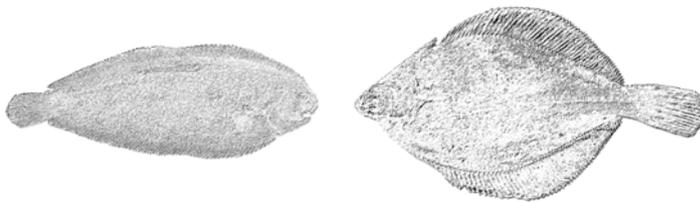


Ex post and *ex ante* evaluation of
the long term management plan
for sole and plaice in the North
Sea (part 1): *ex post*

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Summary

This report describes the first part of an ex post and ex ante evaluation of the long term management plan for sole and plaice in the North Sea as laid out in Council Regulation (EC) No 676/2007. This plan has been in place since 2007. The plan aims to ensure, in its first stage, that the stocks of plaice and sole in the North Sea are brought within safe biological limits. This shall be attained by reducing the fishing mortality rate on plaice and sole by 10 % each year, with a maximum TAC variation of 15 % per year until safe biological limits are reached for both stocks. These measures are to be further supported by imposing limits on the effort of fleets fishing these stocks. Following this, and after due consideration by the Council on the implementation methods for doing so, the plan will ensure that the stocks are exploited on the basis of maximum sustainable yield and under sustainable economic, environmental and social conditions.

The evaluation of the plan includes an examination of its implementation, and the stock and fleet dynamics in relation to the measures and objectives of the plan. The stock dynamics were evaluated using two different stock assessment models: an XSA model and a statistical catch at age (SCA) model. Changes in fleet dynamics were evaluated in terms of overall fishing effort and number of vessels in the Dutch beam trawl and otter trawl fleets.

The regulations in the Council Regulation have been used as the basis for establishing TACs for North Sea plaice and sole for the last two years. However, the actual implementation of these regulations has required a degree of interpretation by those implementing them. The regulations by themselves lack transparency, without proper specification of how they are to be implemented (e.g. how F_{sq} is to be calculated) and how the achievement of objectives is to be assessed (neither in terms of the model used to specify this, nor in the level of uncertainty that is acceptable).

The multiannual plan, without further specifications than the regulations alone, can appear to lack direction. A simple 10% reduction from an unclearly defined F_{sq} does not necessarily steer the stock towards the objectives. This is especially true given retrospective problems in the North Sea plaice and sole stock assessment. A stepwise decrease in the 'distance' between current F and the target F , while potentially invoking the 15% TAC change more often, may be more successful in assuring progress towards the objectives and prevent issues such as the projected increase in sole F from 2008 to 2009.

The rationale for the target fishing mortality reference points in the long term management plan is not given in the Council Regulation. The objective F for the North Sea plaice stock is similar to, though slightly high than, the current proxy of F_{MSY} for this stock as used by ICES. In the case of North Sea sole, the management objective F lies within the broad range of potential proxies for F_{MSY} for the stock. North Sea plaice F is currently below the target F level while, a significant decrease in the F of North Sea sole is still required, especially considering that the current management F for the stock is likely to represent an increase in F from 2008 to 2009. In this context, the long term management plan will steer towards a further decrease in fishing effort by the main fleets targeting sole and plaice.

Under the multiannual plan, the North Sea plaice TAC has been increasing. This increasing trend is likely to persist as long as the stock continues to recover because fishing in the near future should fluctuate around what is considered to be the optimum F for long term sustainable yields. Discarding levels remain high, but currently they are near the lowest level of the past ten years and show a downward trend. North Sea sole TACs have stabilised to a degree under the multiannual plan in the most recent years, but these are likely to continue to fluctuate depending on the strength of incoming year classes.

The data available to analyse the stock dynamics under the multiannual plan allow the following conclusions to be drawn with respect to the chosen reference points and the safe biological limits of the stock:

- Spawning Stock Biomass (SSB) of both species have increased since the implementation of the plan. Plaice has a larger than 95% probability of having reached a stage where the SSB is above B_{pa} for two consecutive years. The XSA stock assessment indicates that this is also the case for sole. An alternative assessment including uncertainty estimates indicate that the probability of being above B_{pa} is not yet larger than 95%.
- The annual fishing mortality rates (F) of the two stocks have been declining in recent years. The North Sea plaice stock is now fished at a level below the management regulation target for this stock (<0.3 per year).

The annual rate of F for the North Sea sole stock remains above the management regulation target for this stock (>0.2 per year).

- According to the latest assessment results, both stocks appear to be within the precautionary zone with regards to SSB and F in 2008.

Hence, despite a lack of clarity in the implementation of the management regulations, the multiannual plan, given the current perception of the stock, appears to be resulting in stock trajectories and fishing levels moving towards the desired objectives and is, therefore, in line with the principles of the precautionary approach.

In the first year of its implementation (2008), it appears that the effort regulations defined for the multiannual plan have been having the desired effect. Overall fishing effort has declined, along with a decrease in the size of the main fishing fleets utilising these resources. These reductions in effort seem to be compensating for issues relating to the practical application of management regulations on the setting of TACs.

1 Introduction

In 2007, the European Commission adopted Council Regulation (EC) No 676/2007, establishing a multiannual plan for fisheries exploiting stocks of plaice and sole in the North Sea (Appendix A). The objective of the plan is to ensure, in its first stage, that stocks of plaice and sole in the North Sea are brought within safe biological limits. This shall be attained by reducing the fishing mortality rate on plaice and sole by 10 % each year, with a maximum TAC variation of 15 % per year until safe biological limits are reached for both stocks. Following this, and after due consideration by the Council on the implementing methods for doing so, the plan will ensure in its second stage that the stocks are exploited on the basis of maximum sustainable yield and under sustainable economic, environmental and social conditions.

The adopted plan should be the main instrument for flatfish management in the North Sea, and should contribute to the recovery of other stocks such as cod. In drawing up the multiannual plan, the Council tries to take into account the fact that the high fishing mortality rate for plaice is to a great extent due to the large discards from beam-trawl sole fishing with 80mm nets in the southern North Sea. The control of the fishing mortality rates envisaged in the plan is to be achieved by establishing an appropriate method for the establishment of the level of total allowable catches (TACs) of the stocks concerned, and a system including limitations on permissible days at sea. Fishing effort on the stocks is restricted to levels at which the TACs and planned fishing mortality rates are unlikely to be exceeded, but are sufficient to catch the TAC allowed on the basis of the fishing mortality rates established in the plan.

The impact of the management measures on the stocks concerned and the fisheries on those stocks shall be evaluated in the second year of application of the regulation and in each of the following years. Also, the Commission shall seek scientific advice from the STECF on the rate of progress towards the objectives of the multiannual plan in the third year of application of the regulation, and each third successive year of application of the regulation.

In order to ensure sufficient input to the proposed evaluation by the Commission, Wageningen IMARES is evaluating the plan, in a study commissioned by the Dutch Ministry of LNV. The evaluation will comprise an *ex post* comparison of the historic performance against the objectives mentioned in the plan, and an *ex ante* test of the plan in terms of its sustainability as defined by ICES.

2 Assignment

In this report, the first tri-annual *ex post* evaluation of the long term management plan for sole and plaice in the North Sea described in Council Regulation EC 676/2007 is presented. It provides background information on the reference points used as objectives in the management regulations and evaluates the implementation of the management regulations by examining the progress of the multiannual plan to date. To this end, the trends in Spawning Stock Biomass (SSB), fishing mortality (F) and fishing effort are documented. These trends are then compared to the forecasted scenarios in an earlier *ex ante* evaluation (Machiels et al. 2008)

3 Materials and Methods

3.1 The management regulation

We follow the description of the long term management plan in Council Regulation EC676/2007 by Machiels et al. (2008):

Objectives

On 11 June 2007 the Council of the European Union adopted a management agreement for fisheries exploiting stocks of plaice and sole in the North Sea. The multiannual agreement should be deemed to be a recovery phase during its first stage and a management plan during its second stage, within the meaning of art 5 and 6 of the

Council Framework Regulation adopted under the reform of the Common Fisheries Policy (Council Regulation (EC) No 2371/2002).

In its first stage the objective of the plan is to ensure that stocks of plaice and sole in the North Sea are brought within safe biological limits, and in a second stage and after due consideration by the Council on the implementing methods for doing so that those stocks, are exploited on the basis of maximum sustainable yield and under sustainable economic, environmental and social conditions.

The operational objectives of the first stage of the agreement are to bring the two stocks to within safe biological limits. For plaice, these safe biological limits are a fishing mortality below 0.6 and an estimated spawning biomass exceeding 230 000 ton. For sole the safe biological limits are a fishing mortality below 0.4 and 35 000 ton. TACs applied will correspond with fishing mortality that will be reduced by 10% year-on-year until the target levels have been reached, while annual variations in TACs will be kept within 15%. According to article 5 of the Regulation the Council will amend the agreed plan when the stocks of plaice and sole have been found to have returned to within safe biological limits for two years in succession. The council shall decide on the basis of a review proposal from the European Commission that will permit the exploitation of the stocks at a fishing mortality rate compatible with maximum sustainable yield. The proposal for review shall be accompanied by a full impact assessment that takes into account the opinion of the North Sea Regional Advisory Council.

Advice on long-term management from ICES indicates that at low target fishing mortalities (considerably lower than the present levels), low risk to reproduction and high long-term yields are achieved simultaneously. The general pattern is that there is no conflict between the two objectives. A low fishing mortality will lead simultaneously to high yield and a low risk to reproduction (lower than the 5-10% risk which has generally been considered acceptable by managers).

Measures

The legal management measures agreed on by the Council of the European Union are given in Chapter II of the Regulation (total allowable catches). Chapter I deals with subject-matter and objective (Article 1-4).

Article 6

Setting of total allowable catches (TACs)

1. Each year, the Council shall decide, by qualified majority on the basis of a proposal from the Commission, on the TACs for the following year for the plaice and sole stocks in The North Sea in accordance with Articles 7 and 8 of this Regulation.

Article 7

Procedure for setting the TAC for plaice

1. The Council shall adopt the TAC for plaice at that level of catches which, according to a scientific evaluation carried out by STECF is the higher of:
 - a. that TAC whose application will result in a 10% reduction in the fishing mortality rate in its year of application compared to the fishing mortality rate estimated for the preceding year.
 - b. that TAC whose application will result in the level of fishing mortality rate of 0.3 on ages 2 to 6 in its year of application.
2. Where application of paragraph 1 would result in a TAC which exceeds the TAC of the preceding year by more than 15%, the Council shall adopt a TAC which is 15% greater than the TAC of that year.
3. Where application of paragraph 1 would result in a TAC which is more than 15% less than the TAC of the preceding year, the Council shall adopt a TAC which is 15% less than the TAC of that year.

