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Evaluations of Management strategies for Norway pout in the North Sea and Skagerrak Report (NOP-MSE)

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DTU Aqua, Copenhagen, Denmark

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Summary

Advice summary

The proposed Management Strategies (Options 1, 2 and 3) are in accordance with the sustainability criteria under the precautionary approach given a minimum TAC of maximum 27 kt and an assumption about future fishing mortality or fishing effort within the range of the values observed for the last decade.

Application of a higher minimum TAC (50 kt), is possible for option 2 and 3. This higher minimum TAC is mainly due to the scenario assumption that the minimum TAC for option 2 and 3 has to be taken within the first half-year while the minimum TAC can be taken within the full year for option 1. With the assumption of an upper limit on realised fishing mortality (Cap F) by half-year, the realised catch can be higher with option 1 which increases the risk of overfishing in years with a low stock size.

The risk for SSB below B_{lim} for option 1 and 3 is not sensitive to the choice of maximum TAC. However, both a high minimum TAC and a high maximum TAC make the risk to B_{lim} more sensitive to the scenario assumption of a Cap F. A high minimum TAC in combination with a high maximum TAC might require effort management to ensure that fishing mortality remains within the range of the values observed for the last decade.

The management strategy evaluations and simulations confirm the general observation that a fixed F strategy will provide a lower long term yield than an escapement strategy for such a short lived species like Norway pout. The “cost” of the escapement strategy is a much more variable fishing mortality from one year to the next. Stability in landings is also lower for the escapement strategy.

MANAGEMENT STRATEGY 1	MANAGEMENT STRATEGY 3	MANAGEMENT STRATEGY 3

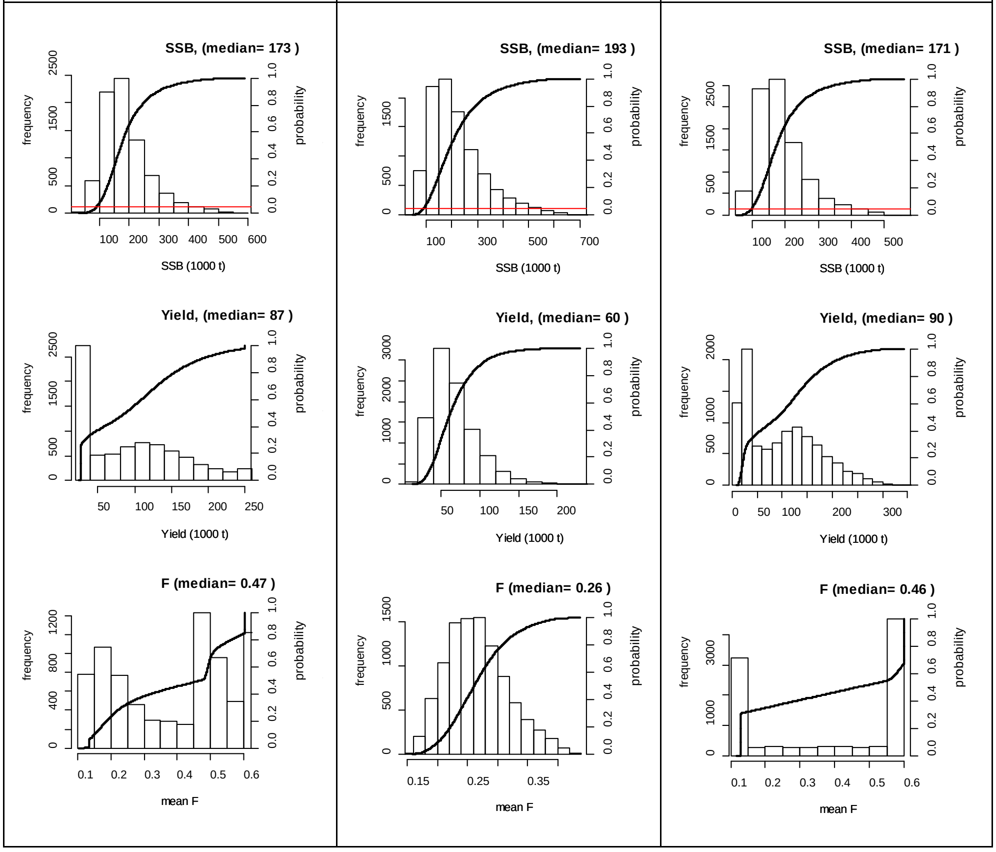

Figure 1. Long term distribution of SSB, yield and F, including cumulative probability for Management strategy 1 to 3 with minimum TAC at around 25kt and maximum TAC at 250 kt (MS1 and MS3).

Request

On basis of an additional request from the EU Commission and Norway 8th February 2012 received by ICES in final form in May 2012 (EU 2012) there is proposed and asked for additional evaluations of modified and alternative harvest control rules for Norway pout in the North Sea and Skagerrak.

Request:

The European Union and Norway jointly request ICES to advice on the management of Norway Pout in ICES Subarea IV (North Sea) and ICES Division Ilia (Skagerrak-Kattegat) and to evaluate the following options:

1. *Whether a management strategy is precautionary if TAC is constrained to be within the range of 20,000 - 250,000 tonnes, or another range suggested by ICES, based on the existing escapement strategy;*
2. *A management strategy with a fixed initial TAC in the range of 20,000 - 50,000 tonnes. The final TAC is to be set by adding to the preliminary TAC around (50%) of the amount that can be caught in excess of 50,000 tonnes, based on a target F of 0.35;*

3. *A management strategy with a fixed initial TAC in the range of 20,000- 50,000 tonnes. The final TAC is to be set by adding to the preliminary TAC around (50 %) of what can be caught in excess of 50,000, based on the escapement strategy.*

Elaboration on the advice

Interpretation of the request

The request from the EU Commission and Norway is not clear, but ICES has interpreted the request in the following way:

1. Management Strategy 1: Here it is asked to evaluate a Management Strategy (MS) on the basis on the existing ICES escapement strategy for Norway pout; however with absolute TAC constraints that include a minimum TAC higher than zero and a ceiling of the TAC. The present management system is based on two yearly assessments (advices) from ICES; one in September with survey indices from the IBTS Quarter 3 survey including 0-group index, and one in May with updates from the IBTS Quarter 1 survey. The timing of the actual use of the advice into TAC regulations has varied in the most recent years. In some years the September advice has been used in regulation of the (in year) 4th quarter fishery while the process in other years has been delayed such that the September assessment will just be used for the TAC in the 1st half year. The May advice has been used in regulation of the (in year) 3rd quarter (and in some years the 4th quarter) fishery.

   ICES has chosen just to evaluate the option where the September assessment is used for advice for the next calendar year. This option is the less robust of the two alternatives as TAC for the fourth quarter is set from the May assessment without knowing the recruitment index from the third quarter.

2. Management Strategy 2: This MS has a fixed initial TAC for the first 6 months of the year followed by an update of the TAC for the full year by the end of June. This TAC advice will be based on the ICES assessment of Norway pout made in May. The TAC for the whole year is based on a fixed F strategy.
   By having a fixed TAC for the first six months irrespective of the state of the stock, there is no reason to update (simulate) the assessment in September.

3. Management Strategy 3: As MS2, but here the within year update is based on the escapement strategy.

The difference between MS1 and MS3 is mainly the use of the initial fixed TAC in MS3, which is assumed to be taken (or possible lost) within the first six months of the year for MS3. However, it is assumed that the (minimum) TAC from MS1 is valid for the whole calendar year, irrespective of the May assessment results.

Method

The proposed harvest control rules of a management plan for Norway pout in the North Sea and Skagerrak were evaluated using the simulation framework SMS in accordance with the ICES guidelines (ICES, 2008) for management strategy evaluation.

