and its potential activity) the coastal country is able to apply for the exploitation of its EEZ resources*" (STECF, 37th plenary meeting, July 2011). In other words, "surplus" is the remaining fraction of the allowable catch after removing the coastal State catches taking into account the coastal States fishing capacity.

Assuming that the coastal state has decided to exploit its stocks at MSY level, this means that the surplus catch in a given year is equal to the catch corresponding to the agreed harvesting minus the potential catch of the coastal State.

With regards to transition periods the EWG considers these should be treated as a different problem from surplus. During the transition period the surplus and the coastal State potential catches are computed using a reference catch which is above MSY, following the decision made about the trajectory to get to MSY or other long term management objective. However, the methods to compute surplus remain valid.

All these rules that formalize how the stock should be harvested depending of specific conditions, are referred as harvest control rule (HCR) and should be part of the management plan for each stock or group of stocks.

Since 2002 the EC is looking for applying the principle of surplus catches when protocols are renewed or when new agreements are concluded with third countries, in particular for mixed FPA (COM(2002) 637 final).

5.1 Comments on the surplus definition and calculation

Computing surplus relies on two elements, the stock's potential (sustainable) catch and the coastal State potential catch.

As referred before, it is the responsibility of the coastal State to define each year the total allowable catch in agreement with UNCLOS (1982) rules and management objectives.

5.1.1 Duration of FPA

In the case of EU protocols, that normally have a duration of three or more years, the potential catches or effort that correspond to the management objectives have to be forecasted for several years ahead of the last observations, *e.g.* small pelagics, cephalopod and shrimps. However, the biomass of these stocks fluctuate strongly due to the species' fast growth, short life span and high recruitment variability triggered by unpredictable variability and changes in the environment, introducing high uncertainty on predictions.

As a consequence, attempts to calculate surplus in terms of total catches are potentially problematic and there may be a need to define FPA that include yearly updates of surplus estimates. For instances, this is the current case of the protocol associated to the FPA signed between the EU and Greenland.

5.1.2 Over-exploited stocks

In the case of over-exploited stocks a political decision has to be taken with regards to the time period in which the stock should be brought back to the MSY level (slow or fast rebuilding of the stock). This decision, which should be taken by the coastal State and included in the HCR, may affect the estimation of the surplus catches in the intervening period. As such transition periods make it more important to monitor the implementation of the FPA and consider the possibility of revising surplus estimations along the period of application.

5.1.3 Trans-boundary stocks

Following UNCLOS Art. 63 when dealing with trans-boundary stocks, management objectives and HCR should be defined at the regional level and the catch corresponding to the HCR can only be estimated for the total stock that is distributed over several countries. The share of the total catch that is allocated to each country is something that can only be decided by the countries themselves during political negotiations. For some of the trans-boundary stocks included in FPAs such national allocations have not yet been agreed upon (*e.g.* West African small pelagic), becoming a major impediment to compute surplus once that the potential catches of the coastal States are not possible to evaluate.

5.1.4 Surplus shared with other foreign fleets

If in addition to the EU fleet there are other foreign fleets working in a particular EEZ, the surplus catch refers to the combined catch of the EU fleet plus the other foreign fleets. The allocation between foreign fleets is a political decision that has to be taken by the coastal State itself taking into account UNCLOS (1982) guidance and rules.

The concern to the EU is to make sure the partition of the surplus doesn't result in catches above the surplus estimations, including transitional periods if required.

A reliable allocation of surplus catches between different foreign fleets assumes that the coastal state has a management plan in operation, effectively enforced and a system that provides reliable fisheries statistics. In the absence of such a management system there is no guarantee that the fisheries are sustainable, even if the EU fleet complies with the allocated catch or effort quota.

5.2 Final thoughts

Although the surplus definition seems to be simple from a theoretical point of view and all conditions for its implementation taken into account by UNCLOS, in practice it is based on two quantities, total allowable catches or effort and coastal State capacity to harvest the stock, which are not simple to estimate and combine. Furthermore, the understanding of the EWG is that the implementation of the surplus concept requires the existence of formal fisheries management and monitoring systems which is rarely the case for Western African stocks.

6 ASSESSMENT MODELS, INDICATORS AND MANAGEMENT REFERENCES POINTS

The EWG was requested to discuss assessment models, indicators and management references points used for some stocks of small pelagic and demersal species distributed in Western African Waters or in Waters of the Gulf of Guinea.

6.1 Framework

These paragraphs build directly on the recent work conducted by ICES in the framework of providing advice for “data poor stocks” as provided in its advice (http://www.ices.dk/committe/acom/comwork/report/2012/2012/General_context_of_ICES_advice_2012.pdf). In this context, a generic classification of stock assessment approaches has recently been provided by ICES according to the amounts and/or types of data that are available for each stock. This should be considered as a general framework and thus it is not linked with any specific area or management body and it should not be considered prescriptive in any way. Instead, this classification is simply useful for organizing information about available approaches and subsequently providing a guide helpful for the assessment working group in the selection of the most appropriate approaches to consider for assessment of the stocks. In this section “Catch” refers to total catch (including discards to extent feasible) in biomass or numbers, but without information about the age and/or length structure of the catch. “Abundance index” refers to a relative index assumed to be proportional to the abundance of fish as modified by the assumed or estimated size or age selectivity of the fishery or survey that is the source of the data. The different situations concerning the amount of data available for conducting assessment and the models that can be used in these different situations are summarized for simplicity in Table 1 of the ICES document (ICES 2012b).

Several ICES workshops and review groups have been held in an effort to develop quantitative advice for data limited stocks (ICES 2012a). These methods are intended to derive quantitative catch advice and to apply more precaution in more uncertain situations. For completeness, these methods apply to very different situation, from “data rich” to “data poor” conditions. The categorization of stocks is intended to reflect the decreasing availability of data, and thus the conclusions on the fishing pressure and state of the stock are likely to be less certain as one goes down the categories. As a consequence, and in the context of the precautionary approach framework, exploitation rates advised for stocks considered as “data poor” will be more conservative than for the “data rich” stocks.

Based on these guidelines and in the context of the precautionary approach, ICES applies a methodology that provides quantitative advice (ICES 2012a) for each stock given the information available. Six categories of stocks were identified by ICES, ranging from data rich through to truly data-poor. Some of the methods to provide quantitative advice have been tested by simulation within ICES, others require further simulation work, and some are based on common sense.

There are alternative approaches to the one presented here. In all cases assessment working groups should explore the most appropriate approach, checking for consistency among the responses. It also should be noted that if the amount of quality of the information available from a given stock changes over time, the stock can me moved from one category to another and consequently also the quantitative advice will change accordingly.

6.2 Application to the West African CECAF stocks under FPA

Table 6.2.1 compiles all the stocks for which CECAF provides assessment and are currently exploited under the FPA fisheries protocols and includes an attempt to categorize these stocks following the work done by ICES proposing assessment methods to be applied given the data availability. Each stock has been categorized according to the amounts and/or types of data that are available for each stock and successively linked to a given methodology to provide quantitative advice. Again, this should be considered as a general and potential framework and thus it is not linked with any specific area or management body. The classification is useful to organize information about available approaches and thus provide guidance to the assessment working group regarding stock assessment and quantitative advice, in face of the different amount of data available for each stock. In the case data quality improves in the future the ICES framework will provide the full guidance on the appropriate assessment methods (ICES 2012a, b).

Table 6.2.1. -West African CECAF stocks under FPA, data characteristics and potential stock and assessment model assignments. The stock and assessment classification is according the present ICES framework (SISAM and Data Limited Stocks, DLS).

Species/Stock	**Pelagic/ Demersal**	**Zone[(1)]**	**Catch**	**Survey [(2)]**	**Age/growth parameter**	**Advice category [(3)]**	**Model category [(4)]**	**Age-structured population dynamics**	**Population dynamics**	**Individual fish growth dynamics**	**Catch-at-age data**	**Abundance indices**	**Multiple fleets**	**Multiple areas**	**Time-varying characteristics**	**Data category**	**Potential model**
S. pilchardus	pelagic	Sahara-Mauritania-Senegal-The Gambia (Zone C)	1990-2011	1995-2010	yes	3,4	3	No	Yes: aggregate biomass dynamics	No	No	Multiple	Varies	No	No	Biomass dynamics	ASPIC
S. aurita	pelagic	Sahara-Mauritania-Senegal-The Gambia (Zone C)	1990-2011	1995-2010	yes	3,4	3	No	Yes: aggregate biomass dynamics	No	No	Multiple	Varies	No	No	Biomass dynamics	ASPIC
T. trachurus	pelagic	Sahara-Mauritania-Senegal-The Gambia (Zone C)	1990-2011	1995-2010	yes	3,4	3	No	Yes: aggregate biomass dynamics	No	No	Multiple	Varies	No	No	Biomass dynamics	ASPIC
T. trecae	pelagic	Sahara-Mauritania-Senegal-The Gambia (Zone C)	1990-2011	1995-2010	yes	3,4	3	No	Yes: aggregate biomass dynamics	No	No	Multiple	Varies	No	No	Biomass dynamics	ASPIC
M. polli& *M. senegalensis*	demersal	Mauritania	1983-2011	Occasional	yes	3,4	3	No	Yes: aggregate biomass dynamics	No	No	Multiple	Varies	No	No	Biomass dynamics	ASPIC
M. polli& *M. senegalensis*	demersal	Guinea Bissau	2000-2011	Occasional	yes	5	1	No	Implicit	No	No	No	No	No	No	Catch only	DCAC
P. longirostris	demersal	Mauritania	1987-2011	Occasional	Other area	3,4	3	No	Yes: aggregate biomass dynamics	No	No	Multiple	Varies	No	No	Biomass dynamics	ASPIC
P. longirostris	demersal	Guinea Bissau	1990-2011	Occasional	Other area	5	1	No	Implicit	No	No	No	No	No	No	Catch only	DCAC
P. notialis	demersal	Mauritania	1987-2011	not	Other area	3,4	3	No	Yes: aggregate biomass dynamics	No	No	Multiple	Varies	No	No	Biomass dynamics	ASPIC
P. notialis	demersal	Guinea Bissau	1990-2011	not	Other area	5	1	No	Implicit	No	No	No	No	No	No	Catch only	DCAC
O. vulgaris	demersal	Mauritania	1990-2011	not	yes	3,4	3	No	Yes: aggregate biomass dynamics	No	No	Multiple	Varies	No	No	Biomass dynamics	ASPIC
O. vulgaris	demersal	Guinea Bissau	1990-2011	Occasional	Other area	5	1	No	Implicit	No	No	No	No	No	No	Catch only	DCAC

S. officinalis	demersal	Mauritania	1990-2011	not	Other area	3,4	3	No	Yes: aggregate biomass dynamics	No	No	Multiple	Varies	No	No	Biomass dynamics	ASPIC
Sepia spp	demersal	Guinea Bissau	1990-2011	not	Other area	5	1	No	Implicit	No	No	No	No	No	No	Catch only	DCAC
L. vulgaris	demersal	Dakhla	1990-2008	not	not	5	1	No	Implicit	No	No	No	No	No	No	Catch only	DCAC

Logbook information is available for all the stocks

(1) Main area. All stocks are distributed over more areas

(2) There are spatial and/or temporal gaps

(3) According to ICES framework for data limited stocks (DLS)

(4) According to data availability, ICES SISAM

7 METHODS TO ESTIMATE SURPLUS

The EWG was requested to suggest possible methods to evaluate surplus values, depending on: a) the type of data available, and b) the type of assessment models used (*e.g.* such methods should distinguish between poor-data stocks and stocks where assessment would have been delivered using surplus production models or analytical models).

7.1 Estimating surplus

Computing surplus (**S**) relies on two elements, the stock's potential (sustainable) catch (**Y**)and the coastal State potential catch (**C**):

$$\mathbf{S = Y - C}$$

However, reliable fisheries statistics are required to estimate the coastal State potential catches, as well as a quantitative stock assessment to estimate the stock's potential.

The next sections will deal with each of these elements in order to better understand how they may impact the estimation of surplus catches.

7.2 Simulation testing of potential stock catches uncertainty and alternative management procedures using MSE

Management strategy evaluation (Kell*et.al* 1999) is an extensively used framework to evaluate the performance of management plans. The evaluation procedure includes an operating model, observation model, assessment model, management decisions, and a feedback from those decisions to the operating model (Figure 7.2.1).