Article 8

Procedure for setting the TAC for sole

1. The Council shall adopt a TAC for sole at that level of catches which, according to a scientific evaluation carried out by STECF is the higher of:
 - a. that TAC whose application will result in the level of fishing mortality rate of 0.2 on ages 2 to 6 in its year of application;
 - b. that TAC whose application will result in a 10% reduction in the fishing mortality rate in its year of application compared to the fishing mortality rate estimated for the preceding year.

2. Where the application of paragraph 1 would result in a TAC which exceeds the TAC of the preceding year by more than 15%, the Council shall adopt a TAC which is 15% greater than the TAC of that year.
3. Where the application of paragraph 1 would result in a TAC which is more than 15% less than the TAC of the preceding year, the Council shall adopt a TAC which is 15% less than the TAC of that year.

Article 9

Fishing effort limitation

1. The TACs referred to in Chapter II shall be complemented by a system of fishing effort limitation established in Community legislation.
2. Each year, the Council shall decide by a qualified majority, on the basis of a proposal from the Commission, on an adjustment to the maximum level of fishing effort available for fleets where either or both plaice and sole comprise an important part of the landings or where substantial discards are made and subject to the system of fishing effort limitation referred to in paragraph 1.
3. The Commission will request from STECF a forecast of the maximum level of fishing effort necessary to take catches of plaice and sole equal to the European Community's share of the TACs established according to Article 6. This request will be formulated taking account of other relevant Community legislation governing the conditions under which quotas may be fished.
4. The annual adjustment of the maximum level of fishing effort referred to in paragraph 2 shall be made with regard to the opinion of STECF provided according to paragraph 3.
5. The Commission shall each year request the STECF to report on the annual level of fishing effort deployed by vessels catching plaice and sole, and to report on the types of fishing gear used in such fisheries.
6. Notwithstanding paragraph 4, fishing effort shall not increase above the level allocated in 2006.
7. Member States whose quotas are less than 5% of the European Community's share of the TACs of both plaice and sole shall be exempted from the effort management regime.
8. A Member State concerned by the provisions of paragraph 7 and engaging in any quota exchange of sole or plaice on the basis of Article 20(5) of Regulation (EC) No 2371/2002 of 20 December 2002 on the conservation and sustainable exploitation of fisheries resources under the Common Fisheries Policy that would result in the sum of the quota allocated to that Member State and the quantity of sole or plaice transferred being in excess of 5% of the European Community's share of the TAC shall be subject to the effort management regime.
9. The fishing effort deployed by vessels in which plaice or sole are an important part of the catch and which fly the flag of a Member State concerned by the provisions of paragraph 7 shall not increase above the level authorised in 2006.

3.2 Background information on reference points

The fishing mortality target reference point for North Sea sole mentioned in Council Regulation (EC) No 676/2007, originates from "a committee of experts examining multi-annual management plans". This committee indicates that "the highest yield of sole can be taken at a fishing mortality rate of 0.2 on ages two to six years". Although it is not explicitly stated which committee report is referred to in this case, it is very likely to be the report of the Report of the ICES ad hoc Group on Long Term Advice (AGLTA) in 2005 (ICES 2005). Likewise, the fishing mortality reference point for plaice is based on an advice from the Scientific, Technical and Economic Committee for Fisheries (STECF) that the fishing mortality rate necessary to produce the highest yield from the stock of plaice in the North Sea in the long term is 0.3.

The target F values can be compared to long term maximum sustainable yield proxies given by ICES. For North Sea plaice, ICES considers F_{\max} a candidate for the reference point consistent with taking high long-term yields. Currently, F_{\max} is estimated to be 0.17 (ICES 2009). This value is thus lower than the target in the management plan. For sole, for which F_{\max} is poorly defined, candidates for reference points consistent with high long-term yields (and a low risk of depleting the productive potential of the stock) are in the range of $F_{0.1}$ - F_{pa} . With $F_{0.1}$ being estimated at 0.11 per year, and F_{pa} being estimated at 0.4, a proxy for the high long term yield is thus found in between this range of 0.11-0.4.

It should be noted that the use of single species estimation of biological reference points, such as the ones used in the management plan and the proxies for long term maximum yields, is currently under much study. For

several North Sea roundfish species, ecosystem model results suggest that it is not possible to simultaneously achieve yields corresponding to MSYs predicted from single-species assessments (Mackinson et al. 2009). However, for North Sea plaice and sole, no ecosystem model is currently available to test such hypotheses, mainly due to insufficient diet data needed to parameterize predator prey relations in the sole and plaice food webs. However, the extent to which this applies to the co-management of these two North Sea flatfish species is unclear. There is no strong predator-prey relationship between these two species and common resource limitation, at least in the short term, seems unlikely with both stocks still below the stock biomass level required to produce maximum sustainable yield. The distributions of the two stocks do not overlap completely, with more adult plaice found further north and sole found predominantly further south in the coastal regions. Discard mortality in plaice does not appear to be related to the fishing mortality exerted on sole (results not shown here), so mixed fishery issues should not prevent the simultaneous achievement of both MSY objectives..

This ill-defined connectivity between the F levels of these two stocks makes it difficult to define an 'optimal' ratio of plaice F_{MSY} to sole F_{MSY} . The proportionality between the fishing mortality targets for North Sea plaice and sole, expressed as F_{plaice}/F_{sole} , is 1.5, although in the long term values would be expected to fluctuate around this. Historically, the proportionality between the two F values (Figure 3.1) has generally been lower than this (1.18 on average). However, there have been periods where it was at 1.5 or above. Given the current estimated fishing mortality rates of the two stocks of 0.75 it is likely that the fishing patterns of the fleets will have to change if the factor of 1.5 is to be achieved. In recent years the ratio of plaice to sole landings catchability (q , calculated as landings F divided by the fleet effort corrected for the selectivity of the fleet) has decreased from 0.60 in 2004 to 0.49 in 2006 and further to 0.37 in 2008, the last year of effort data available for this analysis. This reflects the focusing of fishing effort in the southern North Sea, nearer to the landings ports, in the face of high fuel costs over this period. Reconciling the target F s in the long term will require a reversal in the current trend of catchabilities. In other words, catchability of the plaice stock will need to increase in relation to that of the sole stock, and this is most likely to be achieved with a northward shift in the centre of gravity of the effort by the fleets fishing these two stocks. It is expected that if plaice TACs continue to increase at a greater rate than those for sole this is likely to occur. However, it may be that target ranges of F for each species, rather than point values, are necessary to allow simultaneous achievement of objectives for both stocks.

This issue of reconciling the target F s in the long term will be examined further in part 2 of this report, the *ex ante* evaluation.

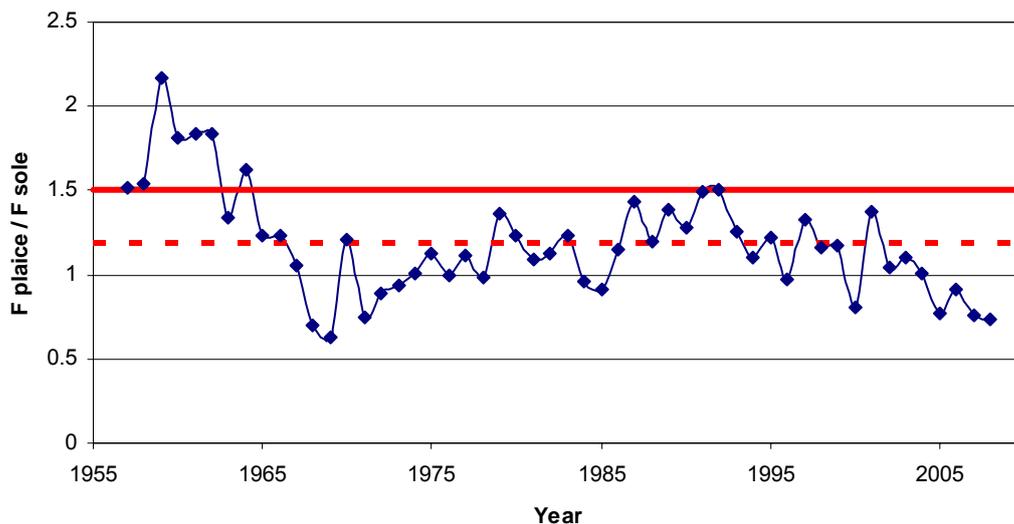


Figure 3.1. Time series of proportionality of sole and plaice fishing mortality, expressed as F_{plaice}/F_{sole} . The solid horizontal red line indicates the same proportionality in the target F values in the multi-annual plan (1.50), and the dashed horizontal red line indicates the mean value over the whole period (1.18).

3.3 Evaluation of the progress of the management plan to date

The management plan was evaluated, describing the implementation of the management plan, and the stock and fleet dynamics in relation to the measures and objectives of the plan.

The stock dynamics were evaluated using two different stock assessment models: an XSA model and a statistical catch at age (SCA) model. The XSA models are currently used by ICES to assess the two stocks. Details of model configurations can be found in ICES (2009). These XSA models were also used as the basis of the previous *ex ante* management plan evaluation (Machiels et al. 2008). The new statistical catch at age (SCA) model (Appendix B) was originally derived for North Sea plaice by Aarts and Poos (2009) with an alternative treatment of discard estimations. This model was adapted for North Sea sole by removing the discard estimation component.

Changes in fleet dynamics were evaluated in terms of overall fishing effort and number of vessels in the Dutch beam trawl and otter trawl fleets.

4 Results

4.1 Management plan implementation

The management plan was published on the 11th of June 2007, coming into action on the 1st of July 2007. However, the advice of the ICES Advisory Committee on Fishery Management on the sole and plaice stock in the North Sea did not take the management plan into account when setting the TAC for 2008, because the plan was not evaluated by ICES. TACs were thus advised on the basis of bringing the stocks back to within biologically safe limits within one year. However, the actual TACs for North Sea sole and plaice set by the European Commission were based on the plan. The actual calculations for the TACs were done by STECF. As a result of this, the TAC for 2008 was the first outcome of the implementation of the management plan.

In addition to the TACs for sole and plaice in 2008 being an outcome of the rules in the management plan, the sea days were also restricted following Council Regulation (EC) No 40/2008. For beam trawlers with mesh sizes ≥ 80 mm and < 90 mm, the maximum days a vessel was allowed to be present in area IV was reduced from 132 days in 2007 to 119 days in 2008. For beam trawlers with mesh sizes ≥ 100 mm and < 120 mm, the maximum days a vessel was allowed to be present in area IV was reduced from 143 days in 2007 to 129 days in 2008.