Results

MS1: The long term performance of MS1 is robust to the choice of minimum TAC given a maximum TAC at 200 kt and a Cap F at 0.6. The probability of a SSB below

B_{lim} is in the range 0–10% for fixed TACs in the range 0–50 kt, and a higher than 5% long term probability for SSB below B_{lim} is estimated for a minimum TAC of around 27 kt. Realized long-term F, SSB and yield is not sensitive to the choice of minimum TAC option giving values of long term SSB around 175 kt, F around 0.45 and yield around 90 kt. Given a minimum TAC at 27 kt, the actual choice of maximum TAC affect the Prob($SSB<B_{lim}$) very little and is less than 5% for the range 100 -250 kt of maximum TAC. The highest long term median yield is obtained with a maximum TAC at around 100 kt, however the highest long-term mean yield is obtained with a maximum TAC at around 250 kt. A high (250 kt) or unlimited maximum TAC is sensitive to the assumption of a Cap F at 0.6, while e.g. a maximum TAC at 100 kt is robust to that assumption.

MS2: The long term performance of MS2 has a probability of $SSB<B_{lim}$ of more than 5%, irrespective of the minimum TAC, if 100% of the TAC for the second half year, based on fixed F at 0.35, is applied. If around 70% of the predicted catch calculated for second half year is applied as the TAC, there is a prob($SSB<B_{lim}$) of less than 5%. Given the 70% of calculated catch used for TAC in the second half year, the MS2 is not sensitive to the choice of the minimum TAC in the first half-year in the range of 25 kt 50 kt. The long term values of SSB, yield and F, using the 25 kt minimum TAC and 70% of the predicted catch (annual F=0.35) applied for the second half year is a median yield at 60 kt, a median F at 0.26, with low variation from one year to the next. This option is not sensitive to the actual choice of Cap F for a minimum TAC at 25 kt, but very sensitive for a minimum TAC at 50 kt.

MS3: The long term performance of MS3 with fixed minimum TAC for the first half-year only, and TAC for the second half year based on the escapement strategy, is not sensitive to the choice of minimum TAC (up to 50 kt) but sensitive to the assumptions about Cap F. Application of the higher minimum TAC is more sensitive to the assumption of a Cap F. Long term yield have a median value at 90 kt and a median F at 0.46, with large variations between years.

Additional consideration

The MSE simulations presented are based on a long row of assumptions of constant values for key parameters such as the fishing pattern, mean weights, maturity and natural mortality at age. Likewise, it is assumed that the estimated stock recruitment relationship is valid for future recruitments. However, this represents the normal ICES procedure to MSE and we have not made additional sensitivity analyses. Given these assumptions the presented scenario results should be regarded more as a sensitivity analysis than as absolute performance in relation to e.g. yield and the probability of SSB above B_{lim}.

The applicability of the fixed minimum TAC within the precautionary framework depends on the assumption on when the fishery will actually cease due to low catch rates (and stock size). In this evaluation of the management strategies it has been assumed that the real fishing mortality cannot exceed values of fishing mortalities (Cap F=0.6) observed for the last 10 years. The sensitivity to the value of Cap F is in general moderate for the presented options, but it is obvious that if the fleet makes a determined attempt to catch the full minimum TAC even though the catch rates are low and the state of the stock is poor, the management strategy will not be precautionary. Given the good historical relation between fishing effort and fishing mortality in the Norway pout fishery, an upper limit on effort will effectively set an upper limit on fishing mortality.

Norway pout is a semi-pelagic species which is widely and rather evenly distributed in the Northern North Sea and it does not show very dense schooling behavior. The fact that the stock does not occur in large, very dense schools lower the risk for continuation of the fishery at low stock size, i.e. it is likely impossible to maintain high catch rates at low stock size. This indicates that the fishery will stop at low stock size.

The Norway pout box (EU Regulation 850/98 Article 26) also contributes to protection of a low Norway pout stock as this box covers a significant part of the distribution area of the stock. This protection supports the validity of the assumption of a Cap F, as Norway pout cannot be fished within that area. By-catch regulation (EU Regulation 850/98 Article 26) including maximum by-catch rates of other gadoids will also limit the fishery of Norway pout at a low stock size.

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1 Basis for the advice: Analysis

1.1 Interpretation of the request

The request from the EU Commission and Norway is not clear, but we have interpreted the request in the following way:

1. Management Strategy 1: Here it is asked to evaluate a Management Strategy (MS) on the basis on the existing ICES escapement strategy for Norway pout; however with absolute TAC constraints that include a minimum TAC higher than zero and a ceiling of the TAC. The present management system is based on two yearly assessments (advices) from ICES; one in September with survey indices from the IBTS Quarter 3 survey including 0-group index, and one in May with updates from the IBTS Quarter 1 survey. The timing of the actual use of the advice into TAC regulations has varied in the most recent years. In some years the September advice has been used in regulation of the (in year) 4th quarter fishery while the process in other years has been delayed such that the September assessment will just be used for the TAC in the 1st half year. The May advice has been used in regulation of the (in year) 3rd quarter (and in some years the 4th quarter) fishery.

   We have chosen just to evaluate the option where the September assessment is used for advice for the next calendar year. This option is the less robust of the two alternatives as TAC for the fourth quarter is set from the May assessment without knowing the recruitment index from the third quarter.

2. This MS has a fixed initial TAC for the first 6 months of the year followed by an update of the TAC for the full year by the end of June. This TAC advice will be based on the ICES assessment of Norway pout made in May. The TAC for the whole year is based on a fixed F strategy.

   By having a fixed TAC for the first six months irrespective of the state of the stock, there is no reason to update (simulate) the assessment in September.

3. As 2, but here the within year update is based on the escapement strategy.

The difference between option 1 and 3 is mainly the use of the initial fixed TAC in 3, which is assumed to be taken (or possible lost) within the first six months of the year for option 3. However, it is assumed that the (minimum) TAC from 1 is valid for the whole calendar year, irrespective of the May assessment results.

1.2 Data and methods

The proposed harvest control rules of a management plan for Norway pout in the North Sea and Skagerrak were evaluated using a simulation framework (SMS) in accordance with the ICES guidelines (ICES, 2008) for management strategy evaluation. The SMS has previously been used for MSE of the short lived species sandeel and Norway pout (ICES, 2007a,b) and multispecies assessments (ICES, 2008). The SMS allows the use of quarterly time steps, which is not the case for the standard software packages used in ICES MSE.

The SMS does not include a full assessment cycle with an explicit stock assessment and a short term forecast using a HCR to calculate the TAC. Instead, it is assumed that the true stock size can be "observed" with some bias and noise and it is this "perceived" stock that makes the basis for the use of a HCR and estimation of a TAC. The true stock size is assumed known in the first projection year and is later updated annually by recruitment and catches derived from application of the HCR on the "perceived" stock.

The SMS method has been extended with options to mimic the requested HRC. Appendix, Chapter 6, Section 1 gives an overview of the extensions.

Risk to B_{lim} (the probability of real SSB being below B_{lim}) is calculated in both the short and long term. For the individual years 2013–2016 the risk to B_{lim} is calculated as the number of times, across 1000 iterations, that SSB in year y is below B_{lim} divided by number of iterations (1000). Long term risk is calculated for the years 2017–2026 as the number of times, across 1000 iteration and 10 years, that SSB is below B_{lim} divided by (1000*10) (Referred to as Risk 1 in Fernandez, 2012).

1.3 Input data

The Norway pout assessment is made using the Seasonal eXtended Survivor Analysis (SXSA) with quarterly time steps (ICES, 2012a,b). The SXSA is a deterministic assessment method with no assumption about stability in exploitation pattern, which is suitable for the variable fishing pattern used for Norway pout. As a deterministic method, SXSA does not provide any estimates of the uncertainties of output variables such as SSB. Uncertainties are, however, needed to estimate the "perceived" stock numbers from the true ones. The output variables from the SXSA and the SMS assessment methods are quite similar (Figure 1), such that uncertainties estimated by the SMS assessment can be used to guide the choice of uncertainties for the perceived stock.