The main purpose is to simulate the behaviour of management procedures on a specific stock or stocks. This is achieved by replicating as realistic as possible the entire system. Since the "truth" (stock biomass, fishing mortality etc.) is known in the simulations the performance of assessment models and management plans can be assessed.

The operating model is designed to replicate as close as possible the known dynamics of the stock under investigation. Therefore it often includes results from the latest or most comprehensive assessment available. To address concerns that scientists or stakeholders have the operational model can be adapted to create, among other things, trends in recruitment and changing natural mortality.

The observation model replicates the process of sampling and compilation of fisheries statistics and can be used to introduce changes in selectivity and variability in catch reporting, for example.

The management procedure can also be used to test how quickly introduced changes are estimated by the assessment model; what is the effect of implementation uncertainty and what this may mean in terms of management success; how survey data impact the quality of the estimates and how alternative assessment/management combinations are able to handle problematic cases (*e.g.* sudden and unpredictable recruitment failure). In short, the management procedure may provide a systematic view of how well we can manage fish stocks.

The implementation model deals with deviances from the intended management actions, taking into account how fishermen will react to those actions, *e.g.* by discarding or over-catching their quota.

In the case of Western African Waters, there is quite strong evidence available that unreported and illegal fishing activities may play an important role in limiting our ability to evaluate the real impact of fishing. According to Agnew et al (2009) developing countries are the ones most at risk from illegal fishing, with total estimated catches in Western Africa being 40% higher than reported catches. They estimate that lower and upper estimates of the total value of current illegal and unreported fishing losses in eastern central Atlantic are between 294,089 t and 562,169 t annually (based on data from 2000-2003). More specifically, for the miscellaneous small pelagic fleets, illegal and unreported fishing in West Africa were estimated to be between 10-30% of total catches, and even larger for shrimp fisheries.

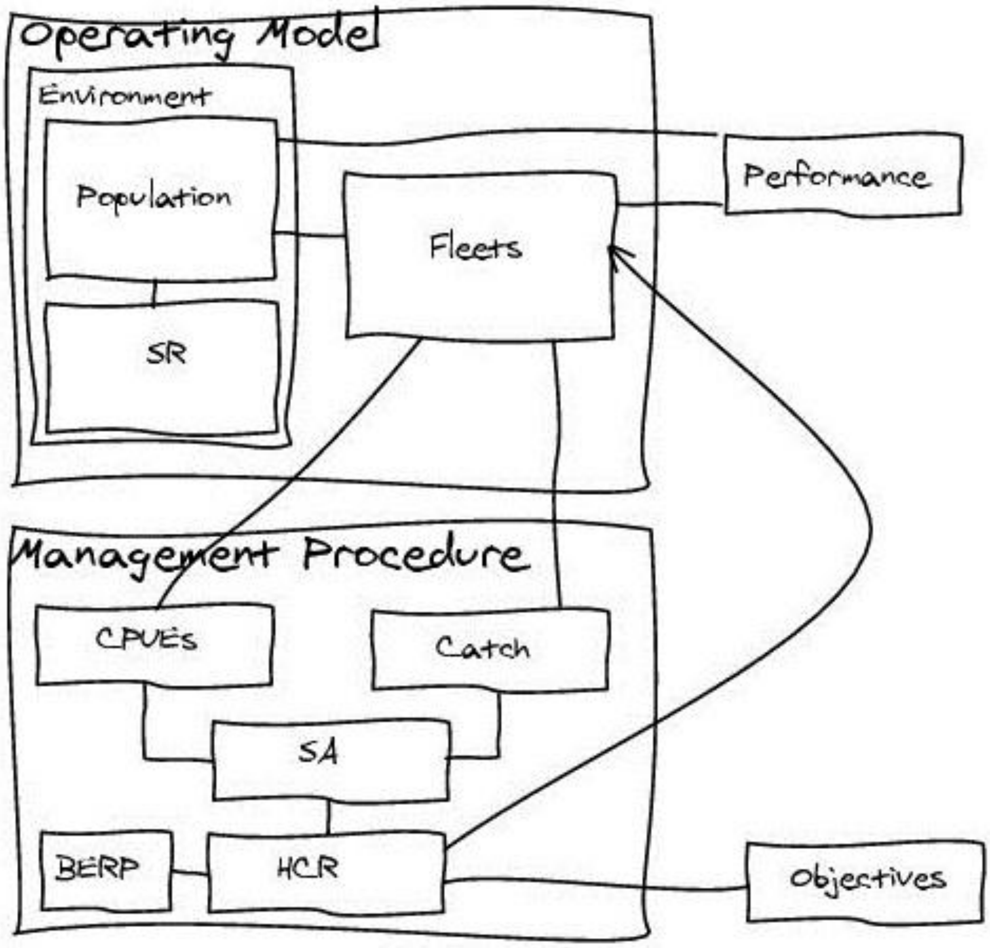

Figure 7.2.1 – MSE algorithm representation. SR stands for Stock recruitment relationship and SA for stock assessment (see Kell*et.al*, 1999 for more details).

The simulation framework is not intended to replace the assessment based on the real data and the simulations are not supposed to be the best possible predictions of future stock sizes. Rather, the simulation results are relative measurements of the likely joint behaviour of the stock – assessment tool – management decisions.

Three management procedures were tested. The traditional assessment based MSY HCR with a Btrigger and Ftarget, but considering relative changes in the stock size and harvest rate with relation to MSY reference point. A catch base HCR that keeps catch at the same level as the average of a specified period. A survey based HCR that reduces catches by 25% if the average survey observations on a specified period are below the historical 10% percentile and increases by 10% if the average survey observations on a specified period are above the historical 90% percentile.

Detailed description of the methodology and results obtained are presented in the working document EWG12 04 Doc 2.

7.2.1 Management scenarios

The scenarios simulated try to give insights about the doubts raised during the discussion of the factors that could have an impact on the estimation of MSY and indirectly on catch surplus.

- Underestimation of catches - which is being modeled through the introduction of bias in catches provided to the assessment model by the OEM. It reflects the situation where company owners under-report catches to the coastal state.
- Abundance index low quality - which is being modeled trough the introduction of bias and variability on the abundance index provided to the assessment model by the OEM. Bias models the effect of having surveys that don't cover the full distribution of the stock. A bias smaller than 1 reflects an underestimation of biomass and vice versa. It's common to use exploratory fishing surveys, which will most of the times look for hot spots of abundance and their estimates of abundance will most likely biased towards higher than reality abundances. On the other hand mixing surveys from different periods and carried out with several vessels, will increase the variability of the abundance index.
- Lag between assessments - is modeled trough the introduction of years without assessment during which the TAC is kept constant as computed on the last assessment. More sophisticated approaches could be implemented if time allows. The simulation assumes that lags between assessments are regular, which is not always the case. It shouldn't be difficult to implement irregular assessment periods, that will reflect a lack of strategy towards management advice.
- Over-catch - it's implemented with two distinct Implementation Error Models (IEM), a constant ratio and a ratio that decreases linearly with the increase in TAC. The idea is that over-catch increases with the decrease in the TAC, which seems more realistic than keeping over-catch with a constant ratio.
- Alternative assessment models - were tested by comparing the Schaeffer and the Fox biomass dynamic models.

As mentioned above two alternative management procedures based on catches and abundance observations were tested to evaluate the possibility of managing the stocks without having a stock assessment.

Table 7.2.1 present the characteristics of the scenarios simulated. The table presents the scenario name (ref), HCR biomass trigger (Btrig), HCR fishing mortality target (Ftar), HCR maximum harvest rate (maxHR), year lag on assessment (aLag), OEM survey bias (srvBias), OEM catch bias (cthBias), survey HCR period for computing average (slag), catch HCR period for computing average (clag) and the type of HCR (am) which may be “schaeffer” or “fox” for biomass dynamic models, “srv” for survey based and “cth” for catch based.

The simulations chosen by the group are represented on the Figures 7.2.2 to 7.2.8. In each figure it's shown a comparison with the base scenario which includes the usual stock parameters, fishing mortality (F), spawning stock biomass (SSB), catch and recruitment, as well as the assessment model parameters, K, r, q, σ, b0 (check EWG-12-04 Doc 2 for more information on model parameters) and the HCR outcomes, TAC and harvest rate (HR).

Table 7.2.1 - Management scenarios

ref	Btrig	Ftar	maxHR	aLag	srvBias	cthBias	slag	clag	am
base	0.50	0.75	0.35	1.00	1.00	1.00			schaeffer
aLag3	0.50	0.75	0.35	3.00	1.00	1.00			schaeffer
aLag5	0.50	0.75	0.35	5.00	1.00	1.00			schaeffer
cthBias0.8	0.50	0.75	0.35	1.00	1.00	0.80			schaeffer
srvBias0.5	0.50	0.75	0.35	1.00	0.50	1.00			schaeffer
srvBias1.5	0.50	0.75	0.35	1.00	1.50	1.00			schaeffer
srv				1.00	1.00	1.00	5.00	5.00	srv
cth				1.00	1.00	1.00		5.00	cth
fox	0.50	0.75	0.35	1.00	1.00	1.00			fox
worstCase	0.50	1.00	1.00	5.00	0.50	0.50			schaeffer

7.2.2 Base case

In the case analysed the base case mimics an ideal situation where there is a management system in place, assessments are made every year, the TAC decisions are based on stock assessments without any delay, advice is used in the TAC decision and the implementation and enforcement of the TAC is on the whole successful.

Figure 7.2.2 shows that the management procedure "learns" to respond in a way that keeps the stock mainly on the safety biomass level, i.e. the flat area of the stock recruitment relationship where the mean recruitment is less dependent on the spawning stock biomass than on the lower biomasses. However, F and SSB levels are close to MSY targets (BMSY=875t) but still below its level. The problem is the estimation of the biomass dynamics parameters, with K being estimated at a very high level, ~3500t, while the simulated value was 1750t. In any case it takes some years for the model parameters to stabilize around median values. Clearly there is a large uncertainty on all estimates as it can be seen by the large range of the percentiles. Figure 7.2.3 shows the three simulations to illustrate the large variability expected, which is blurred by the median of the simulations.

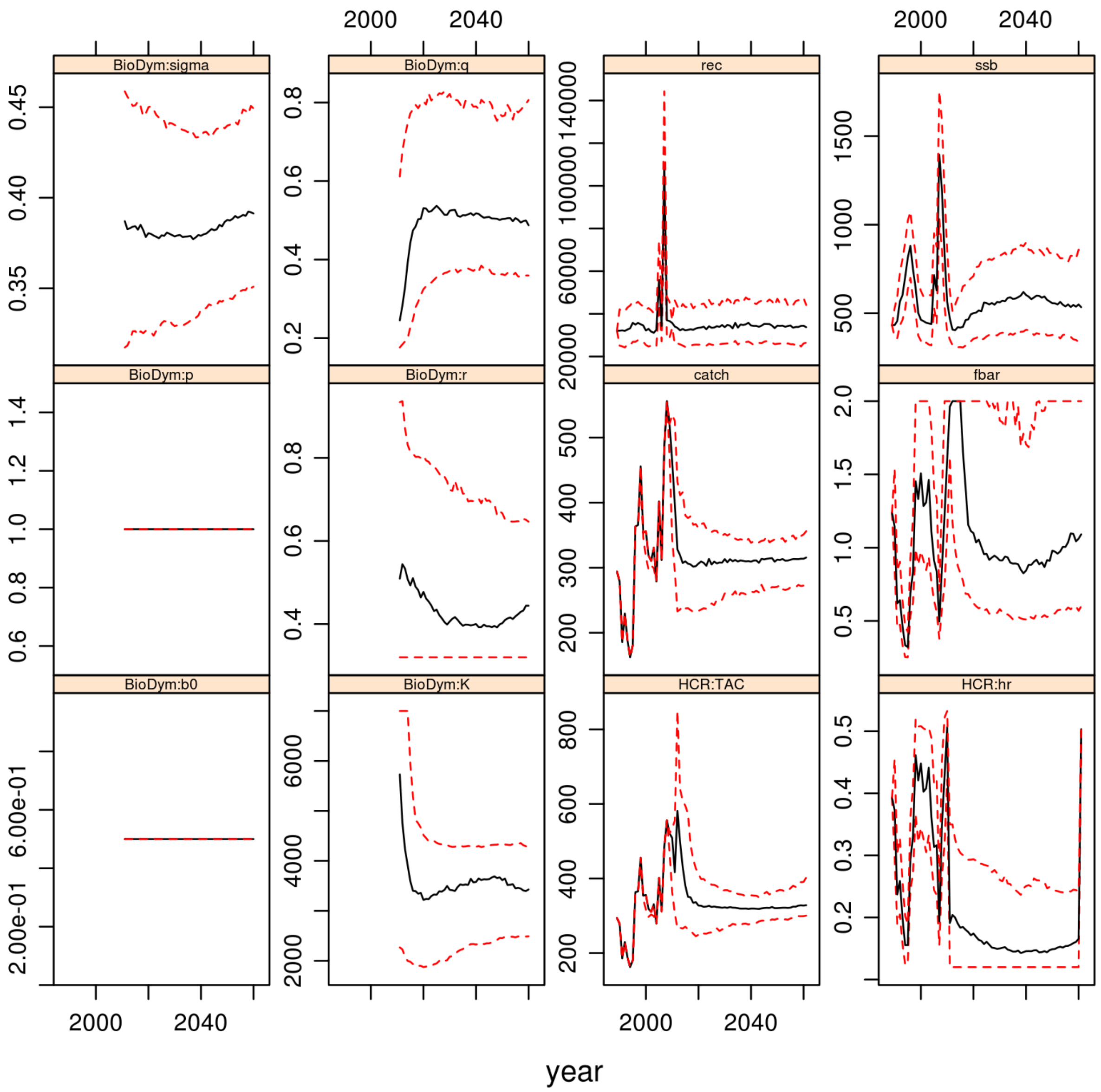

Figure 7.2.2 – Base case scenario. Median and percentiles 0.2 and 0.8 of fishing mortality (F), spawning stock biomass (SSB), catch and recruitment, assessment model parameters, K, r, q, σ, b0 and HCR outcomes, TAC and harvest rate (HR).