In 2008, the management plan was evaluated by ICES, and found that for plaice, it could not yet conclusively be regarded as consistent with the precautionary approach. ICES concluded, however, that for sole the management plan could provisionally be accepted as precautionary. Subsequent TAC advice for 2009 and 2010 on the two flatfish species in the North Sea was then based on the management plan.

One of the implementation details that was not described in Council Regulation (EC 676/2007) was the exact specification of the calculation of the fishing mortality rate estimated for the year preceding the implementation of the TACs in article 7 and article 8. This lack of specification is problematic because the fishing mortality rate F in that year (the current year) cannot be known in the assessment year. Assumptions on the derivation of this F then of course strongly affect the level of TAC and the rate at which the F declines, especially in the case when the stock assessment shows a recurring estimation bias.

4.2 Trends in spawning biomass and fishing mortality

The objective of the plan is to ensure, in the first stage, that stocks of plaice and sole in the North Sea are brought within safe biological limits. Here we compare the historic trends of SSB and F to these initial management objectives.

Plaice is deemed to be within safe biological limits in those years in which (a) the spawning biomass SSB of the stock exceeds 230 000 tonnes, and (b) the average fishing mortality rate F on ages two to six years experienced by the stock is less than 0.6 per year. Sole is deemed to be within safe biological limits in those years in which (a) the spawning biomass of the stock exceeds 35 000 tonnes, and (b) the average fishing mortality rate on ages two to six years experienced by the stock is less than 0.4 per year. Once both stocks are considered to be within these safe biological limits for two successive years, the first stage of the multiannual plan is considered completed.

The SSB estimates for North Sea plaice from the two stock assessment models, the ICES XSA model and the Aarts and Poos (2009) SCA, are presented in Figure 4.1. There are some differences between the estimates from these two models; the SCA estimating slightly lower absolute levels of abundance. However, the general agreement between these models is good, particularly in the trends that they indicate. The spawning biomass of North Sea plaice has fluctuated within the range of the precautionary biomass limits over the recent period. Since 2004, an increase has been observed, gradual at first but more marked in the last two years. Both stock assessments indicate that this increase has left the stock above B_{pa} for two years (2008 and 2009) as required by the management regulation.

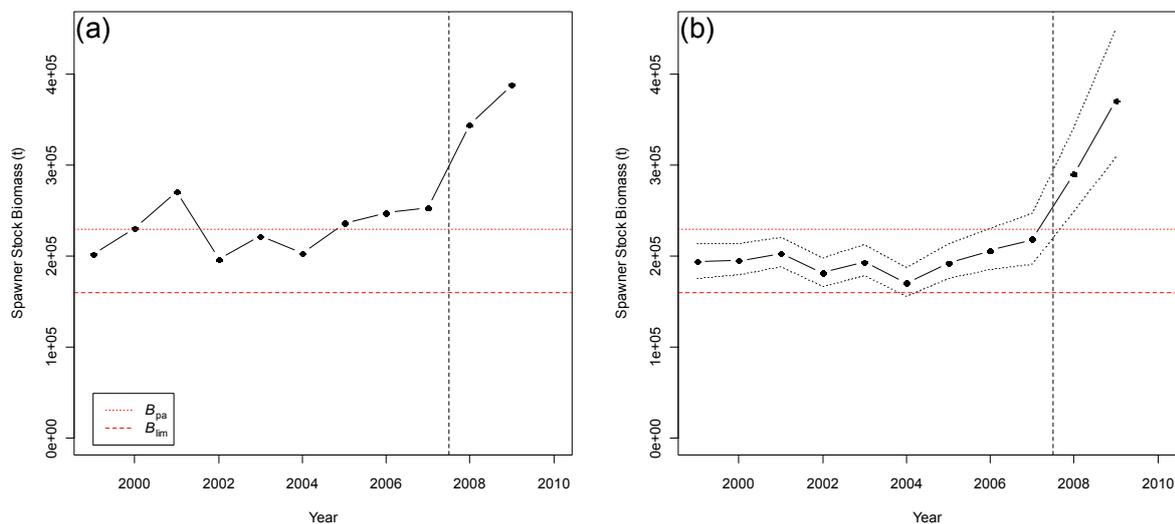


Figure 4.1. Recent North Sea plaice SSB estimates derived from (a) an XSA stock assessment with identical settings to the most recent ICES advice, and (b) a statistical catch at age stock assessment following Aarts and Poos (2009), with 95% confidence intervals (dotted lines). B_{pa} (230 000 t; dotted red line) and B_{lim} (160 000 t; dashed red line) reference points are indicated.

The SSB estimates for North Sea sole from the two stock assessment models are presented in Figure 4.2. The two models give almost identical results, both in trends and absolute estimates of abundance. The spawning biomass of North Sea sole has fluctuated considerably during the last ten years, in one case with observations being lower than B_{lim} in one year, and higher than B_{pa} in the next. In 2008, the SSB increased above B_{pa} , and remained there in 2009. However, the statistical catch at age model indicates that it is less than 95% certain that SSB has been above B_{pa} for these two consecutive years (2008 and 2009).

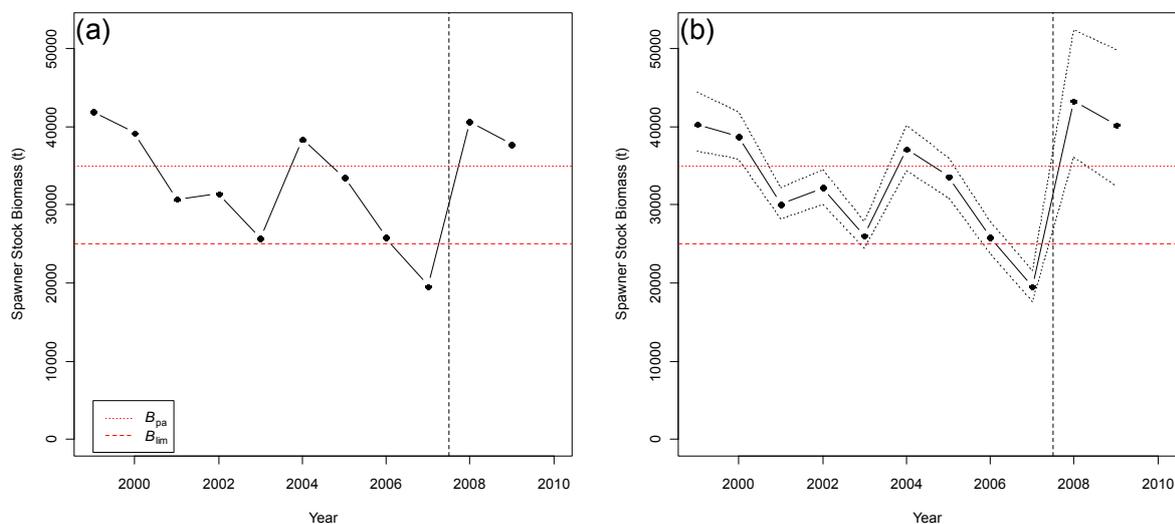


Figure 4.2. Recent North Sea sole SSB estimates derived from (a) an XSA stock assessment with identical settings to the most recent ICES advice, and (b) a statistical catch at age stock assessment following Aarts and Poos (2009), with 95% confidence intervals (dotted lines). B_{pa} (35 000 t; dotted red line) and B_{im} (25 000 t; dashed red line) reference points are indicated.

The most recent assessments are only able to estimate F values up to 2008. The fishing mortality rate for North Sea plaice (Figure 4.3) has decreased considerably over the last 6 years. This decline thus started *before* the implementation of the management plan. The two different stock assessments disagree on the absolute levels of F in the most recent period, but do agree on the downward trend. The perceived decrease has been even more marked, due to a substantial retrospective bias in the XSA assessment, which has downgraded the estimates of F for each of the last three assessments. As a result, the realized F in 2008 is lower than the F_{mgt} used to derive the TAC following the management regulations (Figure 4.3, red points). However, according to the latest XSA assessment, the F value in 2008 is estimated to be approximately 19% lower than the F value in 2007, exceeding the management regulation requirement of a 10% decrease.

Importantly, both stock assessments indicate that the F estimate in 2008 is below the target level, F_{tar} , of 0.3 per year. This means that, given a proper implementation of the long term management plan, the F values should fluctuate around this level for the next couple of years.

The fishing mortality rate for North Sea sole has shown a downward trend in recent years, although this trend is not as strong as that of plaice. Again, this decline started before the implementation of the management plan. The two different stock assessments conform closely on the absolute levels of F in the most recent period, with the XSA estimated levels of F falling within the confidence levels of the SCA estimates. Unlike the plaice assessment there has been no substantial retrospective bias in estimation of F in the last three years for North Sea sole. As a result, the realized F in 2008 is as was recommended by the management plan. However, according to the XSA assessment, the F value in 2008 is estimated to be approximately 17% lower than the F value in 2007.

The F values used to derive the TACs in 2008-2010 do not show a clear downward trend (Figure 4.4, red points). There are two reasons for this lack of trend. The increase from 2008 to 2009 is the result of the retrospective increase in the F estimates. The decrease from 2009 to 2010 is mainly a consequence of the method used to calculate F_{sq} to give the TAC advice. F_{sq} is calculated as the mean F of the previous three years and hence the high F value in 2005 was included in the calculation of F_{sq} for 2007 and 2008, but was not included in the calculation of F_{sq} in 2009. It should be noted that the actual trend in F in these years cannot yet be estimated.

Even though the F value for North Sea sole is estimated to be below F_{pa} , it remains well above the F target of 0.2 per year. Further reductions in fishing mortality are thus required to fulfil the objectives of the management plan.