Input to MSE (presented in Table 1)

- The mean weight at age and in the stock are fixed over time in the SXSA assessment and used directly in the MSE as provided from the inter-benchmark assessment on the stock in Apr-May 2012 and used in the May 2012 assessment (ICES, 2012a,b).
- The mean weight at age in the catch is based on annual observations as provided from the SXSA assessment in May 2012 (ICES, 2012a). The mean over the whole assessment period has been as basis for MSE.
- The natural mortality by age are fixed over time in assessment as used directly in MSE (ICES, 2012a,b).
- The proportion mature by age in the first quarter (spawning season) are fixed over time in assessment as provided from the inter-benchmark assessment on the stock in Apr-May 2012 (ICES, 2012b).
- Exploitation pattern by age and quarter: The exploitation pattern, i.e. age and seasonal selection in the fishery, is assumed to be constant in the MSE. This is not the case in a SXSA assessment and the actual exploitation pattern has furthermore changed from year to year due to the high seasonality and different targeting in the industrial fishing fleets, and not least because of the various annual and seasonal closures of the Norway pout fishery. The exploitation pattern is estimated by SMS from a configuration with constant exploitation pattern in the full assessment period (excluding closed seasons).
- The initial stock number at age by 1st January 2012 are taken from the SMS output. The recruitment and SSB estimates show that the difference between the SMS and SXSA stock numbers is negligible (Figure 1).

- The TAC for 2012 is set to be zero according to the TAC based on the latest ICES advice following the escapement strategy.

Stock recruitment

There is no clear relationship between the recruitment and SSB for this stock (Figure 2). The fit to the "Hockey stick" model with the inflection point at B_{lim} (90.000 tonnes), shows that observations are without extreme outliers and within the 95% confidence limits. The cumulated probabilities of historical and predicted recruitment (for SSB higher than the inflection point) show a pretty good overlap (Figure 3). However, it seems that the predicted recruitment will provide less small recruiting year classes and stronger year classes than the observed historical distribution. The noise function (NORM(0,1), see step 2 in Appendix, Chapter 6, Section 2.2) to produce predicted recruitment has been constrained to deliver factors within ± 2.0 standard deviations to mimic that the observed recruitment is within the 95% confidence interval. Using the full range did not provide a better fit, but (as expected) a much larger range of recruitments than the observed.

Assessment noise (observation error)

The estimated uncertainties from the SMS were used to guide the selection of observation noise, i.e. the noise factor used to link the true stock size to the "observed" or "perceived" stock size estimated by an assessment.

Based on input data 1983-2011, the SMS estimated a CV on the stock size at age, SSB and recruitment in the beginning of the year after the last assessment year (2012) to:

Recruitment, age 0 (quarter 3):	CV at 64%
Stock number, age 1:	CV at 47%
Stock number, age 2:	CV at 28%
Stock number, age 3+:	CV at 24%
SSB:	CV at 20%

Based on these uncertainties, it was decided to use log-normal distributed observation errors for stock sizes at 20% and correlated errors for all age groups. This is equivalent to the CV estimated for the SSB. The SMS does not allow uncertainties by age group and using a CV of 20% with correlation between age groups yields the same results as using a CV of around 30 % without correlation. SMS assumes a constant exploitation pattern which is not the case for Norway pout. A stochastic model without this assumption might therefore give a slightly lower uncertainty than estimated by the SMS.

It is assumed that the assessment is unbiased which reflects the very stable quality of the assessments results over years and consistency in retrospective analyses (ICES 2012a).

"Implementation uncertainties" are assumed negligible and not considered in the MSE.

Cap F

The upper limit on the fishing mortality (Cap F), i.e. the maximum F the fleet can exert with a given (maximum) effort level, is set to 0.6. This F-level is high compared to the latest years observed F-levels, and higher than all yearly Fs observed for the last 10 year period. In the years 2009 and 2010 where the fishery was open and based on the relatively strong 2008 and 2009 year classes the TACs and national quotas set have not been taken by the fishery, and the highest yearly F in this period (2010) was 0.43. Furthermore, the Danish and also the Norwegian fishing fleets targeting Norway pout have been reduced in capacity during the last 10 year period (ICES, 2012a).

The annual Cap F is divided into half years in accordance with the long-term exploitation pattern which shows 22% of the F in the first half-year and 78% in the second. This results in $CapF_{first\ half\ year}$ =0.13 and $CapF_{second\ half\ year}$ =0.47.

The historical relationship between yearly standardized effort and fishing mortality as estimated in the accepted SXSA assessment from May 2012 (ICES, 2012a) is shown in Figure 4 Here the correlation between the total standardized Danish and Norwegian fishing effort in fishing days for the Norway pout fishery and the total fishing mortality by year as estimated by the SXSA is given. Values for 2008 and 2010–2011 are not included because no Norwegian fishing effort data is available for these years. The high correlation between effort and F allows an implementation of an effort ceiling to avoid very high F-values in the future and as such to justify the Cap-F values chosen.

Table 1. Input to the MSE

Mean weight at age in the stock (kg):

	Age 0	Age 1	Age 2	Age 3+
Q1:	0.000	0.009	0.025	0.040
Q2:	0.000	0.012	0.025	0.050
Q3:	0.004	0.025	0.040	0.060
Q4:	0.006	0.025	0.040	0.058

Mean weight at age in the catch (kg):

	Age 0	Age 1	Age 2	Age 3+
Q1:	0.000	0.0098	0.0256	0.0408
Q2:	0.000	0.0136	0.0283	0.0418
Q3:	0.0066	0.0264	0.0380	0.0497
Q4:	0.0080	0.0273	0.0398	0.0519

Proportion mature at age:

	Age 0	Age 1	Age 2	Age 3+
Q1:	0.00	0.20	1.0	1.0

Natural mortality at age:

	Age 0	Age 1	Age 2	Age 3+
Q1:	0.00	0.29	0.39	0.44
Q2:	0.00	0.29	0.39	0.44
Q3:	0.29	0.29	0.39	0.44
Q4:	0.29	0.29	0.39	0.44

Exploitation pattern scaled to mean F_{1-2} at 1.0:

	Age 0	Age 1	Age 2	Age 3+
Q1:	0.000	0.073	0.153	0.153
Q2:	0.000	0.070	0.148	0.148
Q3:	0.005	0.197	0.415	0.415
Q4:	0.053	0.304	0.639	0.639

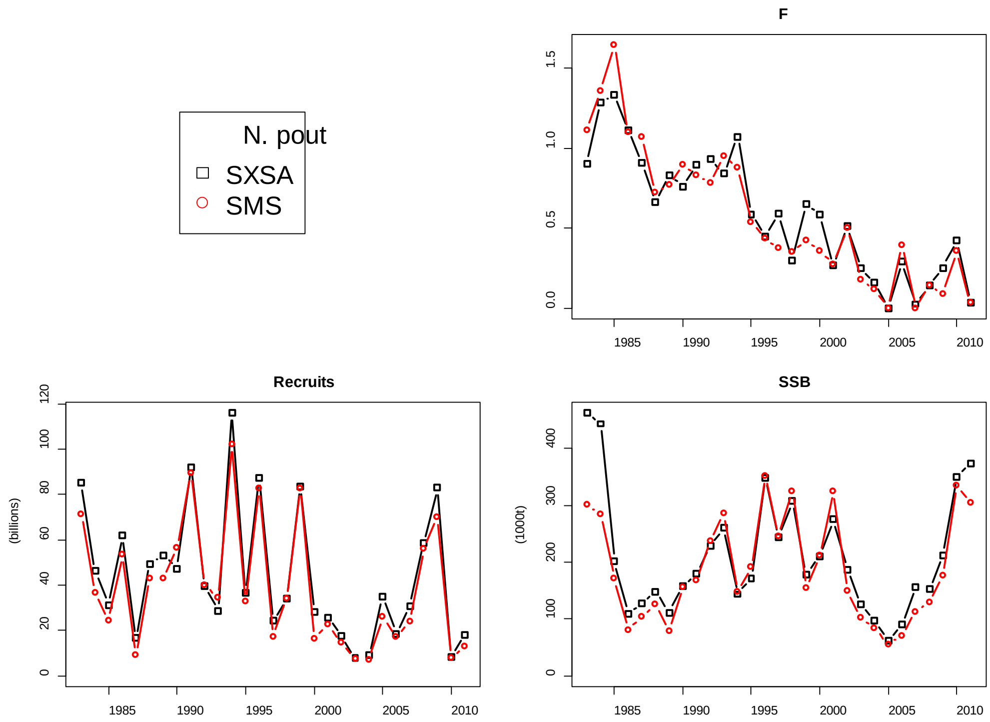

Figure 1 Comparison of output from the default XSA method and the SMS. The mean F values are calculated as the mean of the sum of quarterly F at ages 1 and 2.