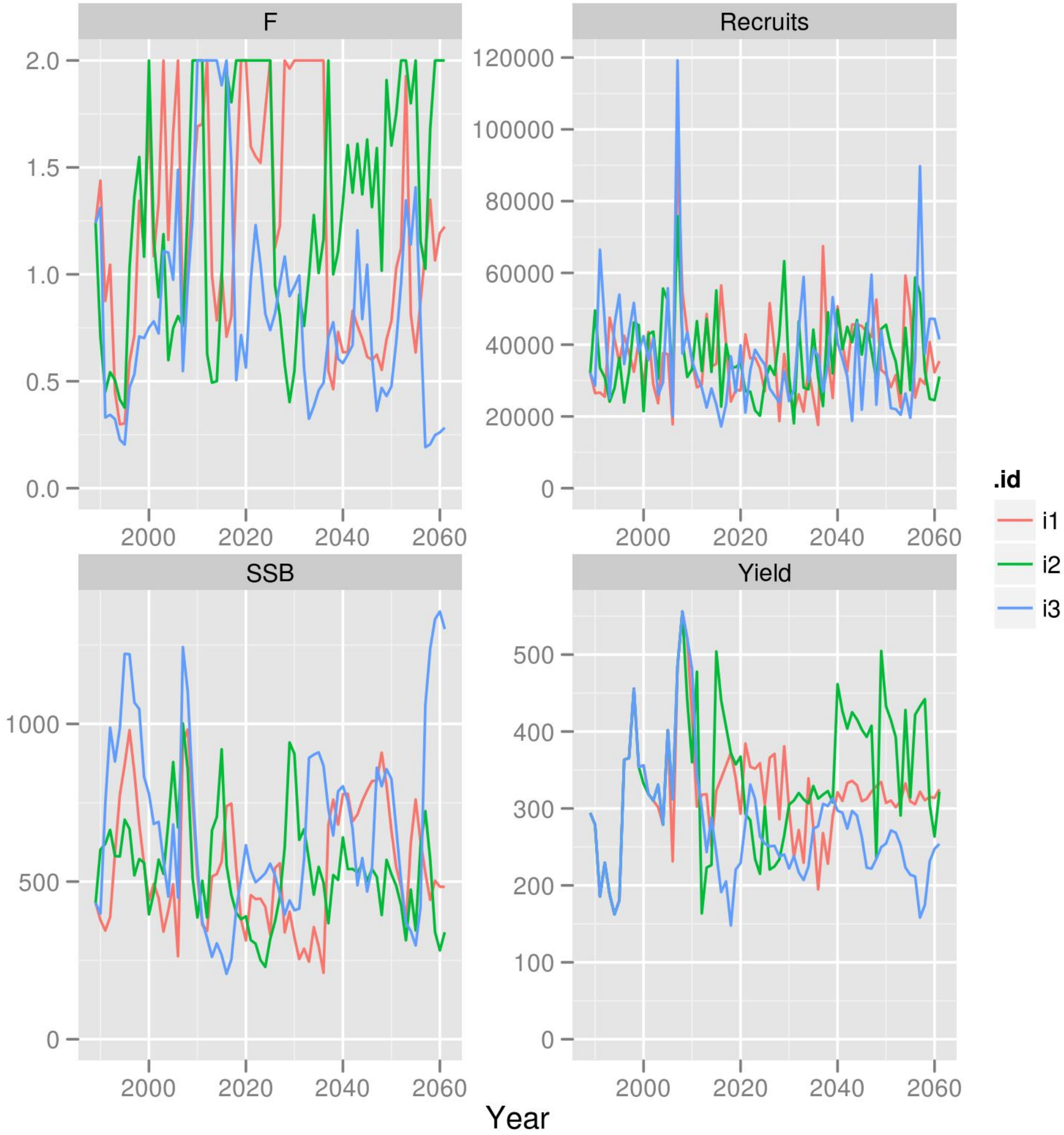

Figure 7.2.3 – Three simulations of the base case showing the large variability associated with the realizations of this scenario.

7.2.3 Lag in stock assessment

Figure 7.2.4 presents the scenarios where assessments are carried out with 3 or 5 year lags. Having assessments with high intervals result in delays responding to increases or decreases in biomass. If biomass is low and catches are high by not having assessments will keep TAC high when biomass keeps declining, and vice-versa. When assessments are available a large adjustment is forced, introducing large variability in the stock and fishery.

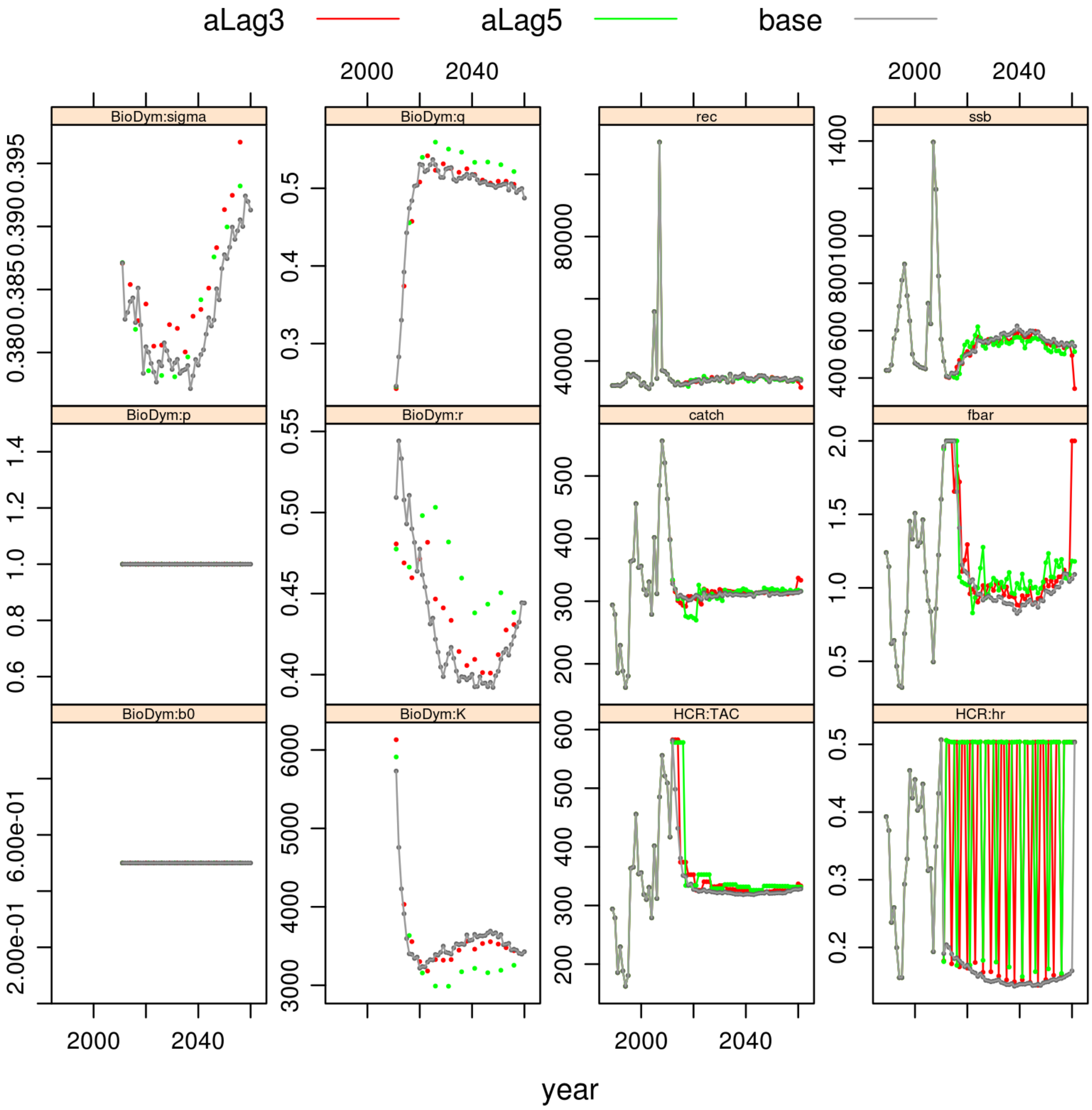

Figure 7.2.4 – Scenarios with assessment lags.

7.2.4 Underreporting of catches

Catch mis-reporting was not well captured by this MSE (Figure 7.2.5). The link between mis-reporting and implementation error requires more work. In the case shown here both effects are mirroring each other and although the TAC is set at very distinct levels the realized catches continue at the same level.