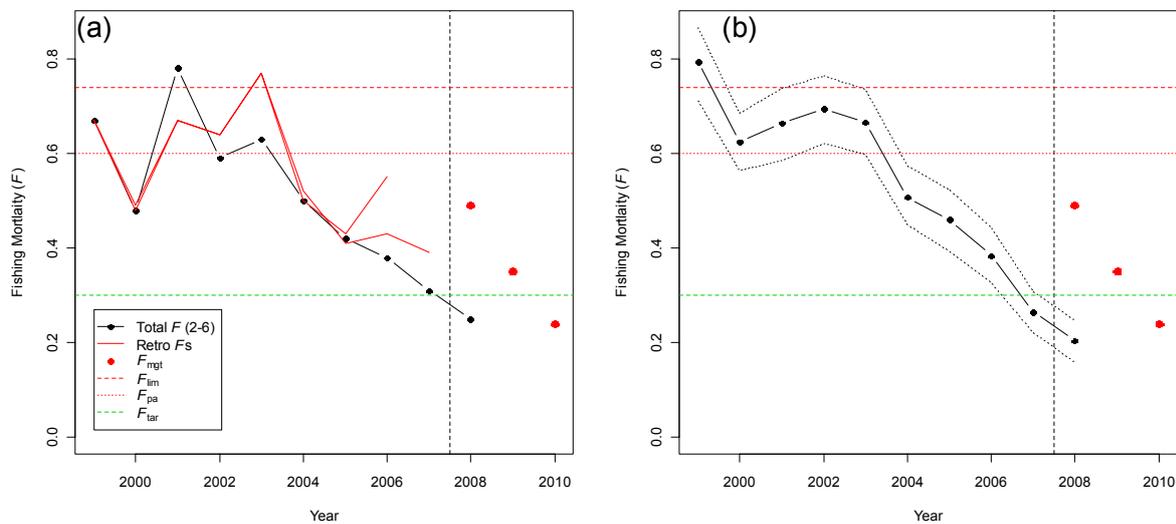


Figure 4.3. Recent North Sea plaice F estimates derived from (a) an XSA stock assessment, with identical settings to the most recent ICES advice, and (b) a statistical catch at age stock assessment following Aarts and Poos (2009), with 95% confidence intervals (dotted lines). The XSA retrospective error in the F estimate is indicated by red lines in panel (a). The F_{mgt} values on which the TAC advice was based are plotted in red (note: the value for 2010 is from the ICES advice and is at present a provisional value). F_{pa} (0.6; dotted red line), F_{lim} (0.74; dashed red line) reference points and the management regulation target F_{tar} (0.3; dashed green line) are indicated.

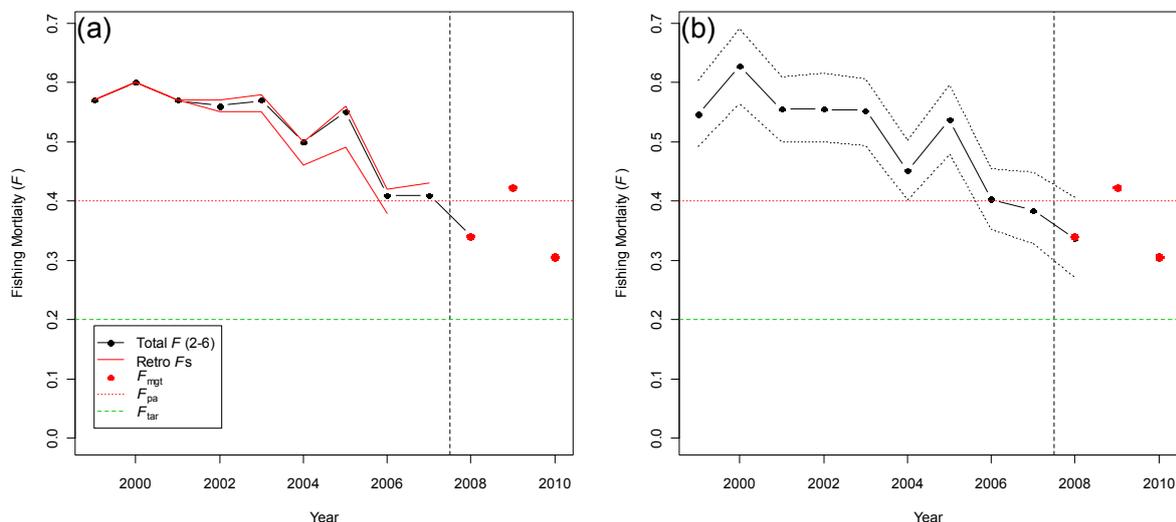


Figure 4.4. Recent North Sea sole F estimates derived from (a) an XSA stock assessment, with identical settings to the most recent ICES advice, and (b) a statistical catch at age stock assessment following Aarts and Poos (2009), with 95% confidence intervals (dotted lines). The XSA retrospective error in the F estimate is indicated by red lines in panel (a). The F_{mgt} values on which the TAC advice was based are drawn in red (note: the value for 2010 is from the ICES advice and is at present a provisional value). The F_{pa} (0.4; dotted red line) reference point and the management regulation target F_{tar} (0.3; dashed green line) are indicated. Note; F_{lim} is not defined for the stock.

4.3 Trends in TACs, landings and discards

Prior to the implementation of the management plan, TACs for North Sea plaice had decreased for 8 consecutive years (Figure 4.5). The first management plan TAC also represented a small (< 5%) decrease but subsequently for 2009 and 2010 TACs have represented large increases from the previous year. In 2010 the TAC recommendation based on the *F* value alone would have meant a greater than 15% increase in TAC, contravening article 7, item 2 of the management regulation. Therefore the TAC was increased by the maximum allowed increase of 15%, corresponding to an *F* lower than 0.3 per year. The actual landings correspond closely to the TACs for North Sea plaice, and have decreased over the last 8 years. Likewise, the discards have decreased, but there is no trend in the proportionality of discards over landings. As the fishing mortality is expected to stay at the current levels, which are lower than those observed earlier, this discard proportionality is expected to decrease if the selectivity pattern of the fishery stays constant.

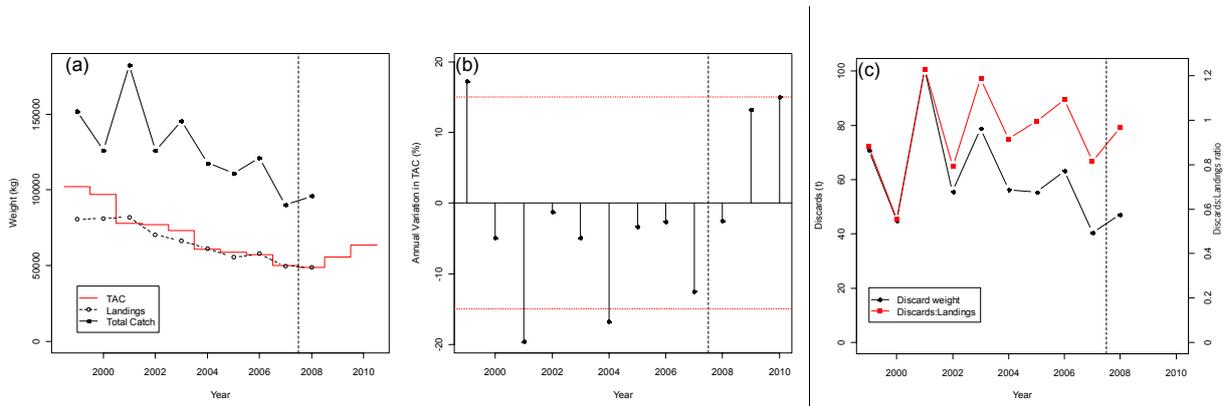


Figure 4.5. Recent trends in the fishery of North Sea plaice: (a) TACs and ICES estimates of landings (dashed lines), catch (solid lines); (b) annual percentage changes in TAC; and (c) ICES estimates of discards and the discard to landings ratio (red line).

The TACs for North Sea sole have fluctuated more over the recent period than those of North Sea plaice. The first management plan TAC represented a large decrease, just short of the 15% limit, but the TACs have increased thereafter for 2009 and 2010. The 15% TAC change regulation has not yet needed to be enforced for the North Sea sole. The actual landings do not correspond as closely to the TACs as is the case for North Sea plaice. The TAC was exceeded from 1999 to 2004, but following this sections of the TAC remained uncaught for three years. In the first year of the management plan the TAC was exceeded by approximately 10%.

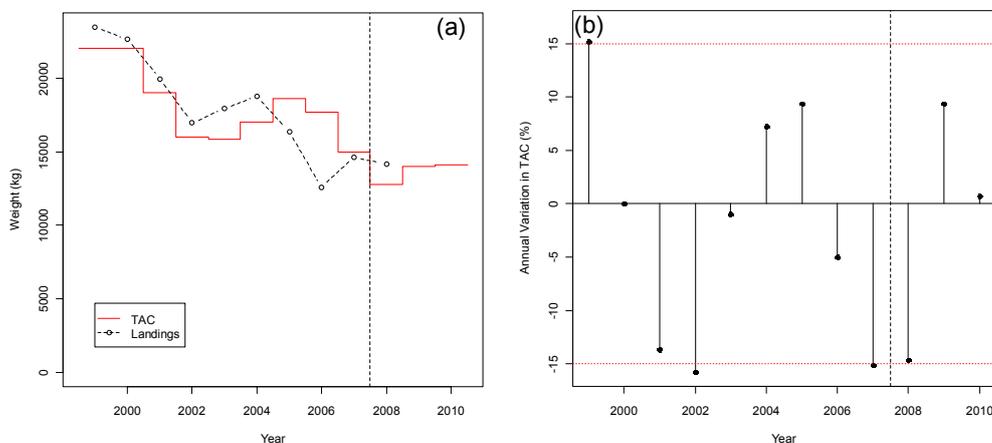


Figure 4.6. Recent trends in the fishery of North Sea sole: (a) TACs and ICES estimates of landings (dashed lines); and (b) annual percentage changes in TAC.

4.4 Trends in the fishing effort of the Dutch trawl fleet

The Dutch trawl fleets fishing in the North Sea have consistently been responsible for more than a third of the plaice landings and the majority of the sole landings from this area (ICES 2009). The Dutch fleet fishing for plaice and sole in the North Sea comprises two gear types: the main being the beam trawl (TBB) and the other being the Otter bottom trawl (OTB). The OTB fleet catches plaice, but at much lower catch rates than the TBB fleet. This lower catch rate, in combination with the much smaller OTB fleet size, makes the beam trawl fleet the main flatfish fishery in the Netherlands.

Both fleets can be divided into two main size classes based on the engine power (HP) of the vessels: ≤ 300 HP (HP class 1) and >300 HP (HP class 2). While the management regulation has no constraint controlling the number of vessels in the fleet, entry of new vessels into the fishery is controlled. Over the last six years the number of TBB vessels in the Dutch fleet has steadily decreased, mainly due to a reduction of HP class 2 vessels (Figure 4.7). There has also been a reduction in OTB vessels over this period, although for the last two years the number of these vessels has increased slightly. The number of HP class 1 OTB vessels has decreased notably and is remaining just short of 30 vessels, but the number of HP class 2 OTB vessels fluctuates more over the years and it is these vessels that are accounting for the overall increase over the last two years. Overall, the number of vessels in the Dutch fleet has decreased from approximately 290 in the years up to 2003, to just short of 190 in 2008, mainly due to the decrease in TBB vessels. This decrease in fleet size combined with the management regulations regarding days at sea per vessel has resulted in a decrease in the number of days at sea and number of horsepower days at sea. This decrease is sharpest in 2008 when a further 23 Dutch trawl vessels were decommissioned (ICES 2008).