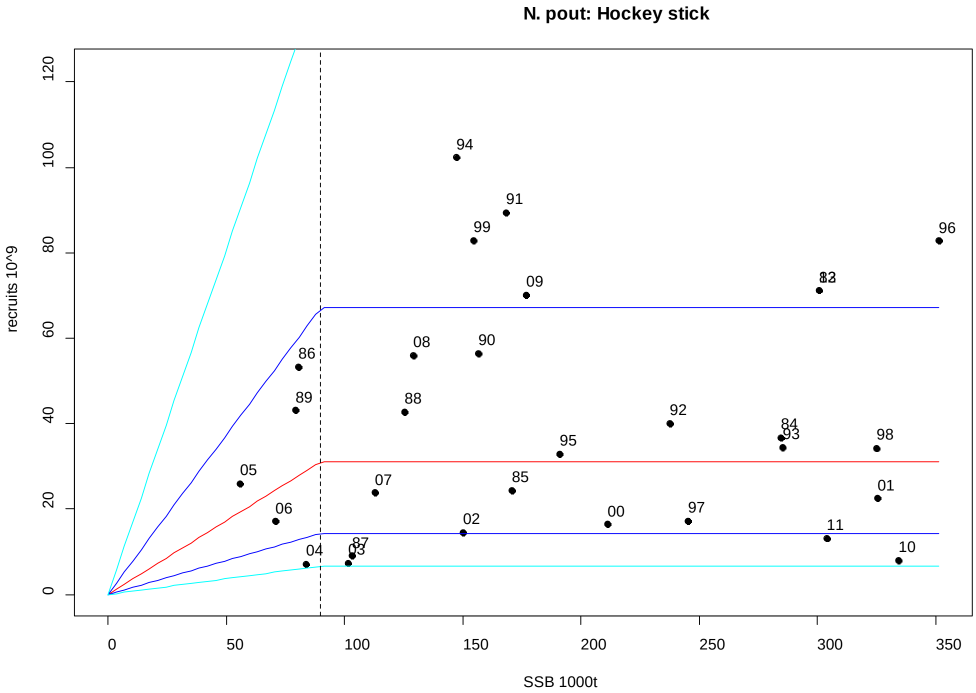

Figure 2 Stock recruitment relationship as estimated by the SMS using the "Hockey stick" model and a fixed inflection point at 90.000 tonnes (B_{lim}). The median (red line) and the one and two time standard deviations lines are shown.

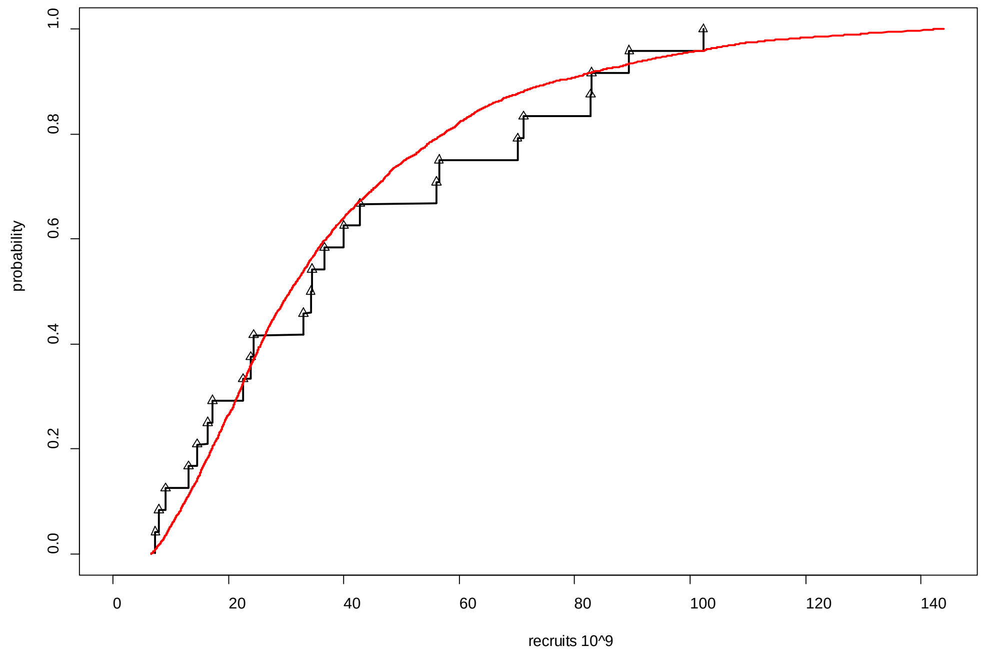

Figure 3. Cumulated probability of historical recruitment and recruitments produced by the estimated stock recruitment relationship.

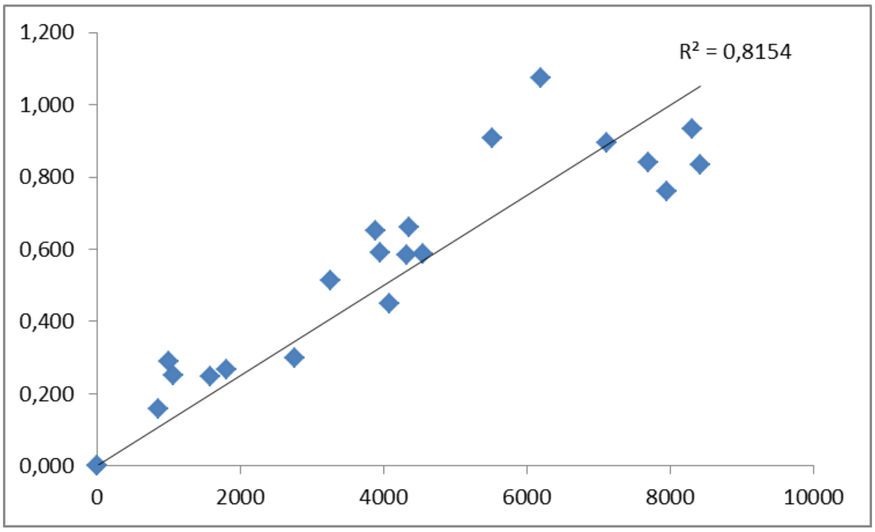

Figure 4. Correlation between the standardized fishing effort and the fishing mortality.

2 Results

2.1 Management Strategy 1

1) *Whether a management strategy is precautionary if TAC is constrained to be within the range of 20,000 - 250,000 tonnes, or another range suggested by ICES, based on the existing escapement strategy;*

For Management Strategy 1 (MS1) the results will focus on the sensitivity of the chosen range for the absolute TAC constraints and the sensitivity to the assumption of a Cap F.

The sensitivity of the choice of minimum TAC is shown in **Figure** 5. Given a maximum TAC at 200 kt and a Cap F at 0.6, the long term performance of the MS1 is robust to the choice of minimum TAC. The probability of a SSB below B_{lim} is in the range 0–10% for fixed TACs in the range 0–50 kt. A higher than 5% probability for SSB below B_{lim} in the long-term is estimated for a minimum TAC of around 27 kt. Realized long-term F, SSB and yield is not sensitive to the choice of minimum TAC option giving values of SSB around 175 kt, F around 0.45 and yield around 90 kt.

The short term risk for the scenarios shows an apparently constant low risk for SSB below B_{lim} in 2013 (Figure 5). This is due to the assumptions and the present state of the stock. The SMS assessment gives a SSB in 2012 at 135 kt (slightly lower than the SXSA assessment), which is between B_{lim} (90 kt) an Bpa(150 kt). With no Norway pout fishery in 2012 (TAC=0), and the assumption that the stock size the 1st January 2012 is known without errors, the only uncertainty for SSB in 2013 is the recruitment in the second half year of 2012. Given the SSB in 2012 is at a moderate level the risk for SSB blow B_{lim} becomes small and independent of the “minimum TAC” which is taken after the 1st January 2013. The risk of SSB below B_{lim} in 2014 is slightly higher than the long-term risk, e.g. the risk in 2014 with a minimum TAC at 27 kt is around 9% while the long-term risk is at 5%. Risk in 2015 and 2016, with a minimum TAC at 27 kt, is closer to the long term-risk, but higher than 5%.