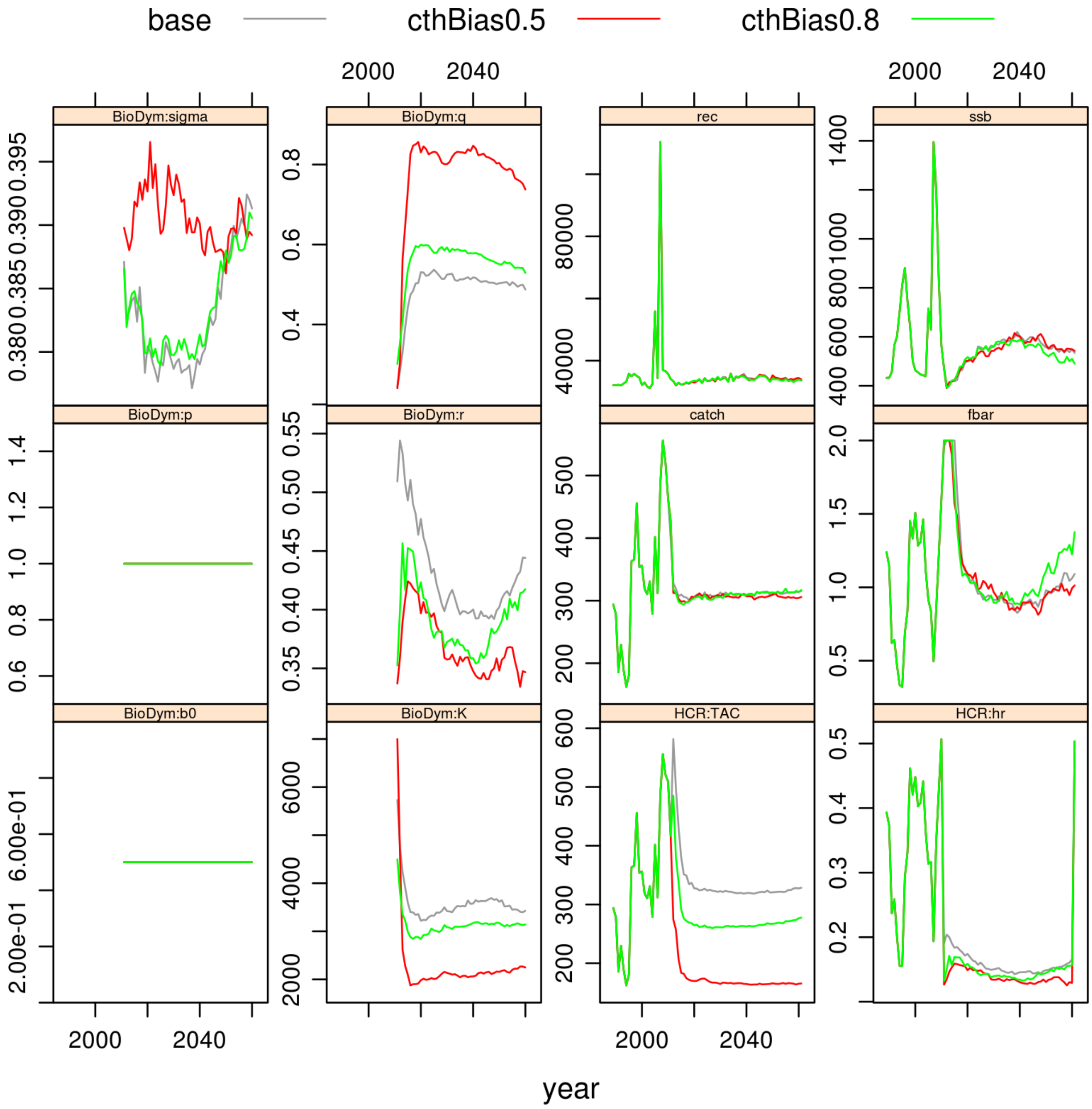

Figure 7.2.5 – Underreporting effect with 50% (0.5 bias) and 20% (0.8 bias)

7.2.5 Bias on surveys

Survey bias was introduced to simulate cases where the surveys do not cover the full area of distribution of the stock (Figure 7.2.6), which may result in underestimation of biomass (0.5 bias) or overestimation (1.5 bias). Catchability is able to differentiate both situations. However, there are huge impacts on the estimation of K and, to a smaller extend, in r. In the case of underestimation these impacts are larger and result in an unrealistic TAC that would lead to stock collapse if the limit in F was not implemented. So the underestimation of biomass seems to be a more dangerous problem because the biomass dynamic model will react by estimating very high biomasses to support observed catches.

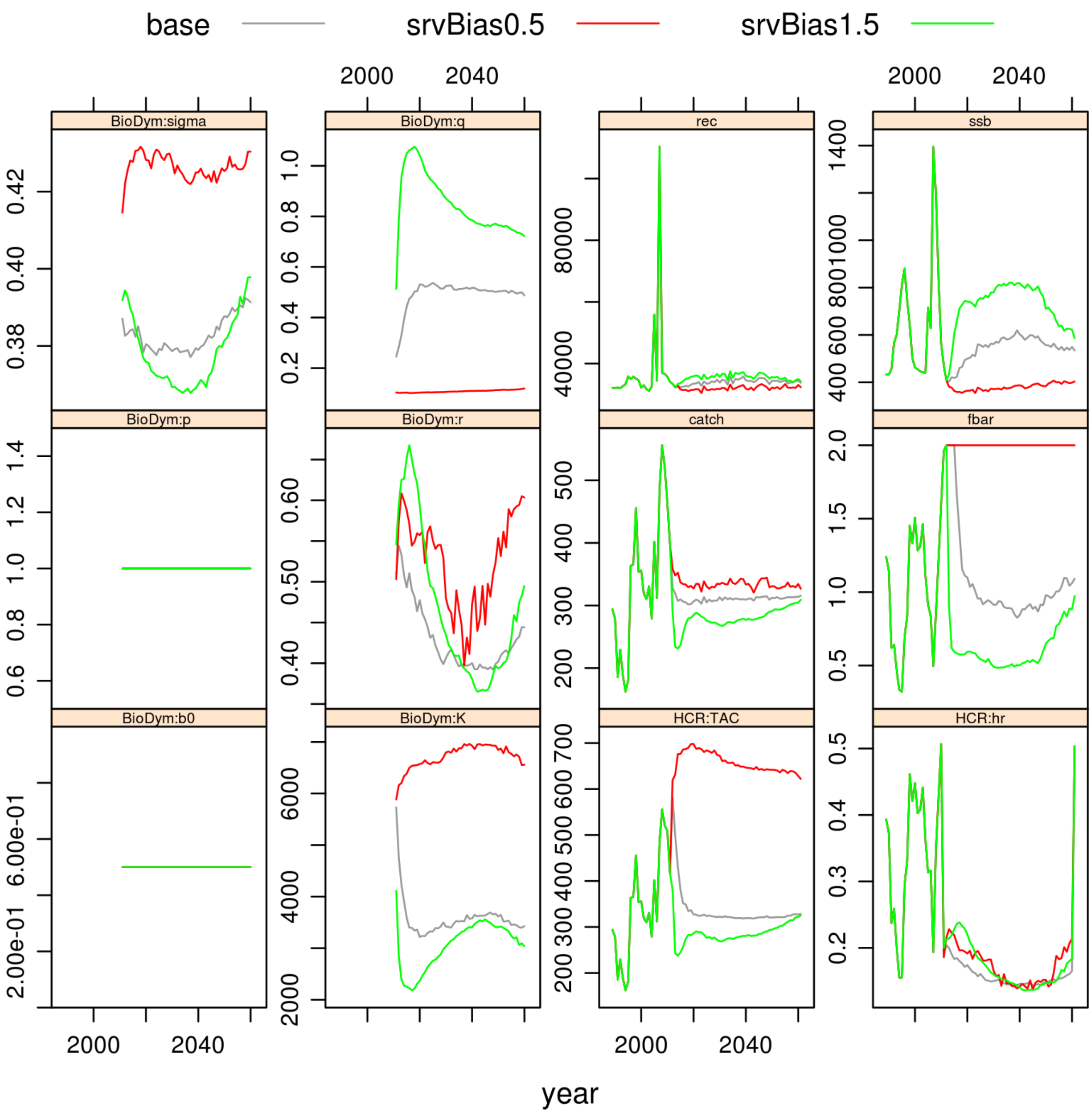

Figure 7.2.6 – Survey coverage effect, biomass overestimation (1.5 bias) or underestimation (0.5 bias)

7.2.6 Fox vs. Schaeffer biomass dynamic models

Figure 7.2.7 shows the effect of using a Fox type BDM, which has the effect of considering the stock to be more productive at lower levels of biomass which results in a higher TAC and lower biomass. Catch is slightly higher but the limits in harvest rate and fishing mortality are operating through the simulated period.

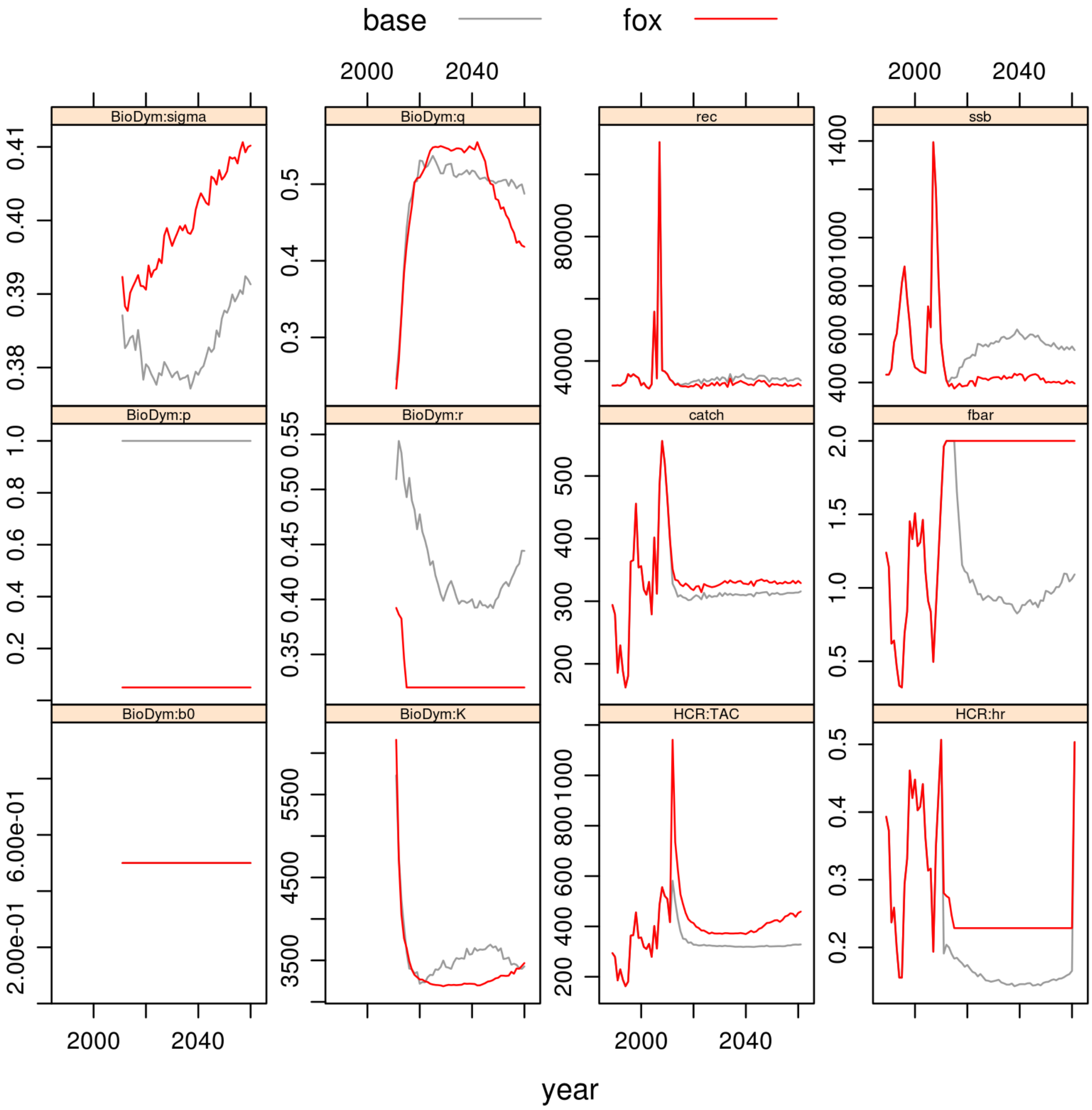

Figure 7.2.7 – Fox and Schaeffer model comparison.

7.2.7 *Worst case scenario*

This scenario shows the limit of our comprehension of the system (Figure 7.2.8). If all high impact factors apply at the same time the stock productivity is estimated at a very distinct level and TACs are set at very high values. The stock is maintained by the F limit that avoids biomass to decrease to the level of collapse.