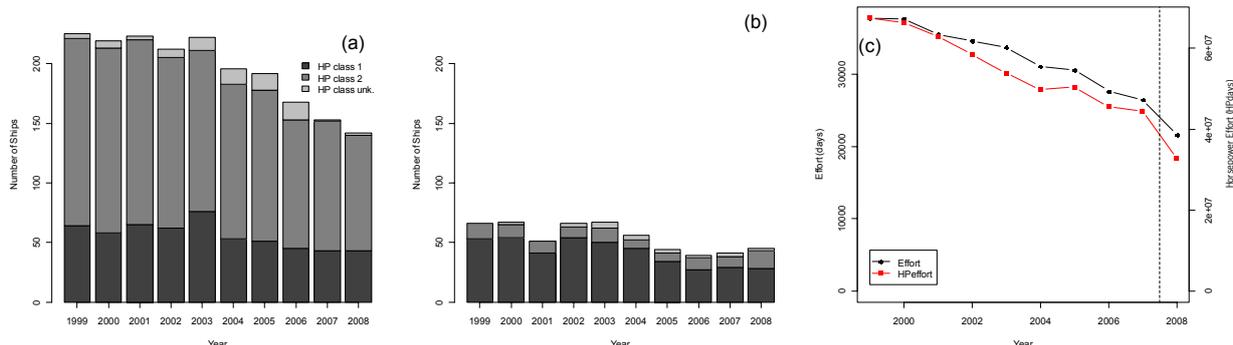


Figure 4.7. The number of vessels, with an effort of at least 10 sea days per year, in the Dutch fleets fishing for sole and plaice in the North Sea by HP class (HP class 1: ≤ 300 HP, HP class 2: >300 HP) for (a) the beam trawl (TBB) and (b) the Otter bottom trawl (OTB) gear type; and (c) total effort (black line, left axis) and HPeffort (red line, right axis) of the Dutch fleet (TBB and OTB combined).

The LPUE time series for plaice indicates that while the fishing effort went down, the LPUE went up during the last three years. This is in direct relation to the increase in plaice SSB. In 2008, the increase was especially large for the OTB gear type. The LPUE time series for sole indicates an increase in LPUE over the last 2 years, related to the strong recruiting 2005 year-class, that increased the SSB in 2008. It should be noted that the demersal otter trawl gear has much lower LPUEs than the beam trawl gear, especially for sole.

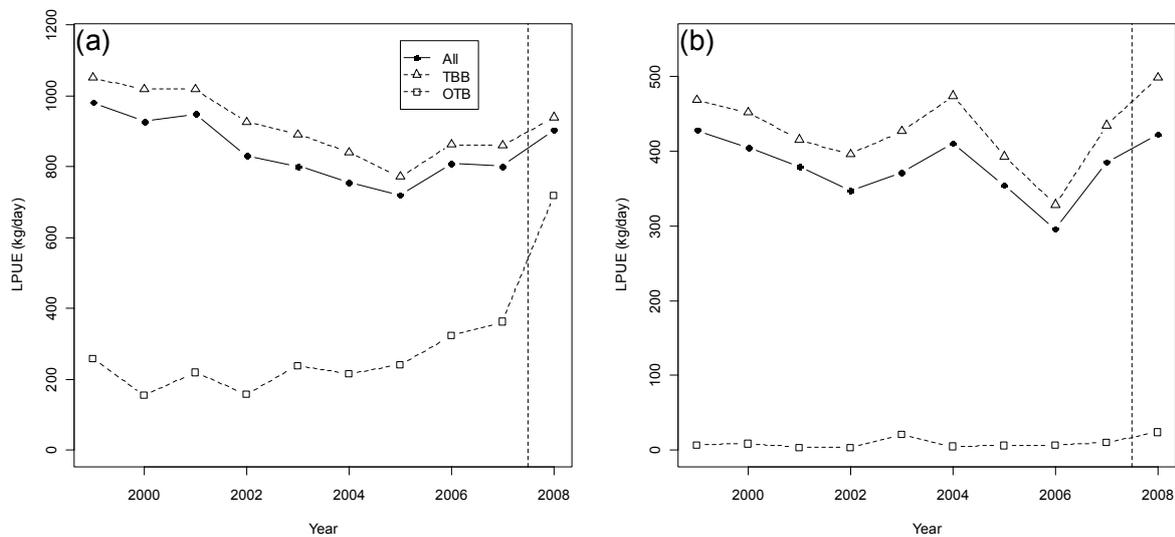


Figure 4.8. Landings per unit effort (LPUE) of the Dutch fleet fishing in the North Sea for (a) plaice and (b) sole, by gear and overall.

4.5 Comparison with previous evaluation scenarios

The previous *ex ante* evaluation of the multiannual plan (Machiels et al. 2008) was based on the 2007 ICES XSA assessment utilizing stock abundance estimates up to 2007 and fishery data up to 2006. Seven scenarios were modeled incorporating alternative fleet behaviours, interpretations of the application of the regulations and stock recruit models (see Machiels et al. 2008 for full details). However, none of these scenarios consider the possibility of a significant estimation error as to the current status of the stock. As a result, the projected scenarios of the North Sea plaice stock (Figure 4.x) all fail to match what is currently considered to be the current status and recent history of the stock. The retrospective decrease in F and increase in SSB has placed the stock out of the range of any of the projected scenarios. The projections of the North Sea sole stock (Figure 4.x) bear a closer resemblance to the current perception of stock status, indicating similar trends in F and SSB, due to the tighter retrospective pattern of this stock.

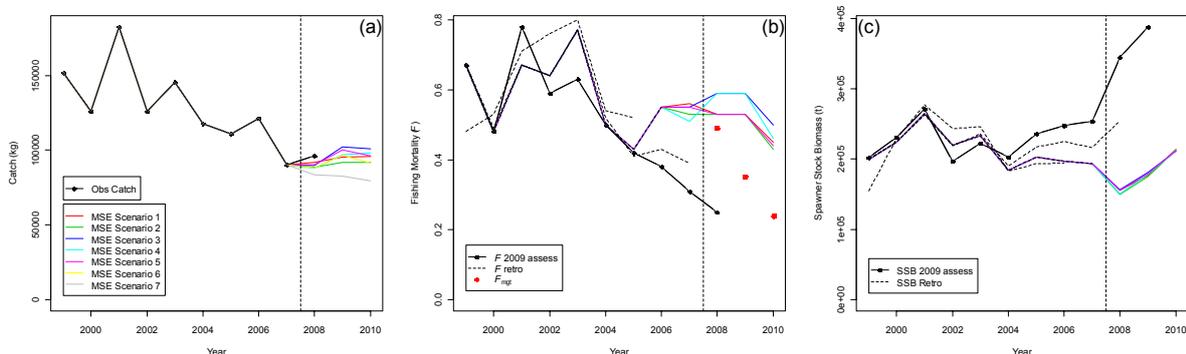


Figure 4.9. A comparison of the most recent ICES assessment for North Sea plaice and the seven evaluation scenarios (mean values) considered for this stock in the previous *ex ante* evaluation of the multiannual plan (Machiels et al. 2008) in terms of (a) catch, (b) fishing mortality and (c) spawner stock biomass.

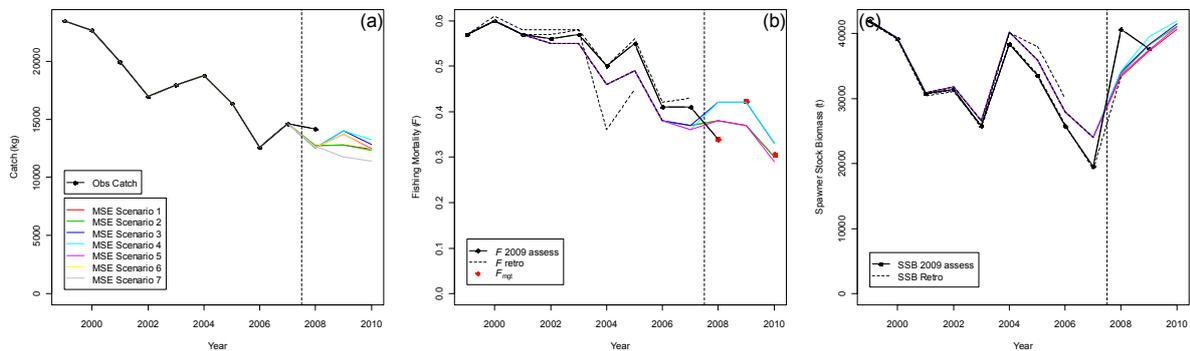


Figure 4.10. A comparison of the most recent ICES assessment for North Sea sole and the seven evaluation scenarios (mean values) considered for this stock in the previous *ex ante* evaluation of the multiannual plan (Machiels et al. 2008) in terms of (a) catch, (b) fishing mortality and (c) spawner stock biomass.

5 Conclusions

Following the implementation of the management regulations on 1st July 2007, as described in Council Regulation (EC) No 676/2007, only two years of *SSB* estimates, and one year of *F* estimates are available for the North Sea plaice and sole stocks. As a result, long term trends in the population dynamics following the implementation of the management plan cannot be described. However these preliminary results do indicate certain trends in stock and fleet dynamics and several conclusions can be drawn from this *ex post* evaluation of the stock and fleet dynamics. The results also highlight issues regarding the actual implementation of the management regulations.