In general, it must be expected that the risk in second part of the range for short term risk (2012–2016) will be driven mainly by the model assumptions and thereby closer to the long-term risk, while the risk in the very first years of the MSE depends mainly on the present state of the stock. The results in Figure 5 are due to the state of the stock in 2012 (below Bpa) and recruitments since 2012 from a stock recruitment relationship. We have however information from the September 2012 survey and assessment that recruitment in 2012 is high (at the same level as in 2009). With the use of the most recent estimate of recruitment in 2012, the risk in 2013–2015 becomes very low (**Figure 6**). The risk for 2016 become slightly lower than the risk presented in Figure 5, but the general observation that the risk in 2016 is close to the long term risk remains.

For all the scenarios presented, we have chosen to show short term risks without using the information about the high 2012 recruitment and thereby assuming that the 2012 recruitment follows the stochastic stock recruitment relationship. This situation reflects a situation where the state of stock in the first year of the management plan is slightly below Bpa, but as such not in a critical state (below B_{lim}). The short term risks presented under these assumptions therefore represents a poorer stock state than the present, and the risks illustrate the ranges of short term risks in such a situation.

Given a minimum TAC at 27 kt, the actual choice of maximum TAC affect the long-term Prob($SSB<B_{lim}$) very little and is less than 5% for the range 100–250 kt of maxi-

mum TAC (**Figure 7**). The highest long-term (median) yield is obtained with a maximum TAC at around 100 kt. Mean F increase with increasing maximum TAC. Median SSB is quite robust to the choice of maximum TAC.

Figure 5 and Figure 7 present the median values over numerous individual simulations. The actual variation between each simulation run is shown in **Figure 8** (max TAC at 100 kt) and **Figure 9** (max TAC 250 kt). With max TAC at 100 kt the yield is either close to the min TAC (27 kt) or the max TAC (100 kt). With such a distribution the mean (71 kt) might be a better measure of the yield than the median value (94 kt). When a max TAC of 250 kt is applied (Figure 9) the median yield (87 kt) is actually lower than for the max 100 kt TAC option, but the mean yield (96 kt) is higher. The two-topped-F-distribution for the max 250 kt option reflects a varying contribution from the two half-years. The max 250 kt limit is reached in less than 5% of the cases, while the minimum TAC is in play in around 25% of the cases.

The sensitivity plots of long term prob($SSB<B_{lim}$) to Cap F for a maximum TAC at 100 kt (**Figure 10**) and 250 kt (**Figure 11**) show that the 250 kt option is very sensitive to the assumption of Cap F, while the 100 kt maximum TAC option is robust.

2.2 Management Strategy 2

2) *A management strategy with a fixed initial TAC in the range of 20,000 - 50,000 tonnes. The final TAC is to be set by adding to the preliminary TAC around 50% of the amount that can be caught in excess of 50,000 tonnes, based on a target F of 0.35;*

Management Strategy 2 (MS2) has a long-term prob($SSB<B_{lim}$) of more than 5%, irrespective of the minimum TAC, if 100% of the predicted catch for the second half year, based on fixed F at 0.35, is applied as the TAC (**Figure 12**). If around 70% of the predicted catch calculated for second half year is applied as the TAC, there is a prob($SSB<B_{lim}$) of less than 5% (**Figure 13**). Given the 70% of calculated catch used for TAC in the second half year, the MS2 is not sensitivity to the choice the minimum TAC in the first half-year. Figure 13 (using 25 kt minimum TAC) results is practically identical to **Figure 14** results (using 50 kt minimum TAC). The distribution of yield (**Figure 15**) also indicates that the application of the minimum TAC clause is rare, so that the actual value of the minimum TAC becomes less important.

The long term distributions of SSB, yield and F, using the 25 kt minimum TAC and 70% of the predicted catch (annual F=0.35) applied for the second half year (Figure 15) give median yield at 69 kt, a median F slightly below the target F at 0.35, with low variation from one year to the next. This option is not sensitive to the actual choice of Cap F (**Figure 16**). With minimum TAC at 50 kt, the sensitivity to the choice of Cap F increases, but factors lower than around 1.5 gives a prob($SSB>B_{lim}$) of less than 5% (**Figure 17**)

2.3 Management Strategy 3

3) *A management strategy with a fixed initial TAC in the range of 20,000- 50,000 tonnes. The final TAC is to be set by adding to the preliminary TAC around (50 %) of what can be caught in excess of 50,000, based on the escapement strategy.*

For Management Strategy 3 (MS3) the TAC for the second half-year is based on the assessment made in May where the catches from the first quarter is known (actually included in the assessment) and there exist a rather precise estimate of the (low) fishery in the second quarter, which is the outside the main fishing season for Norway pout. This means that there are no obvious reasons due to uncertainties on catches and the state of the stock, to use only part of the predicted catch based the escapement strategy, to set the TAC for the second half-year. The "around (50%)" reduction mentioned in the Request is therefore ignored

This Management Strategy (fixed minimum TAC for the first half-year only, and TAC for the second half year based on the escapement strategy) is not sensitive to the choice of minimum TAC (up to 50 kt) but sensitive to the assumptions about Cap F (**Figure 19** and **Figure 20**). As expected, a higher minimum TAC will require a lower Cap F to maintain SSB above B_{lim} with a high probability.

Given a minimum TAC at 25 kt the long term distribution of F (**Figure 21**) is two-topped, where the top of F at around 0.15 represents the years where the fishery is due to the minimum TAC in the first half-year. The high F "top" around 0.6 represents the cases where both half –year's fisheries are conducted. The realized F is at Cap F in around 35% of the total cases.

2.4 Comparison of results

MS1 (Figure 9) and MS3 (Figure 21) are both based on the escapement strategy. The median values from the two scenarios of SSB (173 and 171 kt), yield (87 kt and 90 kt) and F (0.47 and 0.46) are very similar, but the distribution of F is different. MS3 has a much more distinct two-topped distribution than observed for MS1. This difference is mainly due to the assumption of the exploitation pattern for the two scenarios. For MS1 it is assumed that the annual TAC set by the September assessment is fished in accordance to the annual exploitation pattern. This means that if the TAC is low (e.g. at the minimum TAC) only a smaller part will actually be taken in the first half year, due to the exploitation pattern with higher exploitation rates in the second half year. For MS3 the (fixed) first half year initial TAC is assumed to be targeted within that period using the exploitation pattern for the first half-year only. This means that it is only the Cap F for the first half-year that limits F in that period, such that the likelihood for taking the minimum TAC is higher than for MS1.

In cases with a high annual TAC the actual realized catch for MS1 in the first half year can be higher than the fixed TAC for the first half year set by MS2. This increases the risk to B_{lim}, such that the minimum TAC for MS1 (27 kt) becomes lower than for MS3 (25–50 kt).

The simulations confirms the general observation that for short lived species a fixed F strategy (MS2) will provide a lower long term yield than an escapement strategy. The "cost" of the escapement strategy is however a much more variable F (and effort) from one year to the next. Stability in landings is also lower for the escapement strategy.

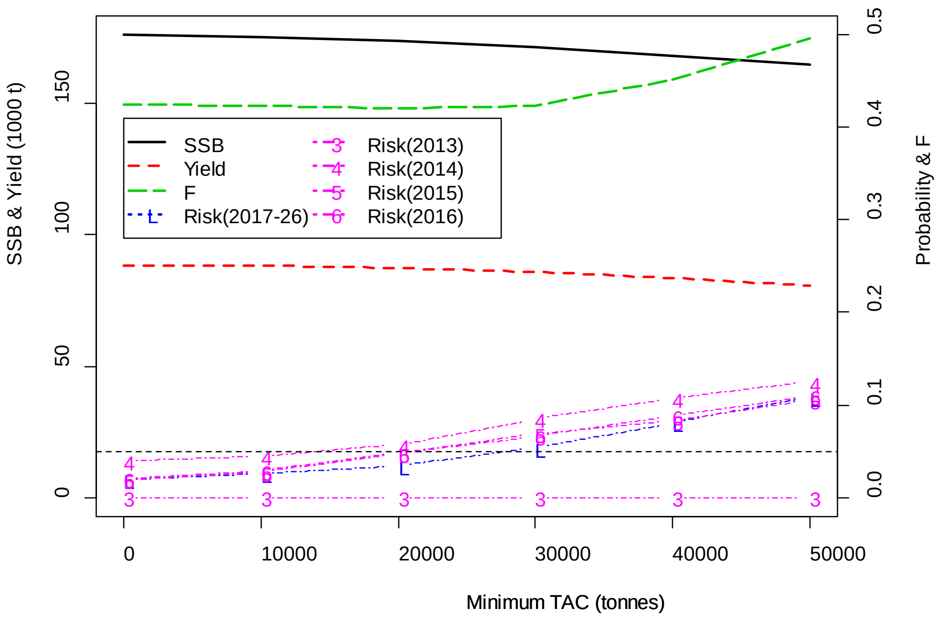

Figure 5 MS1. Sensitivity analysis: Minimum TAC. The graph shows the median value of SSB, yield and F in the years 2017-2026 from 1000 iterations for each value of minimum TAC shown on the X axis. The probabilities (Risk) of SSB below B_{lim} are shown for individual years and a long-term period. Maximum TAC is fixed to 200 kt.