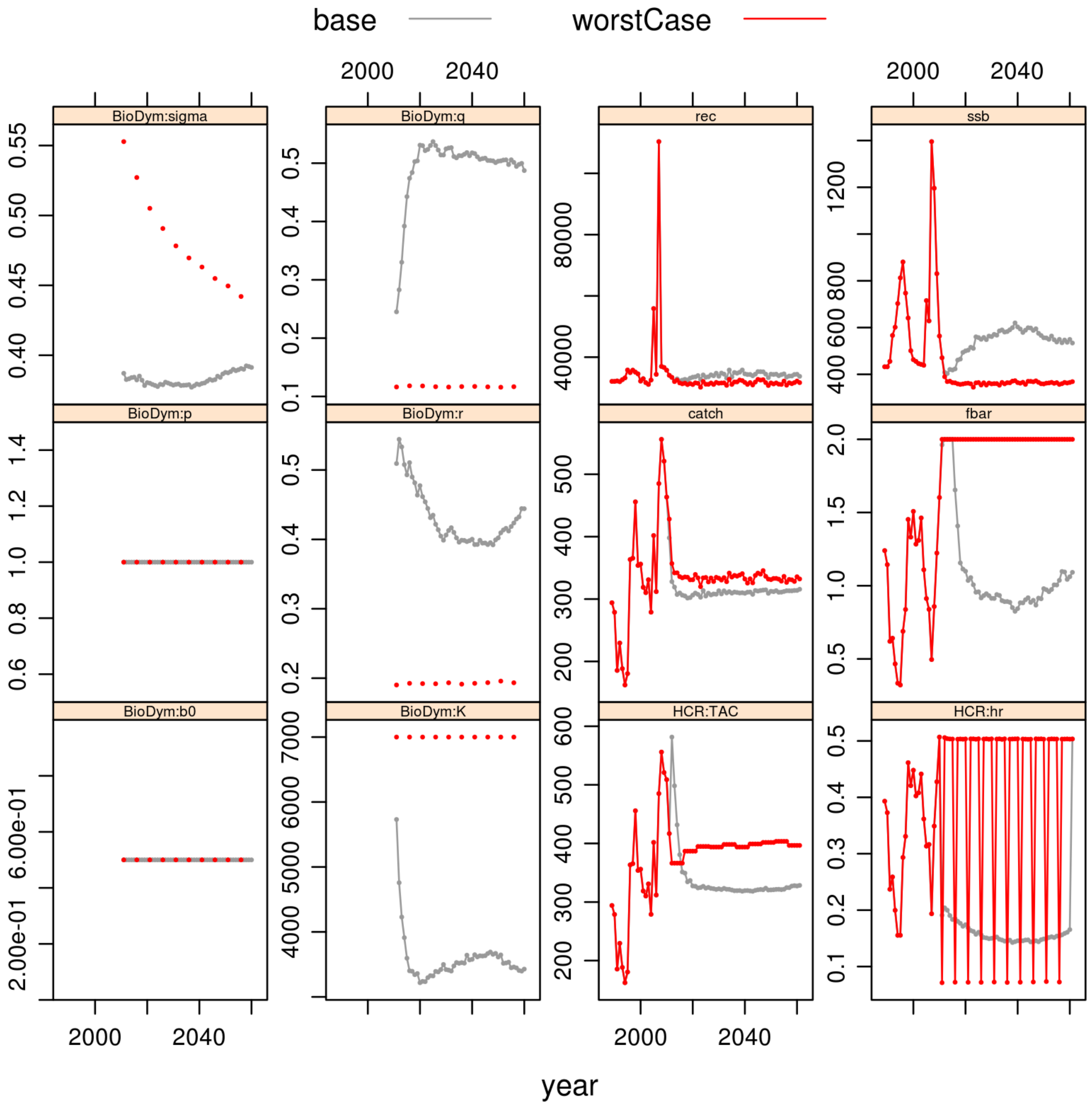

Figure 7.2.8 – Worst case scenario

7.2.8 Alternative management

The alternative management procedures are shown on Figure 7.2.9. The catch management procedure works well in the long term but it takes a long time to response to overexploitation and in the case of recruitment failure or underreporting of catch it may not work. The survey MP responds a lot faster but it relies on a constant relationship between biomass and the abundance index. Using CPUE or a survey series build with distinct surveys may create a problem. Both MP seem to drive the stock to MSY, although understanding the reasons for such behaviour will require further work.

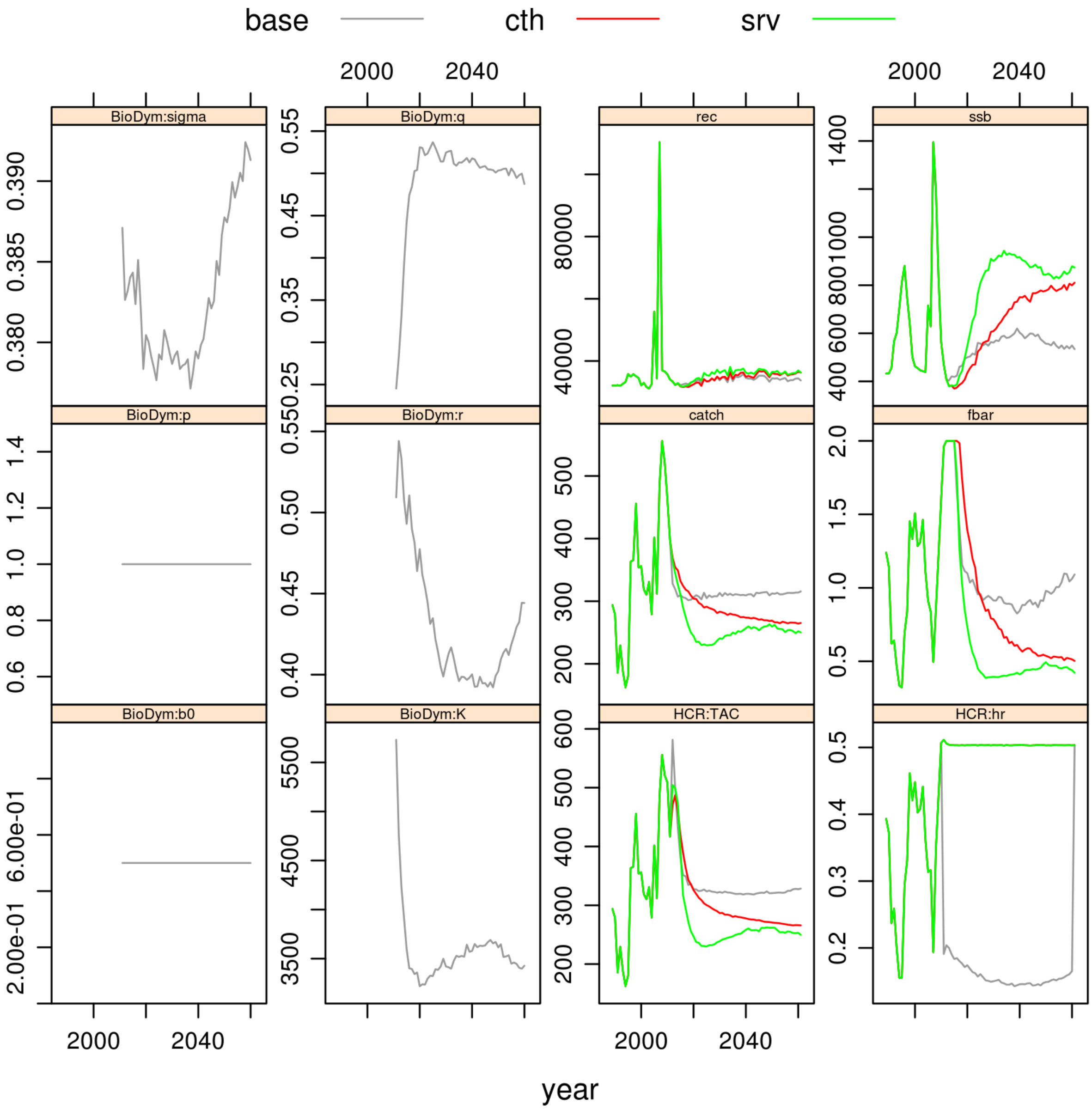

Figure 7.2.9 – Alternative management procedures

7.2.9 Conclusion

Most scenarios showed a large impact on the estimation of MSY. The effect of underreporting was not so clear due to technical limitation about the relationship between underreporting and implementation error.

The alternative management procedures may deliver stability of biomass and catches at a level that is not dangerous for the stock, but further investigation is required to fully understand the risks associated.

7.3 Methods to estimate coastal State's catches

Preliminary, the current situation of the stock and fisheries is conventionally defined by the average values of parameters over the last 3 available years (i.e. 2009/2011 in the case of *Sardinella aurita*): Ycur is the current total catch, Ycurcost. is the current catch of the costal state, Fcurcost. is the partial fishing mortality induced by the costal fleet (Fcurcost. = Fcur · Ycurcost. / Ycur).

For each simulated scenario, the surplus St was calculated every year for all the foreign countries considered as a whole, as the difference between the total allowable catch (TACt, based on the simulated HCR) and an estimate of the harvest of the coastal state (or of all the coastal states sharing the same stock, in the case of widely distributed stocks). Thus:

$$St = TACt - Ytcost$$

Where Ytcost is the catch of the costal state for year t which is estimated using three alternative methods, based on different (and alternative) assumptions.

1. Assuming that the "capacity of the costal state to harvest" is defined by its current fishing effort and assuming that this fishing effort and all other factors related to fishing mortality will remain constant in the future:

$$Ytcost. = TACt \cdot Ftcost. / Ft = TACt \cdot Fcurcost. / Ft$$

where Ft the fishing mortality related in year t to the HCR.

Nevertheless, this equation only applies in case where Ft > Fcurcost.. In the opposite case, the coastal state is able to catch the full TAC alone, and Ytcost. = TACt thus surplus St = 0.

Such a method implies that the catch of the coastal state will change over time, accordingly to the status of the stock. Therefore, in case of a stock that is already overexploited in the current situation, the costal state catch will increase on the long term, benefiting of the rebuilding of the stock. But if the stock is currently under-exploited, the coastal state catch will decrease over time as the same time the stock is more intensively fished (and thus CPUEs decrease). Such a trend would probably be considered as unacceptable by the coastal state and justifies the following methods 2 and 3.

2. Assuming that the HCR will apply for the costal state in the same proportion than for the whole fisheries and therefore assuming that the proportion of the costal state catch is fixed:

$$Ytcost. = TACt \cdot Ycurcost. / Ycur$$

This method implies that the fishing effort of the costal state will change over time. In case of an already overexploited stock, the costal state will have to decrease its fishing effort, and its catch will decrease in the same proportion. It is likely that such a change could be considered as undesirable by costal states. Conversely, in case of an underexploited stock, the costal state will benefit of both the increase in its fishing effort and in its catch (in the same proportion as the foreign fleets)

3. Assuming that the costal state decide to maintain its catch constant:

$$Ytcost. = Ycurcost.$$

(Nevertheless, in the simulations this equation applies only if Ytcost. <TACt, otherwise Ytcost. = TACt)

This method implies that the costal state fishing effort will have to adapt over time. In case of an underexploited stock and following an increasing fishing pressure scenario, the costal effort will have to increase in order to compensate for the CPUEs decrease. It has to be notice that in such a case the catch per unit effort of the local fisheries would be impacted (more effort for unchanged catches), while all the increase in catch would be sold to the foreign fleets. In the opposite, starting with an overexploited stock and thus considering a rebuilding stock scenario, the coastal state would have to decrease its fishing effort, in order to maintain catch constant.

An additional and important case has to be considered. Even if the stock is currently overexploited (by all the fleets together, but not due to the costal state fishing pressure considered in isolation), the costal state could obviously decide to develop its own fisheries and thus to increase its fishing effort. There's number of ways to implement such development and there are methods to compute surplus, as long as the development plan of the coastal state is made available to scientists.

7.3.1 Application to simulated stocks

The three methods of calculating surplus described above were applied to the results of the MSE simulations. Two scenarios were explored: an over-exploited and under-exploited stock. As mentioned above, the current total yield and harvest rate were taken to be the mean over the years 2009 to 2011. The current proportion of the total yield that the coastal state takes was set at 0.2. The results can be seen in the Figures 7.3.1 and 7.3.2. In the figures, the black line shows the median value of the stochastic projections. The first five stochastic iterations are superimposed over this to illustrate the variance in the simulations.

Each column shows the results from one of three methods used to calculate surplus. As mentioned above, the first method of calculating surplus tries to maintain the same level of harvest rate for the coastal country as the current situation. The second method tries to maintain the same proportion of yield for the coastal country as the current situation. In the third method the coastal country takes a fixed level of yield (that cannot exceed the target yield set by the harvest control rule).

The first row shows the ratio between the harvest rate in that year and the current harvest rate of the coastal country. The second row shows the surplus (the difference between the TAC and the yield taken by the coastal country. The third row shows the yield taken by the coastal country.