The management regulations in Council Regulation (EC) No 676/2007 have been used as the basis for establishing TACs for North Sea plaice and sole for the last two years. However, the regulations by themselves lack transparency and the details of how these regulations are to actually be applied has required a degree of interpretation by those trying to implement them. In particular there is no specification of how F_{sq} is to be calculated. At present F_{sq} in year y has been calculated as the mean F of the previous three years ($y-3$ to $y-1$) rescaled to the selection pattern of the most recent year. Considering that the regulations call for a annual decrease in F , assuming the current F to be equal to the three years preceding it seems to be an unreasonable assumption likely to slow progress towards the objectives. In the most recent years ICES has provided advice based on the management plan that considers F_{sq} to be equal to the most recent F estimate, rescaled to the mean selection pattern of the last three years. It is likely that this interpretation of the implementation of the plan will be used in the *ex ante* evaluation although alternative interpretations of how to implement the regulations could be considered. For example, it could be assumed that the TAC will be caught exactly in the intermediate year and the F associated with this TAC, re-scaled, could be used as F_{sq} in the projection. Basing TAC calculations on F is also sensitive to any retrospective changes in perceived F and may in certain years lead to an increase in F from one year to the next (e.g. from 2008 to 2009 for sole). Furthermore, the regulations do not state how the achievement of objectives is to be assessed, neither in terms of the model used to specify this, nor in the level of uncertainty that is acceptable. In terms of evaluating the success of the management plan, the North Sea sole stock could be considered to be within the stock size safe biological limit if the level of uncertainty required is less than 20%. However, if it is required to be less than 5% this is not the case. A clear specification is required of the level of risk to be tolerated.

The multiannual plan without further specifications than the regulations alone can appear to lack direction. A simple 10% reduction from an ill-defined F_{sq} does not necessarily steer the stock towards the objectives. A stepwise decrease in the 'distance' between current F and the target F , while potentially invoking the 15% TAC change more often, may be more successful in assuring progress towards the objectives and prevent issues such as the projected increase in sole F from 2008 to 2009. Conversely, difficulties in application can lead to a

greater than specified F reduction, as has been observed for plaice (19%). This is exacerbated by the retrospective problems in the North Sea plaice and sole stock assessments. One possible way to attempt to moderate these inconsistencies would be a mid-year review of how our perception of the stocks have changed following the provision of advice in June of each year. In this way the TAC for the second half of the year could be adjusted slightly in line to account for potential changes in the perception of stock size. Such a scenario could be included within the *ex ante* evaluation.

The rationale for the target fishing mortality reference points in the long term management plan is not given in Council Regulation No EC 676/2007. The objective F for the North Sea plaice stock is similar to, though slightly higher than, the current proxy of F_{MSY} for this stock as given by ICES. In the case of North Sea sole, the management objective F lies within the broad range of potential proxies for F_{MSY} for the stock. However, before fishing mortality rates of the two stocks can be reconciled to the target $F_{\text{plaice}}:F_{\text{sole}}$ ratio of 1.5, the fishing patterns in the fleets will likely have to change, given the current values. North Sea plaice F is likely to increase slowly (due to TAC increase constraints) and then fluctuate around the 0.3 per year level. Meanwhile, a significant decrease in the F of North Sea sole is required to bring about a ratio of 1.5, yet the current management F for the stock is likely to represent an increase in F from 2008 to 2009. In this context, the long term management plan will steer towards a further decrease in fishing effort by the main fleets targeting sole and plaice. The likely long term ratio in the F s of the two stocks could be examined in the *ex ante* evaluation, however any outcomes are likely to be largely dependent on assumptions made about the fleet behaviour, with regards to fishing location.

Under the multiannual plan, the North Sea plaice TAC has been increasing. This increase is likely to continue as long as the stock continues to recover because fishing in the near future should fluctuate around what is considered to be the optimum F for long term sustainable yields. Discarding levels remain high, but currently they are near the lowest level of the past ten years and show a downward trend. Assuming F remains at the current lower level, it is assumed that the discards to landings ratio will decrease further, potentially decreasing the quantity of discards even further. North Sea sole TACs have stabilised to a degree under the multiannual plan in the most recent years, but these are likely to continue to fluctuate depending on the strength of incoming year classes.

The data available to analyse the stock dynamics under the multiannual plan reveal a few conclusions. With respect to the chosen reference points and the safe biological limits of the stock it appears that:

- SSB of both species have increased since the implementation of the plan. Plaice has a larger than 95% probability of having reached a stage where the SSB is above B_{pa} for two consecutive years. The XSA stock assessment indicates that this is also the case for sole. An alternative assessment including uncertainty estimates indicate that the probability of being above B_{pa} is not yet larger than 95%.
- The annual fishing mortality rates of the two stocks have been on a declining trend in recent years. The North Sea plaice stock is now fished at a level below the management regulation target for this stock (<0.3 per year). The annual rate of F for the North Sea sole stock remains above the management regulation target for this stock (>0.2 per year).
- According to the latest assessment results, both stocks appear to be within the precautionary zone in 2008, with both SSB and F trajectories being indicative of rebuilding stocks and a move towards more sustainable fishing levels.

Hence, despite a lack of clarity in the implementation of the management regulations, the multiannual plan, given the current perception of the stock, appears to be resulting in stock trajectories and fishing levels moving towards the desired objectives and in line with the principles of the precautionary approach.

In the first year of its implementation (2008), it appears that the effort regulations defined for the multiannual plan appear to be having the desired effect. Overall fishing effort has declined along with a decrease in the size of the main fishing fleets utilising these resources. These changes in effort seem to be making up for issues with the practical application of management regulations on setting of TAC. The reduction in effort appears to have brought about the desired changes in actual F as required by the regulation.

None of the evaluation scenarios considered in the previous *ex ante* evaluation of the multiannual plan accounted for the possibility of the observed retrospective pattern in plaice. The scenarios considered placed a high degree of confidence in the most recent assessment and failed to consider the possibility of either a healthier or more

threatened stock. Future *ex ante* evaluations should consider this uncertainty in annual model estimates through alternative initial stock status scenarios. The new SCA model provides uncertainty estimates of the current stock status and these could be incorporated in alternative scenarios. Another possibility is to project the population based on the XSA starting in both 2006 and 2008 in different scenarios, covering the range of perceptions produced by the retrospective pattern in the last three years. It must be noted, however, that the high degree of uncertainty in current stock status will translate into a lower degree of certainty when evaluating likely success of the management regulations. These considerations will be dealt with in Part 2 of the report.

6 Quality Assurance

IMARES utilises an ISO 9001:2000 certified quality management system (certificate number: 08602-2004-AQ-ROT-RvA). This certificate is valid until 15 December 2009. The organisation has been certified since 27 February 2001. The certification was issued by DNV Certification B.V. Furthermore, the chemical laboratory of the Environmental Division has NEN-AND-ISO/IEC 17025:2005 accreditation for test laboratories with number L097. This accreditation is valid until 27 March 2013 and was first issued on 27 March 1997. Accreditation was granted by the Council for Accreditation.

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Justification

Report Number: C114/09
Project Number: 4301217006

The scientific quality of this report has been peer reviewed by the a colleague scientist and the head of the department of IMARES.

Approved: Dr. Doug Beare
Research scientist

Signature:

Date: 11-02-2010

Approved: Dr. Tammo Bult
Head of fisheries department

Signature:

Date: 11-02-2010

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Number of appendix attachments: 2

(2) Advice from a committee of experts examining multi-annual management strategies indicates that the highest yield of sole can be taken at a fishing mortality rate of 0,2 on ages two to six years.

(3) The Scientific, Technical and Economic Committee for Fisheries (STECF) has advised that the precautionary

⁽¹⁾ Opinion of the European Parliament delivered on 28 September 2006 (not yet published in the Official Journal).

(6) Council Regulation (EC) No 2371/2002 of 20 December 2002 on the conservation and sustainable exploitation of fisheries resources under the Common Fisheries Policy ⁽²⁾ requires, *inter alia*, that to achieve that objective, the Community is to apply the precautionary approach in taking measures to protect and conserve the stock, to provide for its sustainable exploitation and to reduce to a minimum the impact of fishing on marine ecosystems.

⁽²⁾ OJ L 358, 31.12.2002, p. 59.

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(Acts adopted under the EC Treaty/Euratom Treaty whose publication is obligatory)

REGULATIONS

COUNCIL REGULATION (EC) No 676/2007

of 11 June 2007

establishing a multiannual plan for fisheries exploiting stocks of plaice and sole in the North Sea

THE COUNCIL OF THE EUROPEAN UNION,

Having regard to the Treaty establishing the European Community, and in particular Article 37 thereof,

Having regard to the proposal from the Commission,

Having regard to the opinion of the European Parliament ⁽¹⁾,

Whereas:

(1) Recent scientific advice from the International Council for the Exploration of the Sea (ICES) has indicated that the stocks of plaice and of sole in the North Sea have been subjected to levels of mortality by fishing which have exceeded the level determined by ICES as being consistent with the precautionary approach, and the stocks are at risk of being harvested unsustainably.

(2) Advice from a committee of experts examining multi-annual management strategies indicates that the highest yield of sole can be taken at a fishing mortality rate of 0,2 on ages two to six years.

(3) The Scientific, Technical and Economic Committee for Fisheries (STECF) has advised that the precautionary

⁽¹⁾ Opinion of the European Parliament delivered on 28 September 2006 (not yet published in the Official Journal).

biomass for the stock of plaice in the North Sea should be 230 000 tonnes, that the fishing mortality rate necessary to produce the highest yield from the stock of plaice in the North Sea in the long term is 0,3 and that the precautionary biomass for the stock of sole in the North Sea should be 35 000 tonnes.

(4) Measures need to be taken to establish a multiannual plan for fisheries management of the stocks of plaice and sole in the North Sea. Such measures, where they concern the stock of plaice in the North Sea, are to be established in the light of consultations with Norway.

(5) The objective of the plan is to ensure, in a first stage, that stocks of plaice and sole in the North Sea are brought within safe biological limits, and in a second stage and after due consideration by the Council on the implementing methods for doing so that those stocks, are exploited on the basis of maximum sustainable yield and under sustainable economic, environmental and social conditions.

(6) Council Regulation (EC) No 2371/2002 of 20 December 2002 on the conservation and sustainable exploitation of fisheries resources under the Common Fisheries Policy ⁽²⁾ requires, *inter alia*, that to achieve that objective, the Community is to apply the precautionary approach in taking measures to protect and conserve the stock, to provide for its sustainable exploitation and to reduce to a minimum the impact of fishing on marine ecosystems.

⁽²⁾ OJ L 358, 31.12.2002, p. 59.