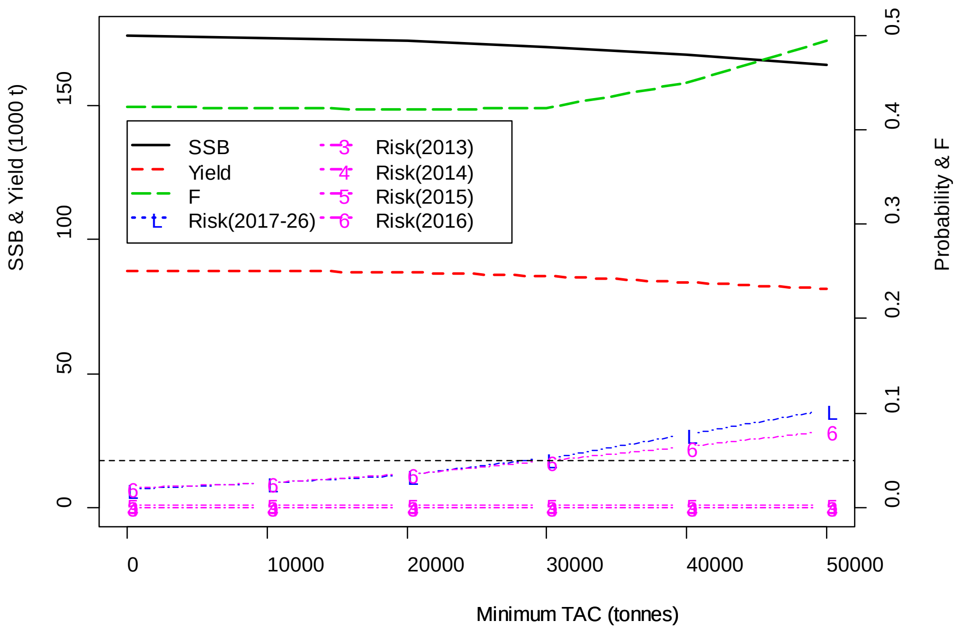

Figure 6. MS1. Sensitivity analysis: Minimum TAC. Maximum TAC is fixed to 200 kt. "Real" recruitment in 2012 is fixed at the level of recruitment as estimated for 2009 (70 billions).

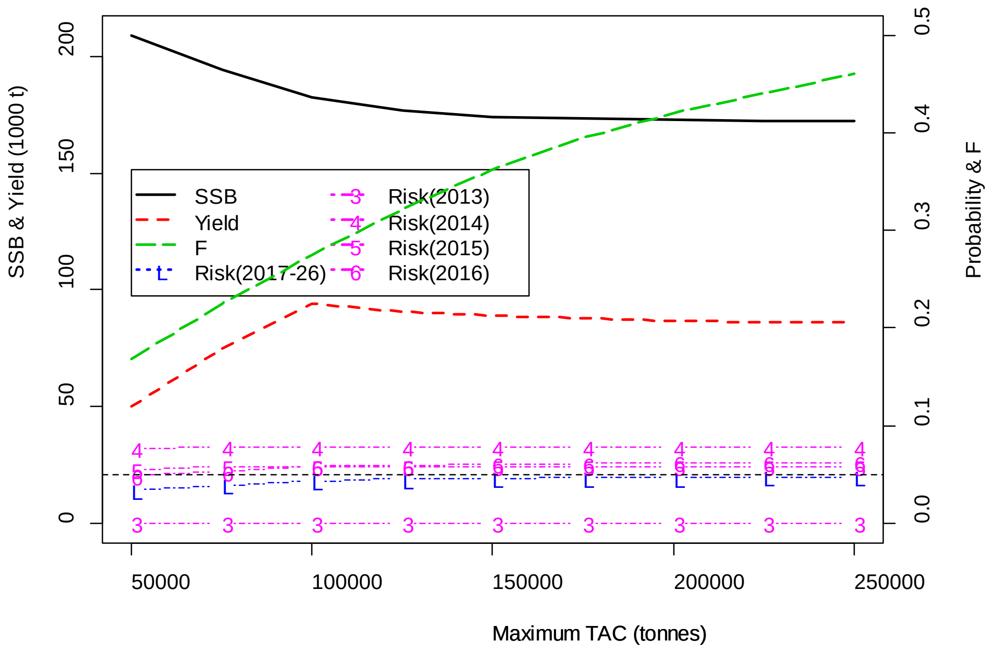

Figure 7. MS1. Sensitivity analysis: Maximum TAC. Minimum TAC is fixed at 27 kt.