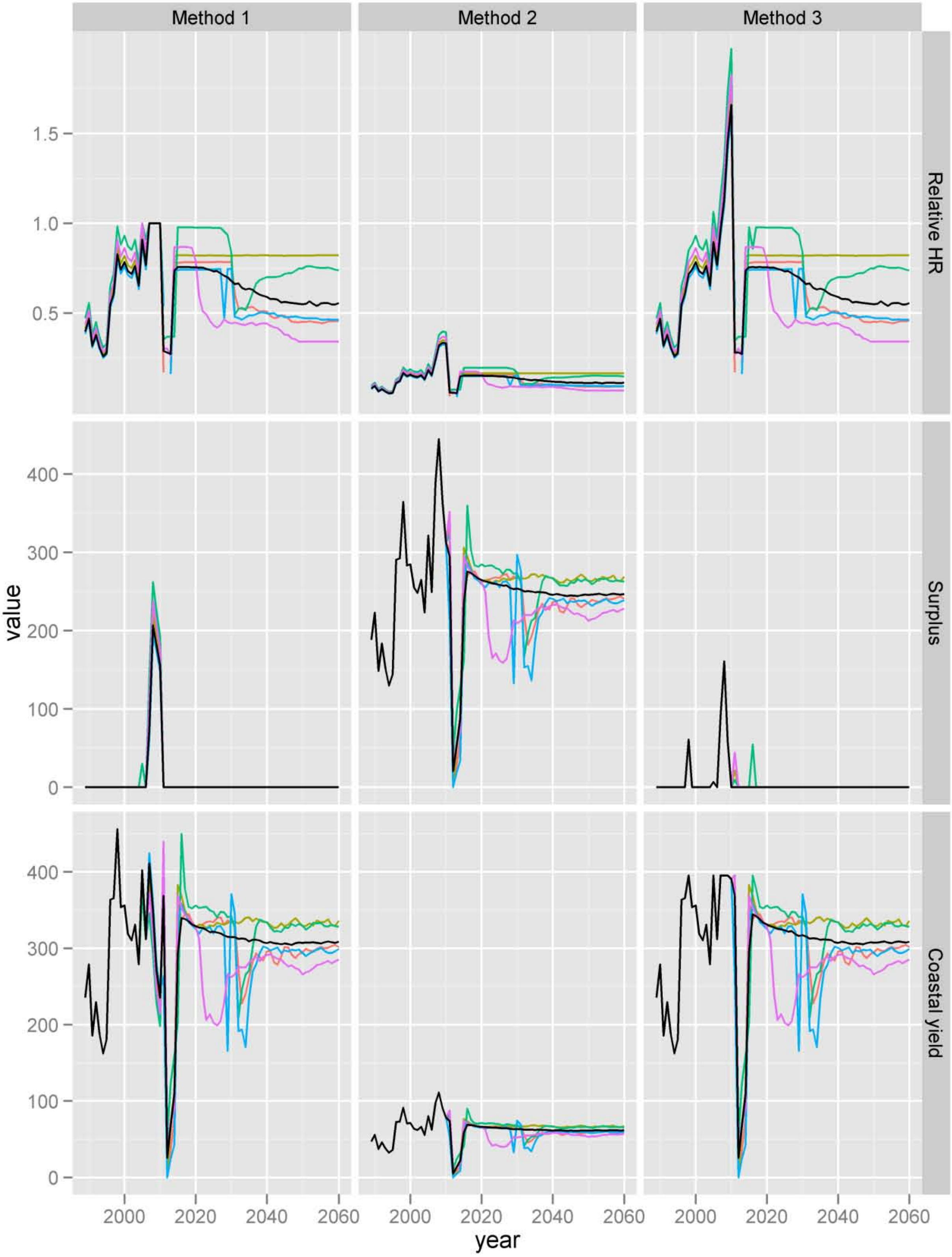

Figure 7.3.1 – Results from applying the three surplus computation methods to an over-exploited stock. The black line shows the median value. The coloured lines show the first five stochastic iterations to illustrate the variance in the simulations.

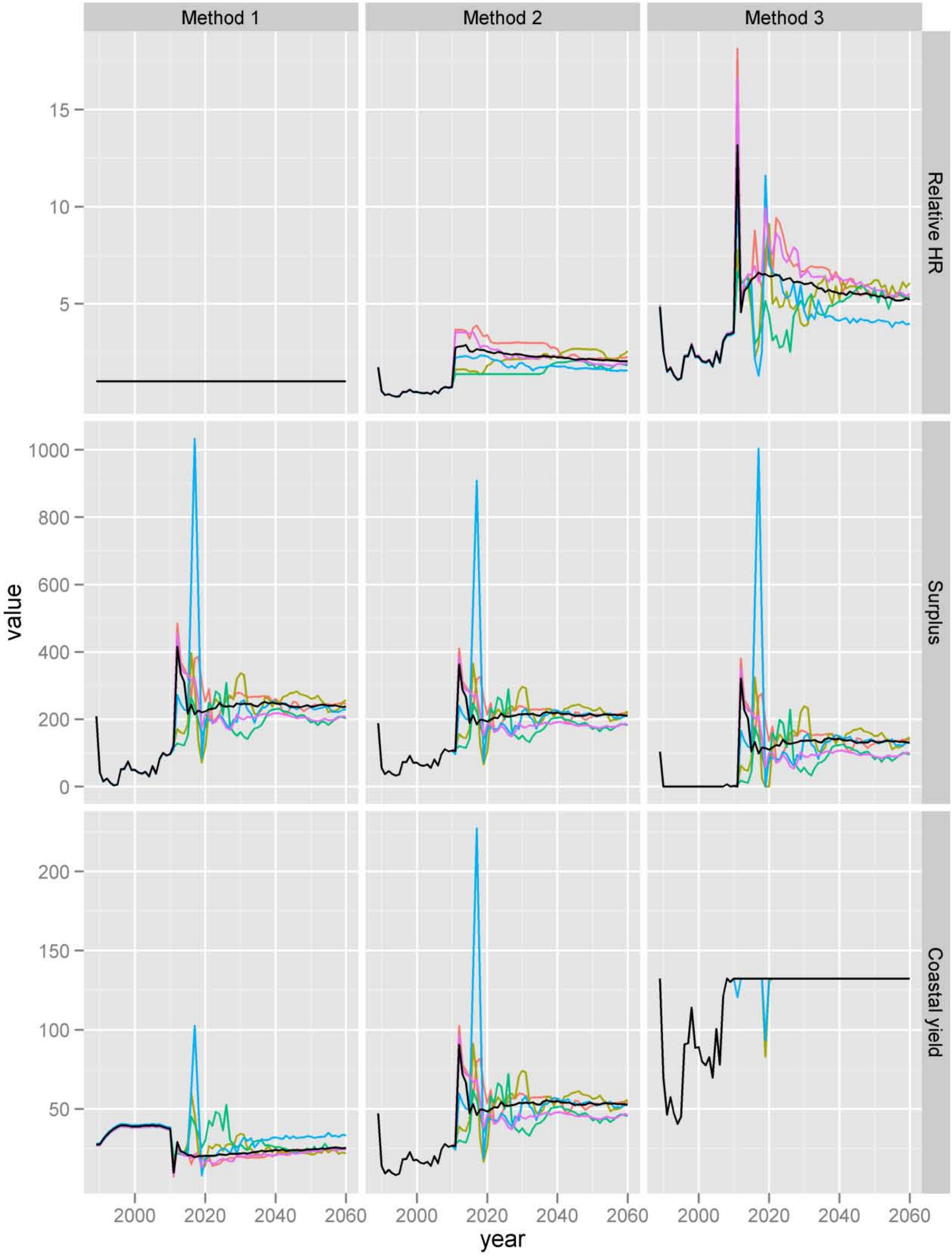

Figure 7.3.2 – Results from applying the three surplus computation methods to an over-exploited stock. The black line shows the median value. The coloured lines show the first five stochastic iterations to illustrate the variance in the simulations.

When the stock is over-exploited the results from applying surplus method 1 and method 2 are quite different. The stock is over-exploited by the coastal state alone. This means that method 1 is unable to maintain the harvest rate of the coastal state at the current rate. Instead the harvest rate is set as high as it can be without exceeding that which will catch the TAC. The surplus is consequently zero. Applying method 2 to the over-exploited stock results in a lower harvest rate by the coastal state and there is a correspondingly higher surplus. However this results in a lower yield for the coastal state than when method 1 is applied.

When the stock is under-exploited there is less of contrast between applying method 1 and method 2. Method 1 is able to maintain the harvest rate of the coastal state at the current level whereas under method 2 the harvest rate is slightly higher. The surplus is higher under method 1 and the yield of the coastal state under method 2 is higher.

The performance of method 3 under both under and over-exploited conditions is dependent on the fixed level of yield that the coastal country takes and the status of the stock. The higher the fixed level of yield and the lower the stock status, the lower is surplus.

8 Deliver preliminary calculations of surplus for mixed FPAs of the Western African area

The methods described in the previous section to estimate surplus were tested on three real case studies, *S.aurita* in West Africa, *T.trecae* in West Africa and *P.longirostris* in Mauritania, to provide preliminary estimates of surplus. These stocks were assessed by CECAF and estimates of Fmsy and MSY based on a Biodyn model were used in the exercise. Surplus, coastal States catch and relative change of the coastal State fishing effort, were calculated using the three methods presented in section 7, either based on MSY or on a short term basis in relation to a given management option. Thus, three alternative total allowable catch were considered:

- the MSY considered as the long term target,
- the short term TAC assuming the fishing mortality would be equal to Fmsy in the coming year,
- the short term TAC assuming the fishing mortality would follow a five year transition schemes to the Fmsy, and thus would be equal to Fcur - 0.2 (Fmsy-Fcur).

The short term TAC is deduced from the related F as follow: TAC=Ycur .F / Fcur (where Ycur is the total current catch and F the short term fishing mortality).

Afterwards the EWG used statistical methods to estimate the uncertainty of surplus in two examples based on *S.aurita* population dynamics, one over-exploited and another under-exploited. The exercise aimed at a better understanding of the characteristics of the estimators being proposed, show the kind of uncertainty one should expect for the estimation of surplus and describe one possible methodology to estimate surplus uncertainty.

8.1 *Sardinellaaurita* in West Africa

8.1.1 Current problems in the assessment

The FAO/CECAF working group on small pelagics in northwest Africa has come across several problems in assessing the stock of *S.aurita*. The Biodyn model used for the assessment compares annual catches with annual indices of abundance. The catch used in the model is the entire catch taken in the sub-region. The main fisheries in the sub-region are the artisanal fisheries in Senegal (40% of the total catch) and the industrial fisheries in Mauritania (also 40% of the total catch). The catches in Senegal mainly consist of the recruiting age groups (1-2 years old), whereas the catch in Mauritania consists mainly of adult fish of 3 years and older.

In the period up until 2010, an acoustic index derived from surveys with R/V "Dr.Fridtjof Nansen" and surveys with national research vessels was used as an abundance index in the Biodyn model. It was difficult to fit the model with this index because in some years the acoustic surveys had apparently missed the main concentrations of sardinella. This was presumably due to the timing of the surveys in relation to the variability in the timing of migration of the stock. The surveys are always conducted in November, at the time when the fish are migrating from Morocco back to Senegal.

The coastal countries have developed their own acoustic surveys into a coordinated regional framework from 2008 onwards. Due to operational issues these acoustic surveys were not used in the last two assessments. Therefore, the CPUE of the Dutch trawlers in Mauritania was used in the last two *S.aurita* assessments, in spite of its limitations as an abundance index, *e.g.* these vessels do not exclusively target sardinella, only operate in Mauritanian waters and do not represent the total abundance in the whole sub-region where the stock is distributed. This fact may have had consequences in the results obtained in the last assessments.

Finally, the Biodyn model cannot incorporate variations in recruitment, although these variations are known to occur in the area. The model is therefore adjusted by including an environmental factor for years in which a strong years-class is assumed to have been born. This procedure, however, is subjective because no quantitative data on recruitment are yet available.

As a consequence of the above mentioned issues there is great variability in the assessments performed in the last 6 years (Table 8.1.1 and Figure 8.1.1).