- (7) This Regulation should aim at a progressive implementation of an ecosystem-based approach to fisheries management, and should contribute to efficient fishing activities within an economically viable and competitive fisheries industry, providing a fair standard of living for those who depend on fishing North Sea plaice and sole and taking into account the interest of consumers. The Community bases its policy partly on the policy recommended by the appropriate Regional Advisory Council (RAC). A large part of the catches of plaice in the North Sea are taken together with catches of sole. The management of plaice cannot be addressed independently of the management of sole.
- (8) Consequently, in drawing up the multiannual plan, account should also be taken of the fact that the high fishing mortality rate for plaice is due to a great extent to the large discards from beam-trawl sole fishing with 80mm nets in the southern North Sea.
- (9) Such control of the fishing mortality rates can be achieved by establishing an appropriate method for the establishment of the level of total allowable catches (TACs) of the stocks concerned, and a system including limitations on permissible days at sea whereby fishing efforts on those stocks are restricted to levels at which the TACs and planned fishing mortality rates are unlikely to be exceeded, but are sufficient to catch the TAC allowed on the basis of the fishing mortality rates established in the plan.
- (10) The plan should cover all flatfish fisheries having a significant impact on the fishing mortality of the plaice and sole stocks concerned. However, Member States whose quotas for either stock are less than 5 % of the European Community's share of the TAC should be exempted from the provisions of the plan concerning effort management.
- (11) This plan should be the main instrument for flatfish management in the North Sea, and should contribute to the recovery of other stocks such as cod.
- (12) Control measures in addition to those laid down in Council Regulation (EEC) No 2847/93 of 12 October 1993 establishing a control system applicable to the Common Fisheries Policy⁽¹⁾ need to be included in order to ensure compliance with the measures laid down in this Regulation.
- (13) In 2006 the Commission initiated a debate concerning a Community strategy for a gradual reduction in fishing mortality in all major fisheries by means of a communication concerning the attainment of the maximum sustainable yield objective by 2015. The Commission has submitted this communication to the RACs for their opinion.
- (14) The Commission has requested STECF to report on key aspects of impact assessment in relation to the management of plaice and sole, which should be based on accurate, objective and comprehensive biological and financial information. That impact assessment will be annexed to the Commission's proposal concerning the second stage of the multiannual plan.
- (15) The multiannual plan should be deemed to be a recovery plan during its first stage and a management plan during its second stage, within the meaning of Articles 5 and 6 of Regulation (EC) No 2371/2002,

HAS ADOPTED THIS REGULATION:

CHAPTER I

SUBJECT-MATTER AND OBJECTIVE

Article 1

Subject-matter

1. This Regulation establishes a multiannual plan for the fisheries exploiting the stocks of plaice and sole that inhabit the North Sea.
2. For the purposes of this Regulation, 'North Sea' means the area of the sea delineated by the International Council for the Exploration of the Sea as Sub-area IV.

Article 2

Safe biological limits

1. For the purposes of this Regulation, the stocks of plaice and sole shall be deemed to be within safe biological limits in those years in which, according to the opinion of the Scientific, Technical, and Economic Committee for Fisheries (STECF), all of the following conditions are fulfilled:
 - (a) the spawning biomass of the stock of plaice exceeds 230 000 tonnes;

⁽¹⁾ OJ L 261, 20.10.1993, p. 1. Regulation as last amended by Regulation (EC) No 1967/2006 (OJ L 409, 30.12.2006, p. 11).

- (b) the average fishing mortality rate on ages two to six years experienced by the stock of plaice is less than 0,6 per year;
- (c) the spawning biomass of the stock of sole exceeds 35 000 tonnes;
- (d) the average fishing mortality rate on ages two to six years experienced by the stock of sole is less than 0,4 per year.

2. If the STECF advises that other levels of biomass and fishing mortality should be used to define safe biological limits, the Commission shall propose to amend paragraph 1.

Article 3

Objectives of the multiannual plan in the first stage

1. The multiannual plan shall, in its first stage, ensure the return of the stocks of plaice and of sole to within safe biological limits.
2. The objective specified in paragraph 1 shall be attained by reducing the fishing mortality rate on plaice and sole by 10 % each year, with a maximum TAC variation of 15 % per year until safe biological limits are reached for both stocks.

Article 4

Objectives of the multiannual plan in the second stage

1. The multiannual plan shall, in its second stage, ensure the exploitation of the stocks of plaice and sole on the basis of maximum sustainable yield.
2. The objective specified in paragraph 1 shall be attained while maintaining the fishing mortality on plaice at a rate equal to or no lower than 0,3 on ages two to six years.
3. The objective specified in paragraph 1 shall be attained while maintaining the fishing mortality on sole at a rate equal to or no lower than 0,2 on ages two to six years.

Article 5

Transitional arrangements

1. When the stocks of plaice and sole have been found for two years in succession to have returned to within safe biological limits the Council shall decide on the basis of a proposal from the Commission on the amendment of Articles

4(2) and 4(3) and the amendment of Articles 7, 8 and 9 that will, in the light of the latest scientific advice from the STECF, permit the exploitation of the stocks at a fishing mortality rate compatible with maximum sustainable yield.

2. The Commission's proposal for review shall be accompanied by a full impact assessment and shall take into account the opinion of the North Sea Regional Advisory Council.

CHAPTER II

TOTAL ALLOWABLE CATCHES

Article 6

Setting of total allowable catches (TACs)

Each year, the Council shall decide, by qualified majority on the basis of a proposal from the Commission, on the TACs for the following year for the plaice and sole stocks in the North Sea in accordance with Articles 7 and 8 of this Regulation.

Article 7

Procedure for setting the TAC for plaice

1. The Council shall adopt the TAC for plaice at that level of catches which, according to a scientific evaluation carried out by STECF is the higher of:
- (a) that TAC the application of which will result in a 10 % reduction in the fishing mortality rate in its year of application compared to the fishing mortality rate estimated for the preceding year;
- (b) that TAC the application of which will result in the level of fishing mortality rate of 0,3 on ages two to six years in its year of application.
2. Where application of paragraph 1 would result in a TAC which exceeds the TAC of the preceding year by more than 15 %, the Council shall adopt a TAC which is 15 % greater than the TAC of that year.
3. Where application of paragraph 1 would result in a TAC which is more than 15 % less than the TAC of the preceding year, the Council shall adopt a TAC which is 15 % less than the TAC of that year.

Article 8**Procedure for setting the TAC for sole**

1. The Council shall adopt a TAC for sole at that level of catches which, according to a scientific evaluation carried out by STECF is the higher of:

- (a) that TAC the application of which will result in the level of fishing mortality rate of 0,2 on ages two to six years in its year of application;
- (b) that TAC the application of which will result in a 10 % reduction in the fishing mortality rate in its year of application compared to the fishing mortality rate estimated for the preceding year.

2. Where the application of paragraph 1 would result in a TAC which exceeds the TAC of the preceding year by more than 15 %, the Council shall adopt a TAC which is 15 % greater than the TAC of that year.

3. Where the application of paragraph 1 would result in a TAC which is more than 15 % less than the TAC of the preceding year, the Council shall adopt a TAC which is 15 % less than the TAC of that year.

CHAPTER III**FISHING EFFORT LIMITATION****Article 9****Fishing effort limitation**

1. The TACs referred to in Chapter II shall be complemented by a system of fishing effort limitation established in Community legislation.

2. Each year, the Council shall decide by a qualified majority, on the basis of a proposal from the Commission, on an adjustment to the maximum level of fishing effort available for fleets where either or both plaice and sole comprise an important part of the landings or where substantial discards are made and subject to the system of fishing effort limitation referred to in paragraph 1.

3. The Commission shall request from STECF a forecast of the maximum level of fishing effort necessary to take catches of plaice and sole equal to the European Community's share of the TACs established according to Article 6. This request shall be formulated taking account of other relevant Community legislation governing the conditions under which quotas may be fished.

4. The annual adjustment of the maximum level of fishing effort referred to in paragraph 2 shall be made with regard to the opinion of STECF provided according to paragraph 3.

5. The Commission shall each year request the STECF to report on the annual level of fishing effort deployed by vessels catching plaice and sole, and to report on the types of fishing gear used in such fisheries.

6. Notwithstanding paragraph 4, fishing effort shall not increase above the level allocated in 2006.

7. Member States whose quotas are less than 5 % of the European Community's share of the TACs of both plaice and sole shall be exempted from the effort management regime.

8. A Member State concerned by the provisions of paragraph 7 and engaging in any quota exchange of sole or plaice on the basis of Article 20(5) of Regulation (EC) No 2371/2002 that would result in the sum of the quota allocated to that Member State and the quantity of sole or plaice transferred being in excess of 5 % of the European Community's share of the TAC shall be subject to the effort management regime.

9. The fishing effort deployed by vessels in which plaice or sole are an important part of the catch and which fly the flag of a Member State concerned by the provisions of paragraph 7 shall not increase above the level authorised in 2006.

CHAPTER IV**MONITORING, INSPECTION AND SURVEILLANCE****Article 10****Fishing effort messages**

1. Articles 19b, 19c, 19d, 19e and 19k of Regulation (EEC) No 2847/93 shall apply for vessels operating in the area. Vessels equipped with monitoring systems in accordance with Articles 5 and 6 of Commission Regulation (EC) No 2244/2003 of 18 December 2003 laying down detailed provisions regarding satellite-based vessel monitoring systems⁽¹⁾ shall be excluded from hailing requirements.

2. Member States may implement alternative control measures to ensure compliance with the obligation referred to in paragraph 1 which are as effective and transparent as these reporting obligations. Such measures shall be notified to the Commission before being implemented.

⁽¹⁾ OJ L 333, 20.12.2003, p. 17.

Article 11**Margin of tolerance**

1. By way of derogation from Article 5(2) of Commission Regulation (EEC) No 2807/83 of 22 September 1983 laying down detailed rules for recording information on Member States' catches of fish⁽¹⁾, the permitted margin of tolerance, in estimation of quantities in kilograms live weight of each of plaice and sole retained on board of vessels that have been present in the North Sea shall be 8 % of the logbook figure. In the event that no conversion factor is laid down in Community legislation, the conversion factor adopted by the Member State whose flag the vessel is flying shall apply.

2. Paragraph 1 shall not apply concerning a species of aquatic organism if the quantity of that species retained on board is less than 50 kg.

Article 12**Weighing of landings**

The competent authorities of a Member State shall ensure that any quantity of sole exceeding 300 kg or of plaice exceeding 500 kg, caught in the North Sea shall be weighed before sale using scales that have been certified as accurate.

Article 13**Prior notification**

The master of a Community fishing vessel that has been present in the North Sea and who wishes to land any quantity of plaice or sole in a port or a landing location of a third country shall inform the competent authorities of the flag Member State at least 24 hours prior to landing in a third country, of the following information:

- (a) the name of the port or landing location;
- (b) the estimated time of arrival at that port or landing location;
- (c) the quantities in kilograms live weight of all species of which more than 50 kg is retained on board.

The notification may also be made by a representative of the master of the fishing vessel.