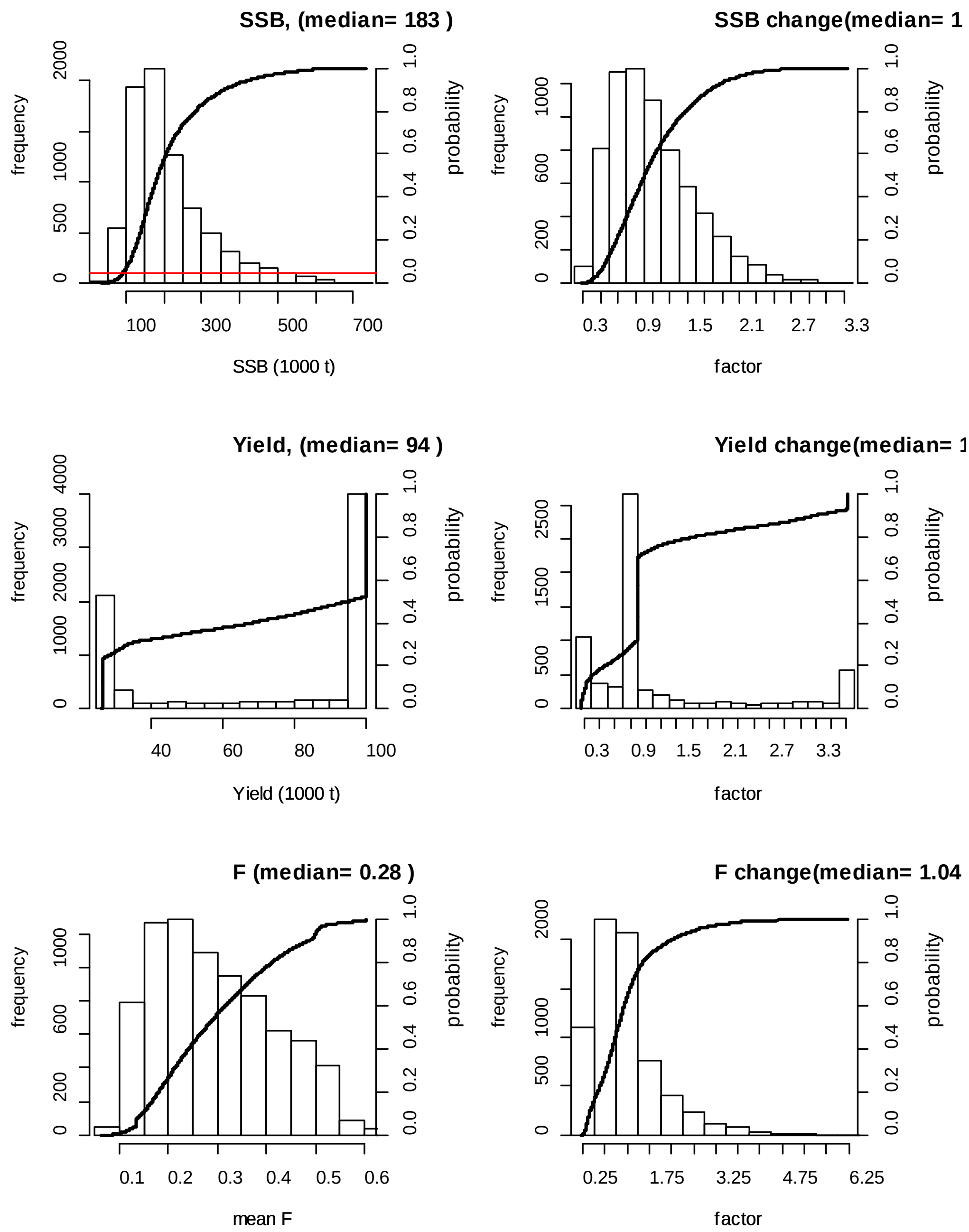

Figure 8. MS1. Distribution of SSB, yield and F, including cumulative probability in the years 2017-2026 from 1000 iterations (left column). The relative change from one year to the next is shown in the right column. Minimum TAC at 27 kt and maximum TAC at 100 kt.

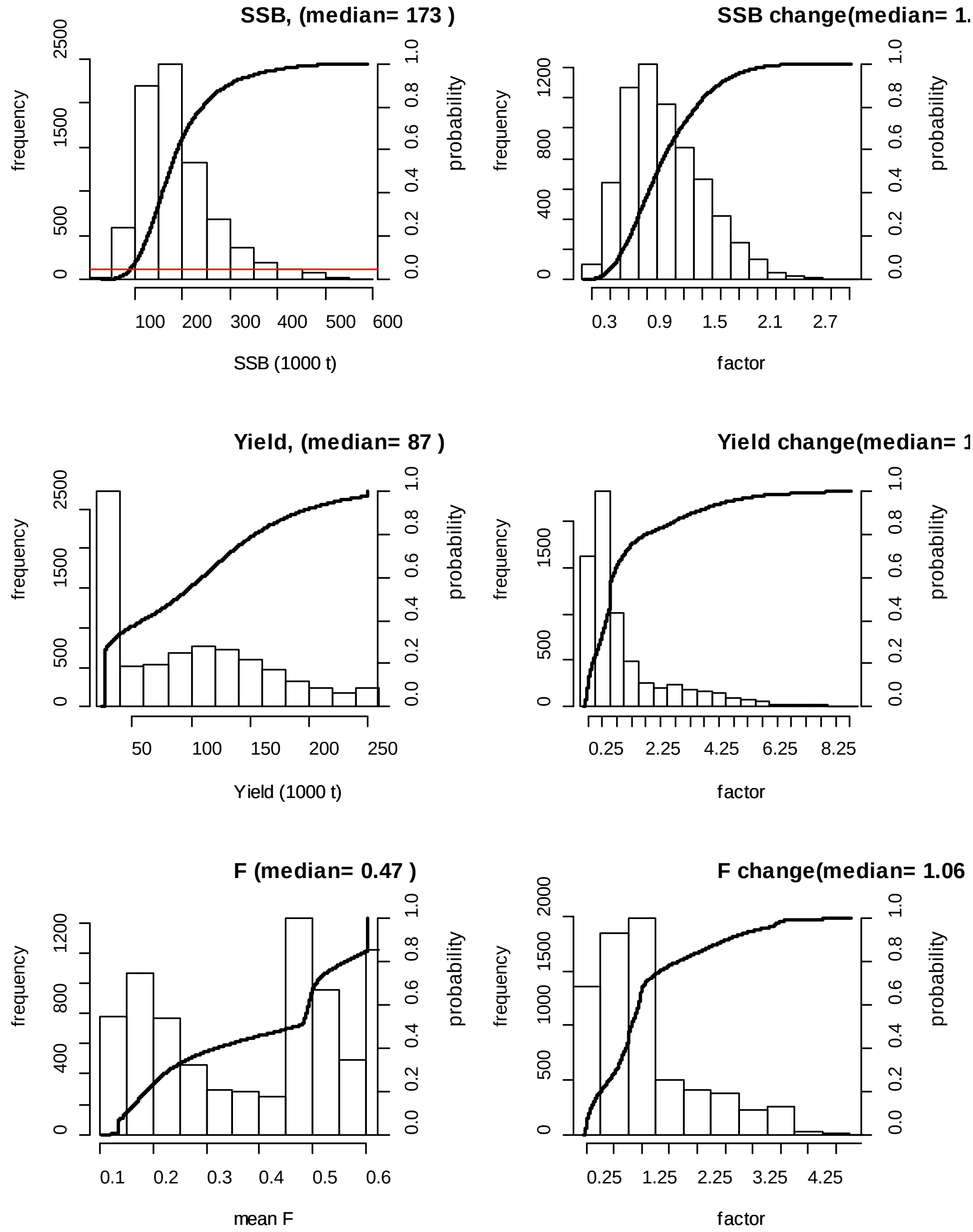

Figure 9. MS1. Distribution of SSB, yield and F, including cumulative probability in the years 2017-2026 from 1000 iterations (left column). The relative change from one year to the next is shown in the right column. Minimum TAC at 27 kt and maximum TAC at 250 kt.

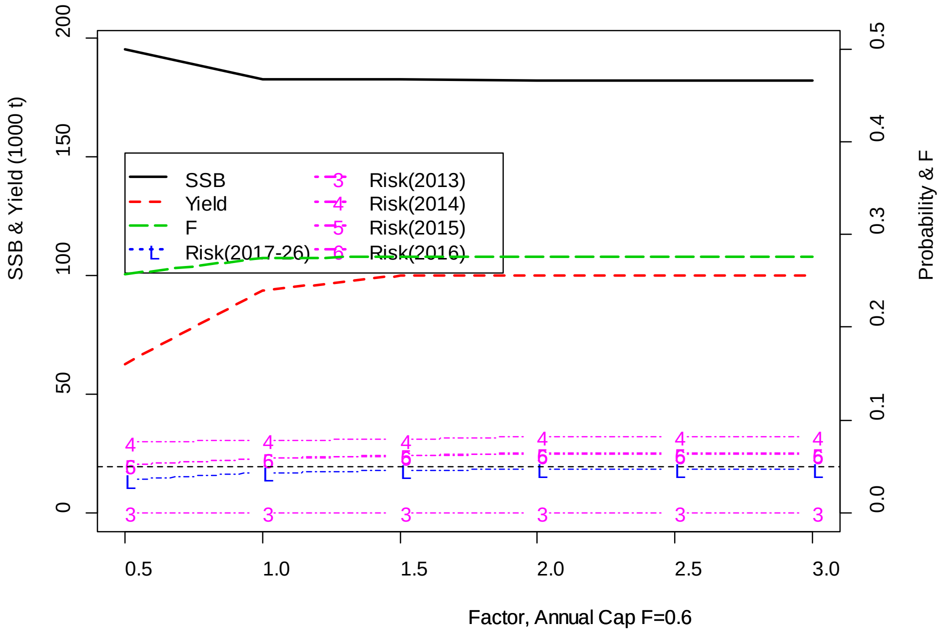

Figure 10. MS1. Sensitivity analysis: Cap F. As default a cap F at 0.47 for the second half year and a Cap F at 0.60 for the whole year are used. The x-axis shows the given factor used to multiply the default Cap F values. Minimum TAC is fixed at 27 kt and maximum TAC is fixed at 100 kt.