Table 8.1.1 Variations in r and K obtained by different assessments done in the last 6 years (CECAF)

Parameters	2006	2007	2008	2009	2010	2011	2012
r	0.49	0.14	0.26	0.50	0.23	0.65	0.64
K	1939	4270	2647	2239	6068	1750	1709

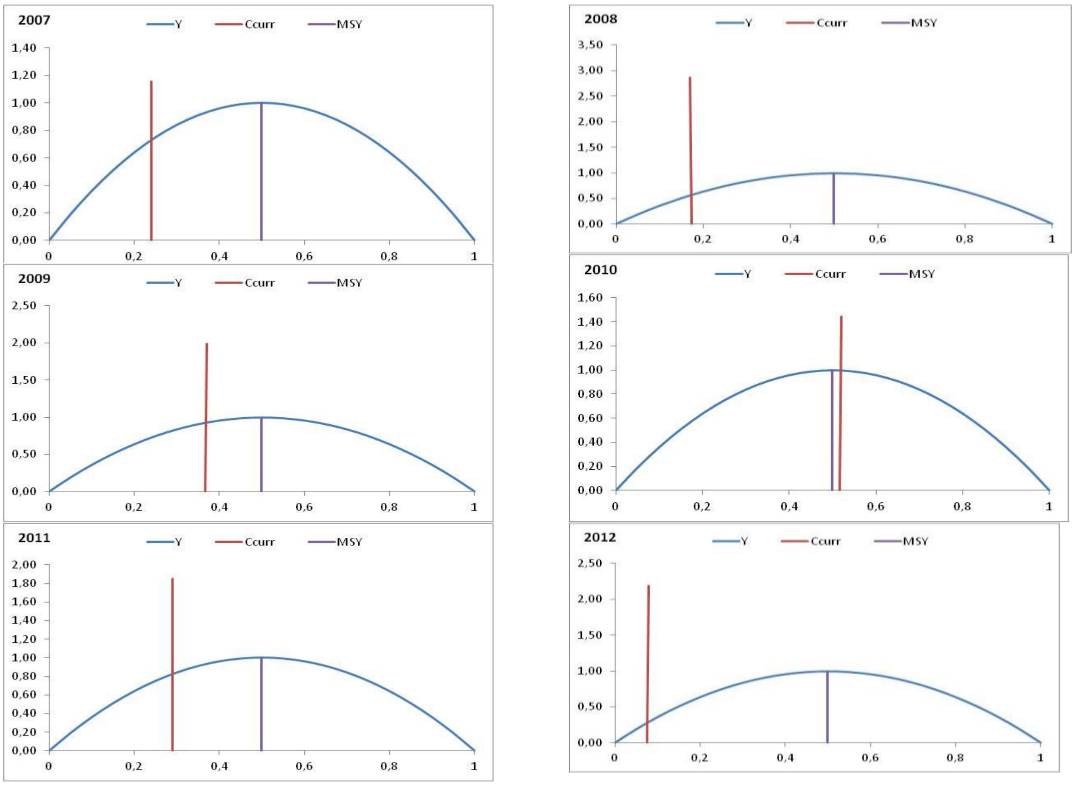

Figure 8.1.1 Assessment of *Sardinella aurita* in the last 6 years (CECAF)

8.1.2 Surplus estimates

In the case of *Sardinella aurita*, the last CECAF assessment in 2012 was considered inconsistent by the CECAF working group itself and thus the surplus estimate methods were tested using the 2011 assessment.

The stock is considered as strongly overexploited, with a 2010 catch of the Coastal states (Morocco, Mauritania, Senegal and The Gambia) higher than MSY (289 000 and 285 000 t, respectively; see Table 8.1.2).

Table 8.1.2 Short term (2012) and long term surplus estimates for *S.aurita* is based on CECAF's 2011 assessment using the three methods developed in the previous section. Method 1: ratio of fishing effort; method 2: ratio of catch; method 3: constant catch. Current yield in 2010 was 535 000t and coastal States' yield was 289 000t.

	Short term target (2012)		Equilibrium target
	F = Fmsy	F = transition	F = Fmsy
F	0.33	0.91	0.33
Total yield	168 143	461 629	285 000
Surplus (meth 1)	0	172 629	0
Surplus (meth 2)	77 314	212 263	131 047
Surplus (meth 3)	0	172 629	0
Coastal States yield (meth 1)	168 143	289 000	285 000
Coastal States yield (meth 2)	90 829	249 366	153 953
Coastal States yield (meth 3)	168 143	289 000	285 000
Coastal States effort ratio (meth 1)	0.58	1.00	0.58
Coastal States effort ratio (meth 2)	0.31	0.86	0.31
Coastal States effort ratio (meth 3)	0.58	1.00	0.58

In this case the coastal States alone are able to catch the entire MSY. Thus, assuming a constant costal fishing effort (and a constant fishing power), the long term projection of surplus is equal to zero (method 1). To reach Fmsy, coastal States will have to decrease their fishing effort by 42% in the long term, even if no foreign fleets remain. The short term surplus is also estimated equal to zero if Fmsy is immediately implemented and decreases progressively if a 5-year transition scheme is considered.

Method 2, based on a constant catch ratio between coastal and foreign fleets, is the only one where the surplus is estimated to be positive. But this method implies that the fishing effort of the coastal States would decrease 69% in the long term and 69% or 14% in the short term, depending on the scenario considered.

Method 3, based on the assumption of constant catches for the coastal States leads almost to the same long term and short term projections as Method 1(due to the fact that coastal catch projections are bounded by the MSY).

Even considering the high uncertainty in MSY and Fmsy estimates this case study clearly illustrate a situation where the stock is overexploited and coastal States alone can catch the whole MSY with their own current fishing capacities. In such case, there will be no surplus on the long term (short term estimates depending on the agreed management scheme), and allowable catches might be sold to foreign countries only if coastal States decide to decrease their own fishing effort.

8.2 *Trachurustrecae* inWest Africa

The last available assessment for *T.trecae* by CECAF was performed in 2011, with catches until 2010, showing that the stock is strongly overexploited, with a very limited part of the catch due to coastal States' fleets (10 290 among 366 900 t). Table 8.2.1 presents the estimates of surplus following the methods presented in the previous section.

Table 8.2.1 Short term (2012) and long term surplus estimates for *T.trecae* based on CECAF's 2011 assessment using the three methods developed in the previous section. Method 1: ratio of fishing effort; method 2: ratio of catch; method 3: constant catch. Total yield in 2010 was 366 900t and coastal States' yield was 10 290t.

	Short term target (2012)		Equilibrium target
	F = Fmsy	F = transition	F = Fmsy
F	0.36	0.83	0.36
Total yield	139 868	321 492	272 400
Surplus (meth 1)	129 577	311 201	252 359
Surplus (meth 2)	135 945	312 475	264 760
Surplus (meth 3)	129 577	311 201	262 110
Coastal States yield (meth 1)	10 290	10 290	20 041
Coastal States yield (meth 2)	3 923	9 017	7 640
Coastal States yield (meth 3)	10 290	10 290	10 290
Coastal States effort ratio (meth 1)	1.00	1.00	1.00
Coastal States effort ratio (meth 2)	0.38	0.88	0.38
Coastal States effort ratio (meth 3)	1.00	1.00	0.51

In such a case, positive surplus do exist in the short term and in the long term, whatever the method used for calculation is. In all cases foreign countries have to decrease their catches compared to the current situation (i.e. compared to the last available year) and decrease their fishing effort of around 66% in order to reach the F_{msy} (i.e. from 0.95 to 0.36).Method 1, based on a constant coastal fishing effort assumption, lead to an increase in the long term catch of coastal fleets, which is beneficial for the rebuilding of the stock. Conversely methods 2 and 3 imply a strong decrease in the fishing effort of the coastal fleets (with decreasing coastal catches for method 2 and constant coastal catches for method 3).

8.3 *Parapenaeuslongirostris* in Mauritania

CECAF's assessment in 2010 using catches up to 2008 considered this off shore shrimps stock to be not fully exploited (Fcur=0.28, while Fmsy=0,41). Although coastal catches were reported for 2008, it is known that the Mauritanian fishery came to an end after this year. Table 8.3.1 presents the estimates of surplus following the methods presented in the previous section.

Table 8.3.1 - Short term (2010) and long term surplus estimates for *P.longirostris* based on CECAF's 2010 assessment using the three methods developed in the previous section. Method 1: ratio of fishing effort; method 2: ratio of catch; method 3: constant catch. Total yield in 2008 was 3 242t and coastal States' yield was 271t.

	Short term target (2010)		Equilibrium target
	F = Fmsy	F = transition	F = Fmsy
F	0.41	0.31	0.41
Total yield	4 747	3 543	3 545
Surplus (meth 1)	4 747	3 543	3 545
Surplus (meth 2)	4 747	3 543	3 545
Surplus (meth 3)	4 747	3 543	3 545
Coastal States yield (meth 1)	0	0	0
Coastal States yield (meth 2)	0	0	0
Coastal States yield (meth 3)	0	0	0
Coastal States effort ratio (meth 1)	-	-	-
Coastal States effort ratio (meth 2)	-	-	-
Coastal States effort ratio (meth 3)	-	-	-

In such a case, assuming that the coastal state will not develop a new fishery, the surplus is of course equal to the total available catch in all methods and targets (i.e. the TAC on the short term and the MSY in the long term).

8.4 Surplus Uncertainty

Because surplus is estimated using the outputs from a stock assessment model, it is possible to investigate how uncertainty in the stock assessment feeds through to the surplus estimate. The EWG carried out an exercise using *S.aurita* data from the 2011 CECAF assessment to illustrate an approach to estimating uncertainty both in the stock assessment and in estimates of surplus. The CECAF stock assessment for *S.aurita* is a Pella-Tomlinson biomass dynamic model with environmental covariates which here is approximated by a Schaeffer biomass dynamic model without environmental covariates; the intention is not to replicate the CECAF assessment just to approximate it.

The key parameters of interest used for estimating MSY reference points and surplus are the growth rate r and carrying capacity K. A good way to carry the uncertainty in r and K through to surplus is to generate pairs of r and K values in such a way that they reflect what the data can tell you about these parameters. Surplus can then be calculated on each r and K pair, resulting in a range of surplus estimates that incorporate the uncertainty from the assessment. Pairs of r and K values were generated by fitting a Bayesian version of the model using an MCMC sampling algorithm - the approach taken was to use an implementation of the model in ADMB (Fournier et al, 2012) and use the built in MCMC option to take 1000 samples after thinning by 10. Uniform priors were placed on each model parameter.

8.4.1 Uncertainty in the assessment

A by-product of this exercise is that the nature of the uncertainty in the stock assessment can be investigated. In particular, parameter estimation in biomass dynamic models is often problematic when the data does not have enough contrast to disentangle the growth rate and the carrying capacity. This typically results in a strong non-linear correlation between r and K and for *S.aurita* (at least for the approximating model used) the data are such that there is also strong bimodality in the r-K distribution. This can be seen in the contour plot of the posterior density of r and K in Figure 8.4.1. The implication is that model fits are likely to be highly sensitive to starting values used in the optimising procedure unless a global optimiser is used.

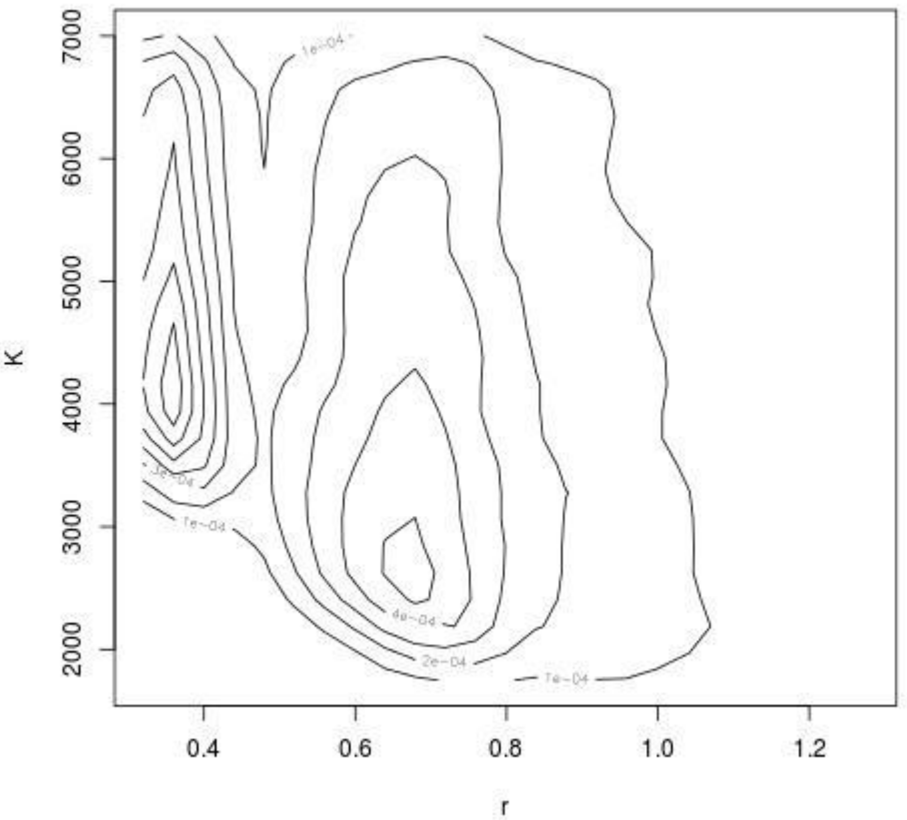

Figure 8.4.1 - Joint uncertainty in the estimates of growth rate r and carrying capacity K from the approximate assessment of *S.aurita*. The contours show the estimate of the posterior density surface from 1000 MCMC samples.