⁽¹⁾ OJ L 276, 10.10.1983, p. 1. Regulation as last amended by Regulation (EC) No 1804/2005 (OJ L 290, 4.11.2005, p. 10).

Article 14**Separate stowage of plaice and sole**

1. It shall be prohibited to retain on board a Community fishing vessel in any individual container any quantity of plaice or any quantity of sole mixed with any other species of marine organisms.

2. The masters of Community fishing vessels shall give inspectors of Member States such assistance as will enable the quantities declared in the logbook and the catches of plaice and of sole retained on board to be cross-checked.

Article 15**Transport of sole and plaice**

1. The competent authorities of a Member State may require that any quantity of plaice exceeding 500 kg or any quantity of sole exceeding 300 kg caught in the geographical area referred in Article 1(2) and first landed in that Member State is weighed before being transported elsewhere from the port of first landing using scales that have been certified as accurate.

2. By way of derogation from Article 13 of Regulation (EEC) No 2847/93, quantities of plaice exceeding 500 kg and quantities of sole exceeding 300 kg which are transported to a place other than that of landing shall be accompanied by the declaration provided for in Article 8(1) of that Regulation. The exemption provided for in Article 13(4)(b) of Regulation (EEC) No 2847/93 shall not apply.

Article 16**Prohibition of transshipments of sole and plaice**

A Community fishing vessel that is present in the North Sea shall not tranship any quantity of plaice or sole to any other vessel.

CHAPTER V**FOLLOW-UP****Article 17****Evaluation of management measures**

1. The Commission shall, on the basis of advice from STECF, evaluate the impact of the management measures on the stocks concerned and the fisheries on those stocks, in the second year of application of this Regulation and in each of the following years.

2. The Commission shall seek scientific advice from the STECF on the rate of progress towards the objectives of the multiannual plan in the third year of application of this Regulation and each third successive year of application of this Regulation. The Commission shall, if appropriate, propose relevant measures, and the Council shall decide by qualified majority on alternative measures to achieve the objectives set out in Articles 3 and 4.

*Article 18***Special circumstances**

In the event that STECF advises that the spawning stock size of either or both plaice or of sole is suffering reduced reproductive capacity, the Council shall decide by qualified majority on the basis of a proposal from the Commission on a TAC for plaice that is lower than that provided for in Article 7, on a TAC for sole that is lower than that provided for in Article 8, and on levels of fishing effort that are lower than those provided for in Article 9.

CHAPTER VI

FINAL PROVISIONS*Article 19***Assistance under the European Fisheries Fund**

1. During the first stage foreseen in Article 3 of this Regulation, the multiannual plan shall be deemed to be a recovery

plan within the meaning of Article 5 of Regulation (EC) No 2371/2002, and for the purposes of Article 21(a)(i) of Council Regulation (EC) No 1198/2006 of 27 July 2006 on the European Fisheries Fund⁽¹⁾.

2. During the second stage foreseen in Article 4 of this Regulation, the multiannual plan shall be deemed to be a management plan within the meaning of Article 6 of Regulation (EC) No 2371/2002, and for the purposes of Article 21(a)(iv) of Regulation (EC) No 1198/2006.

*Article 20***Entry into force**

This Regulation shall enter into force on the 20th day following its publication in the *Official Journal of the European Union*.

This Regulation shall be binding in its entirety and directly applicable in all Member States.

Done at Luxembourg, 11 June 2007.

For the Council
The President
H. SEEHOFER

⁽¹⁾ OJ L 223, 15.8.2006, p. 1.

Appendix B. The Statistical Catch at Age (SCA) model

Model description

The model is elaborately described in Aarts and Poos (2009). Here we present the text from Aarts and Poos (2009), changing parts to make the text more concise, and to describe the differences between the sole and plaice assessment. For an in-depth description we refer to Aarts and Poos (2009). In short, the model is a traditional discrete-time age-structured population dynamics model

$$N_{a+1,t+1} = N_{a,t} e^{-Z_{a,t}},$$

where $N_{a,t}$ are the numbers at age a at time t , and $Z_{a,t}$ the total mortality, which is composed of the instantaneous natural mortality rate M and the fishing mortality rate $F_{a,t}$.

Natural and fishing mortality

Natural mortality is assumed to be constant (0.1) in time and equal for all ages. Fishing mortality $F_{a,t}$ is the result of catchability q , annual fishing effort θ_t , and the selectivity pattern $f_{a,t}$, such that

$$F_{a,t} = q\theta_t f_{a,t}.$$

Catchability q is the extent to which a stock is susceptible to fishing. The fishing effort θ_t is the total amount of fishing in a year. With the available data, it is only possible to estimate the product of these two. The selectivity pattern $f_{a,t}$ defines the relative likelihood that an individual of age a in the population is caught and is constrained to have a maximum of 1. A smooth function of age is used, constructed using four b-spline basis functions $h_k(a)$. Each b-spline basis function is a cubic polynomial of the explanatory variable, but it is only non-zero within a certain range (defined by so-called knots) of the explanatory variable. Next, each basis function $h_k(a)$ is weighted by a constant $b_{k,t}$. Summing these weighted functions results in the complex smooth function of age:

$$f_{a,t} = \text{logit}^{-1} \left(\sum_{k=1}^4 b_{k,t} h_k(a) \right).$$

In this function, logit^{-1} is $\exp(\cdot)/(1 + \exp(\cdot))$ and ensures that $f_{a,t}$ takes values between 0 and 1. Because of the local nature of the basis function, the fit of the smooth function in one range of the data (e.g. at low ages) is independent of its fit at the other extreme (e.g. at high ages). Similar to many other assessment techniques, we assume that the fishing mortality of the last age class is equal to the fishing mortality of the preceding age. Temporal changes in the spatial overlap between fishing effort and the different age classes of the fish population can result in changes in the selectivity pattern. This is captured by modelling the weighting constants as a function of time, hence the subscript t in $b_{k,t}$. To prevent overparameterization, only a linear function for the temporal changes in selectivity was inspected, i.e.

$$b_{k,t} = \beta_{0,k} + \beta_{1,k}t.$$

Discards and landings

The expected catch $C_{a,t}$ for age a and year t is calculated from

$$C_{a,t} = \frac{F_{a,t}}{Z_{a,t}} N_{a,t} (1 - e^{-Z_{a,t}}).$$

For plaice, the catch consist of discards $D_{a,t}$ and landings $L_{a,t}$. We assume that an age-dependent fraction $d_{a,t}$ of the catch is discarded, such that

$$\begin{aligned} D_{a,t} &= d_{a,t} C_{a,t}, \\ L_{a,t} &= (1 - d_{a,t}) C_{a,t}. \end{aligned}$$

Although landings data are generally available, discard data are often lacking or, as in our study, only available for the most recent years. For sole, we assume that the landings are equal to the catches, and there is no discarding. For plaice, we assume that the discard fraction $d_{a,t}$ is a smooth function of age where each smooth parameter is modeled as a second-order orthogonal polynomial function of time.

Tuning series

The tuning series data for plaice are collected over a short period (August–September) of each year. Because the survey vessel catches are a very small part of the population, it is assumed that these catches do not affect the mortality of the population as a whole. The population size $N_{a,t}$ represents the population size on 1 January of year t . When the scientific survey takes place later in the year, the population size may be reduced considerably by fishing and natural mortality. To correct for this, the mean population size during the time of the survey is estimated as

$$N_{a,t}^U = N_{a,t} \frac{e^{-\kappa Z_{a,t}} - e^{-\lambda Z_{a,t}}}{(\lambda - \kappa) Z_{a,t}},$$

where κ and λ are the start and end, respectively, of each survey expressed as a fraction of a year. Consequently, the catch of survey $U_{a,t}$ of age a in year t can easily be calculated as

$$U_{a,t} = s_{u,a} N_{a,t}^U q_u,$$

where q_u is the efficiency, which is survey vessel u -specific, and $s_{u,a}$ the age-specific selectivity of the survey vessel u . Again, we model $s_{u,a}$ as a smooth function of age. Survey selectivity $s_{u,a}$ is assumed to remain constant in time. It should be noted that for sole, the commercial LPUE series of the Dutch beam trawl fleet is used in the assessment (similar to the ICES WGNSSK assessment). Here, the assumption of constant q_u may be violated. Because the LPUE series span the entire year, κ and λ are set to 0 and 1, respectively

Likelihood function

The available datasets for parameter estimation are (i) landings-at-age, (ii) discards-at-age, and (iii) tuning series from three surveys. Conforming with most other statistical catch-at-age assessment, the data are assumed to be lognormally distributed, with means and age-specific standard deviations predicted by the model. Zero values were replaced by half of the lowest value observed in the dataset where each occurred. This approach guards against zeros in the likelihood function by taking account of the scale of the data. The total log-likelihood is then

$$\begin{aligned} \ell &= \ell_D + \ell_L + \ell_U, \\ \text{where } \ell_D &= \sum_{a,t} n(\log(D_{a,t}); \log(\hat{D}_{a,t}), \sigma_a^D), \\ \ell_L &= \sum_{a,t} n(\log(L_{a,t}); \log(\hat{L}_{a,t}), \sigma_a^L), \\ \ell_U &= \sum_{a,t} n(\log(U_{a,t}); \log(\hat{U}_{a,t}), \sigma_a^U). \end{aligned}$$

The values of σ_a are modelled as the exponent of an orthogonal polynomial function of age, with 2 d.f. The standard deviations are constrained to be at least 0.05, to facilitate convergence of the minimizer used to find the maximum likelihood. For sole, the likelihood function for the discards observations is removed from the total likelihood function, because we assume there are no discards.

Parameter estimation and model selection

All model fitting was done using the FLR package. The negative of the likelihood function was minimized using the BFGS quasi-Newton or variable metric algorithm. Several starting values were selected randomly from a uniform distribution within appropriate boundaries, leading to different parameter estimates. This suggests that the likelihood function had several local maxima. We therefore selected the parameter estimates corresponding to the highest maximum likelihood among >50 runs. The model often converged to these parameter estimates, and we assumed that these correspond to the global maximum. Also, all eigenvalues of the numerically differentiated Hessian matrix at the parameter values presented here were positive, indicating that the parameter values indeed represented a maximum of the log-likelihood function.

Quantifying uncertainty

Maximizing the log-likelihood function results in maximum likelihood parameter estimates and the variance–covariance matrix that is derived from the inverse of the Hessian. For estimating parameter uncertainty, we selected 10 000 random values from a multivariate normal distribution with those parameter means and variance–covariances. The resulting random realizations are then used to estimate 95% confidence intervals for population and fisheries characteristics of interest, using the percentile method.