8.4.2 Uncertainty in surplus

Surplus was estimated using the approaches described in the response to ToR3. Given a single sample from the model parameters it is straightforward to forecast yield based on a transition rule for achieving Fmsy. The transition rule considers a status quo harvest rate for 2011 and 2012 moving to Fmsy in 2015 in three steps, unless status quo harvest rate is below Fmsy in which case the move is to Fmsy in one step. Combining all the estimates of yield and surplus obtained from each sample of the assessment model parameters results in a distribution of yield and surplus for each forecast year incorporating the uncertainty in the stock assessment.

A summary of the forecasts are given in Figure 8.4.2 showing the evolution of harvest rate, stock biomass and total yield. Figure 8.4.3 shows the estimates of surplus, coastal State yield and coastal

State effort ratio for two of the methods described before, the first surplus calculation assumes that the proportion of the coastal state effort is fixed (method 1) and the other assumes that the proportion of the yield taken by the coastal State is fixed (method 2). The current total yield and harvest rate is taken as the mean of the years 2008 to 2010. The current proportion of total yield that the coastal country takes is assumed to be 0.8. The first row shows the ratio between the harvest rate in that year and the current harvest rate of the coastal country. The second row shows the surplus (the difference between the TAC and the yield taken by the coastal country. The third row shows the yield taken by the coastal country.

8.4.3 Comments

The estimates of r and K from the approximate assessment using ADMB was r = 0.32 and K = 4495, while the estimates from the CECAF assessment was r = 0.65 and K = 1750. These estimates (allowing for discrepancies in the estimates of K due to environmental covariates) are broadly consistent with Figure 8.4.1 with each assessment focusing on a different mode. Which is the correct mode is not clear and is perhaps a choice that should be guided by expert knowledge. The simulations were made based on the distribution of r and K given in Figure 8.4.1 which is has more density on the high K, low R peak (rather than the low K, high r peak estimated by CECAF). This resulted in 800 of the 1000 simulations defining the *S.aurita* stock as underexploited in that the status quo harvest rate was below Fmsy. The forecast simulations and surplus estimates, therefore, show similar results as the underexploited example in the response to ToR 3. Since there are more underexploited simulations, the harvest rate mostly increases resulting in decreases in biomass. For method one (constant F / harvest rate) this results in a decrease in the coastal yield while surplus on average increases, however the uncertainty is large: approximate 95% interval for the surplus estimate for method 1 in 2015 is between 0 and 1120 while for surplus in 2012 is between 75 and 105. For method 2 (constant catch proportion) the coastal yield increases as the yield increases requiring the coastal state to increase effort while surplus remains relatively constant: the approximate 90% interval for the surplus estimate for method 2 in 2015 is between 50 and 280while for surplus in 2012 is between 75 and 105.

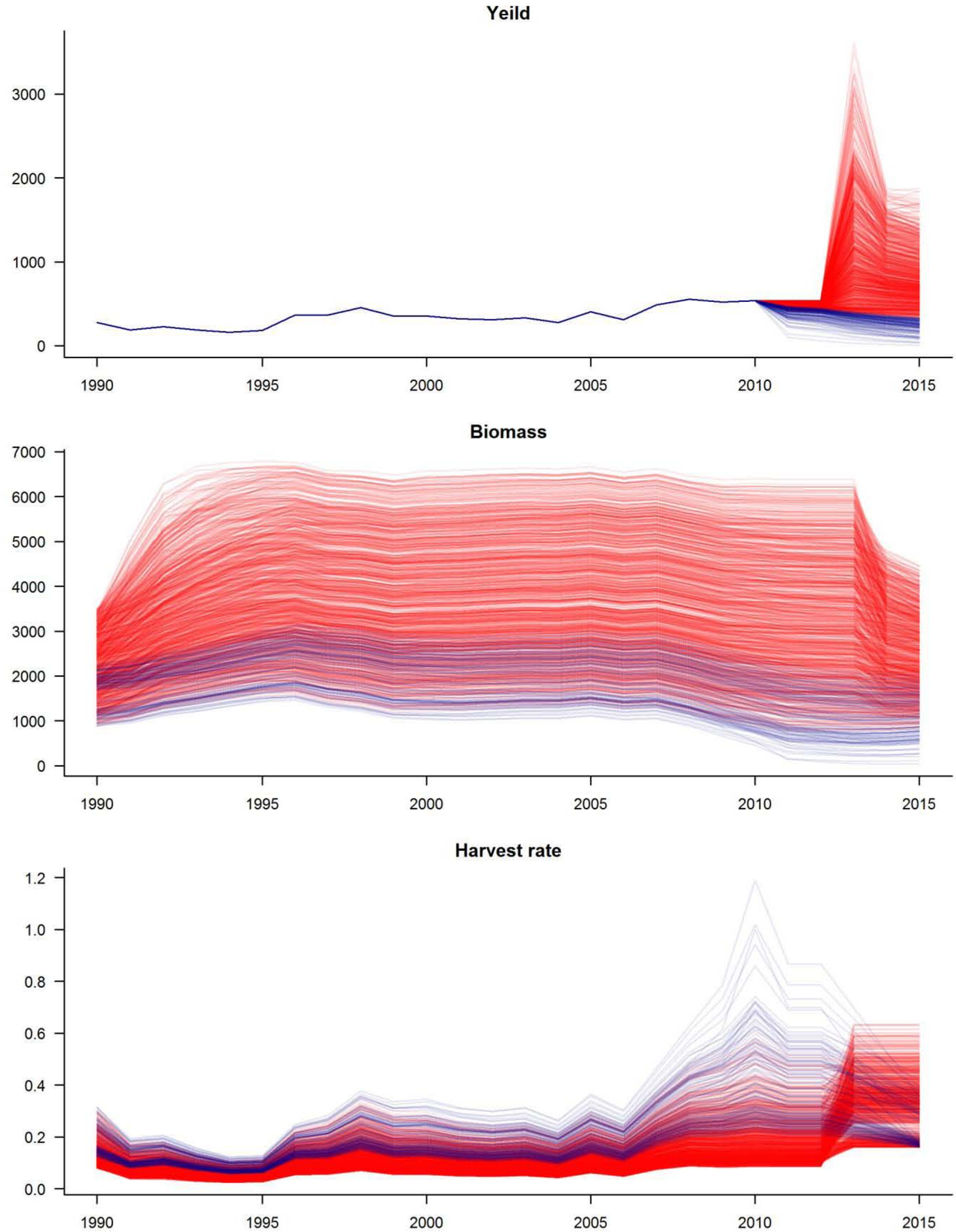

Figure 8.4.1 - Uncertainty on assessment model parameters propagated through the projection up to 2015. 1000 simulations are plotted with each line coloured according to the perception of the stock in that simulation: blue is over-exploited, red is under-exploited.

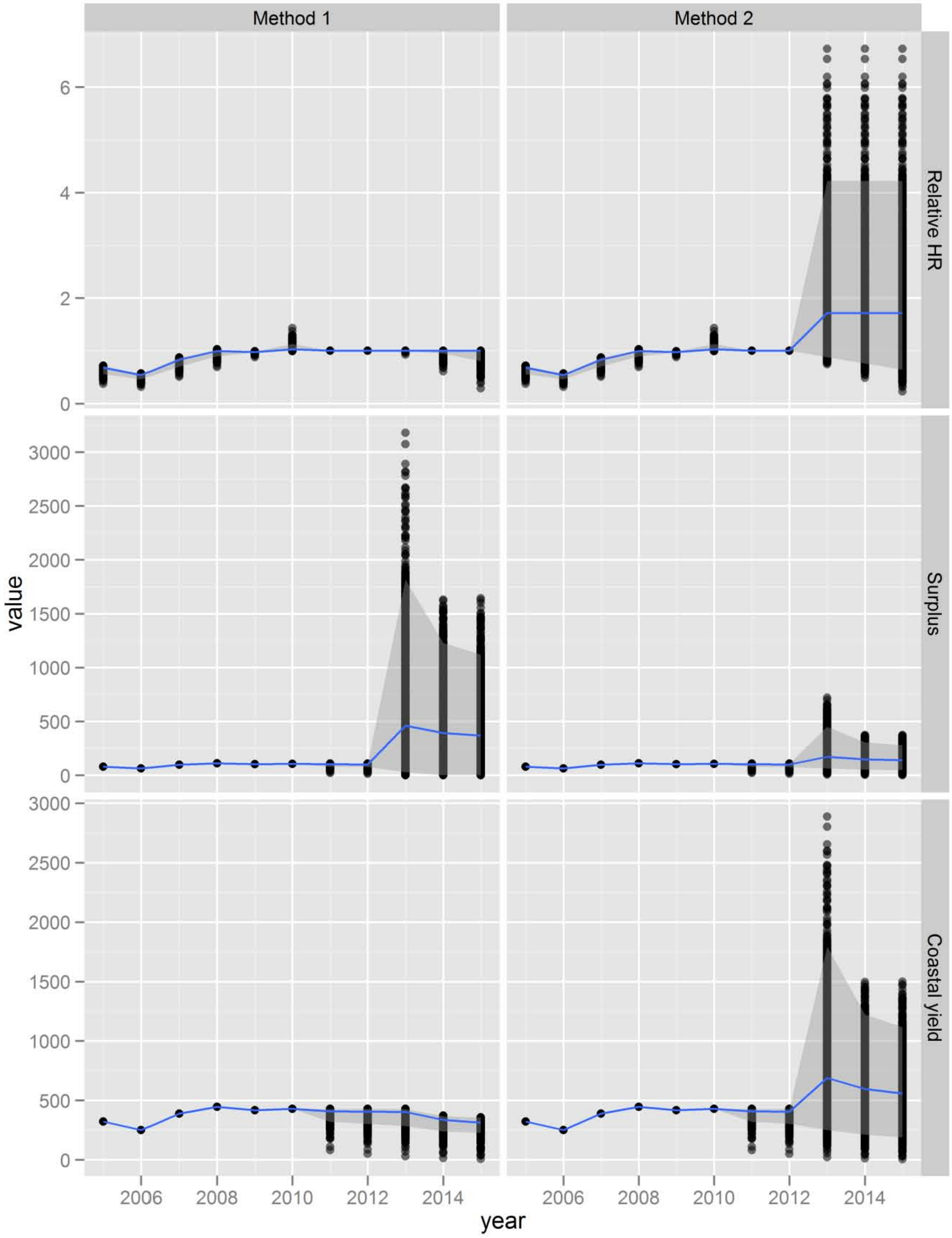

Figure 8.4.2 - Surplus estimates and related indicators along with the variability induced by the uncertainty in the assessment model parameters. Shaded regions show approximate point-wise 90% (credible) intervals and the opaque dots show the underlying full distribution.

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11 List of Background Documents

Background documents are published on the meeting’s web site on:
http://stecf.jrc.ec.europa.eu/web/stecf/ewg04

List of background documents:

1. EWG-12-04 Doc 1 - Declarations of invited and JRC experts.
2. EWG-12-04 Doc 2–Jardim, E., Mosqueira, I., Millar, C., Osio, C.&Charef, A. 2012. MSE testing of factors likely to have an effect on catch surplus calculations through impacting MSYestimates.JRC Scientific and Policy Report JRC 72625. EUR 25389 EN, ISBN 978-92-79-25438-3, ISSN 1831-9424, doi:10.2788/33845. Luxembourg (Luxembourg): Publications Office of the European Union. 20 p.

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Abstract

The STECF Expert Working Group EWG-12-04 International Dimension met in Varese, Italy, 4-8 June 2012. The EWG Report was reviewed and by the STECF at its 40th plenary session held in Copenhagen from 9-13 July 2012.

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The Scientific, Technical and Economic Committee for Fisheries (STECF) has been established by the European Commission. The STECF is being consulted at regular intervals on matters pertaining to the conservation and management of living aquatic resources, including biological, economic, environmental, social and technical considerations.

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