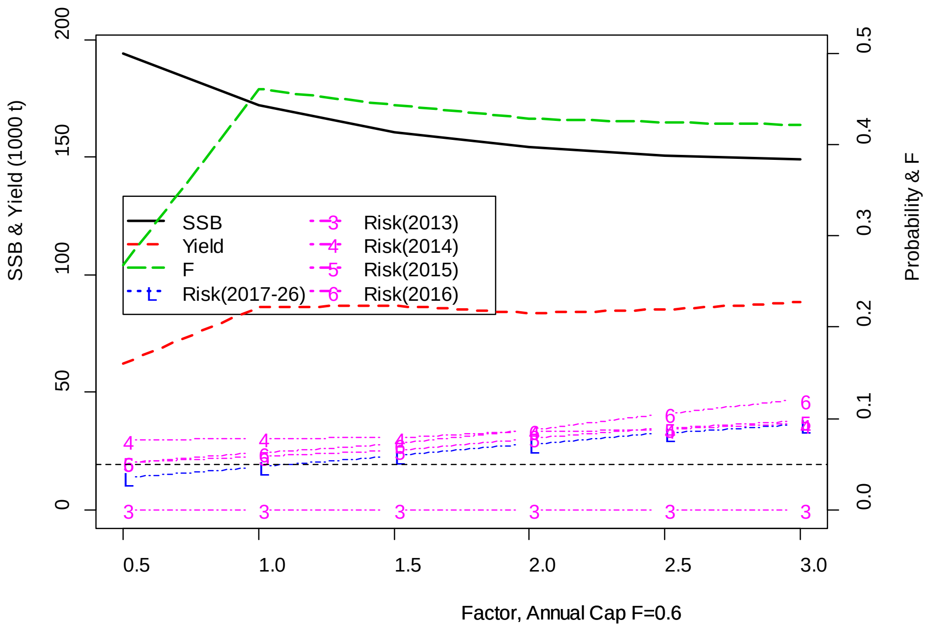

Figure 11. MS1. Sensitivity analysis: Cap F. Minimum TAC is fixed at 27 kt and maximum TAC is fixed at 250 kt.

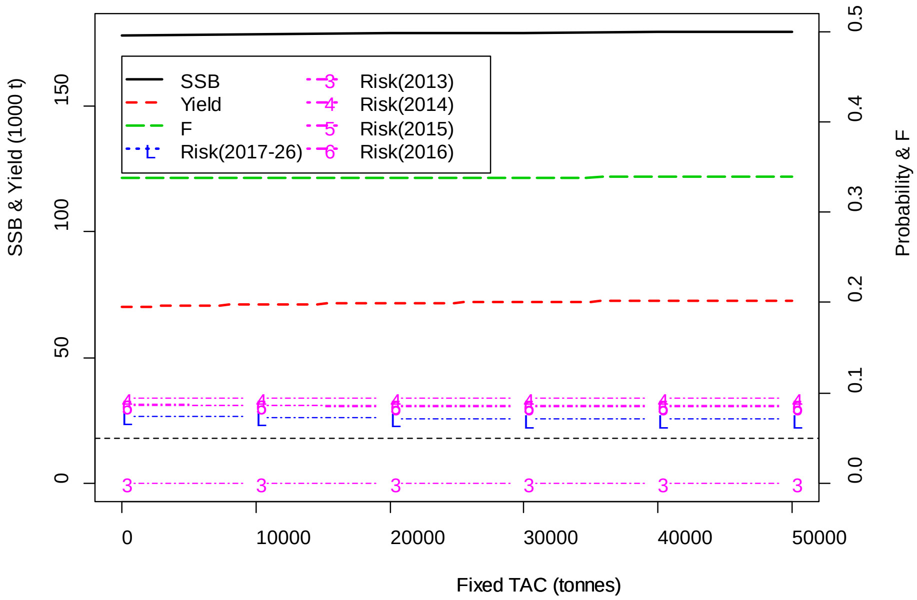

Figure 12. MS2. Sensitivity analysis: Fixed TAC. The graph shows the median value of SSB, yield and F in the years 2017–2026 from 1000 iterations for each value of fixed TAC shown on the X axis. The probabilities (Risk) of SSB below B_{lim} are shown for individual years and a long-term period. Maximum TAC is fixed to 200 kt. 100% of the calculated TAC for the second half-year is used for the final second half year TAC.

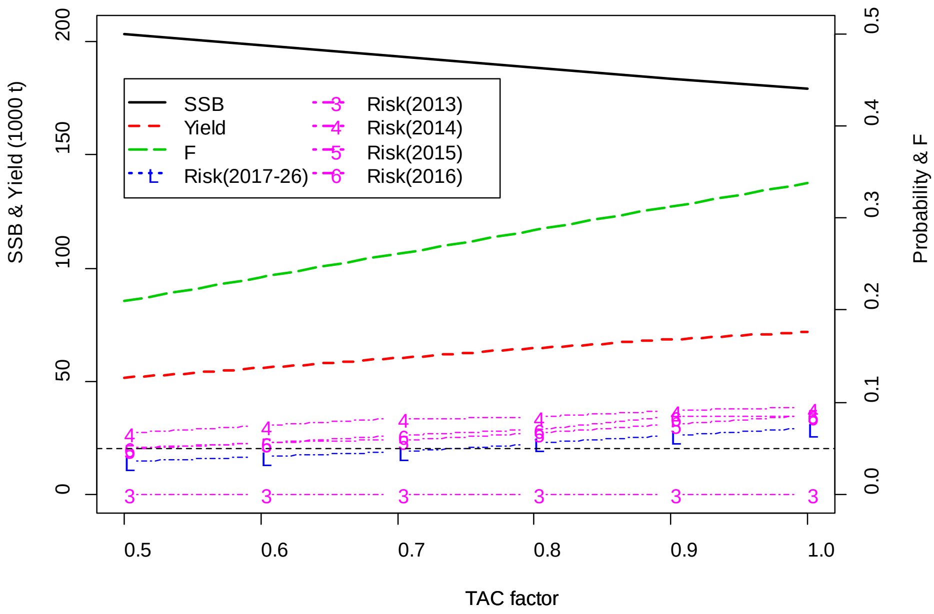

Figure 13. MS2. Sensitivity analysis: TAC factor. The x-axis shows the given factor used to multiply the calculated TAC for second half-year to get the actual TAC. Fixed initial TAC at 25 kt.

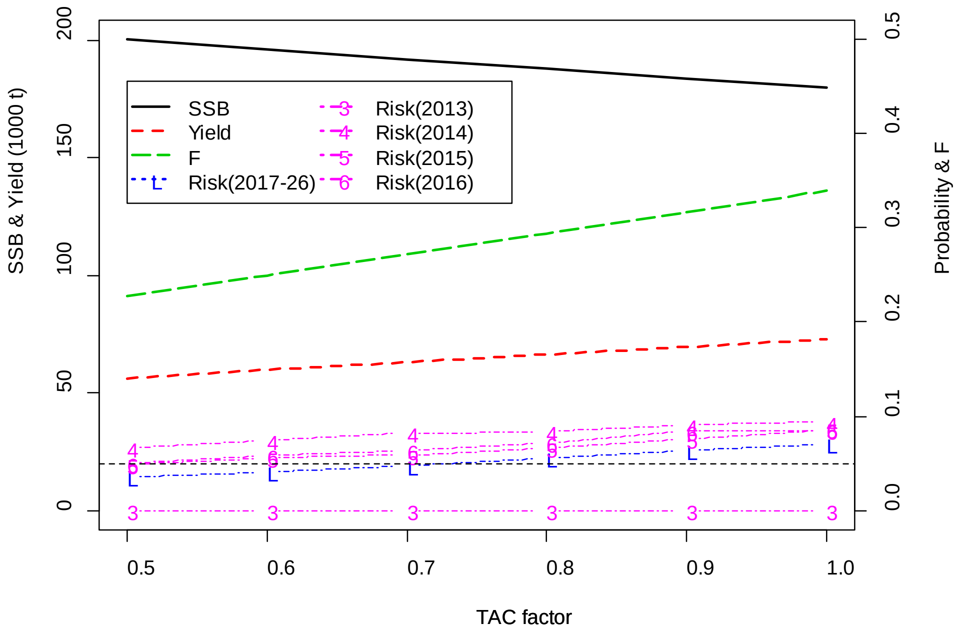

Figure 14. MS2. Sensitivity analysis: TAC factor. The x-axis shows the given factor used to multiply the calculated TAC for second half-year to get the actual TAC. Fixed initial TAC at 50 kt.

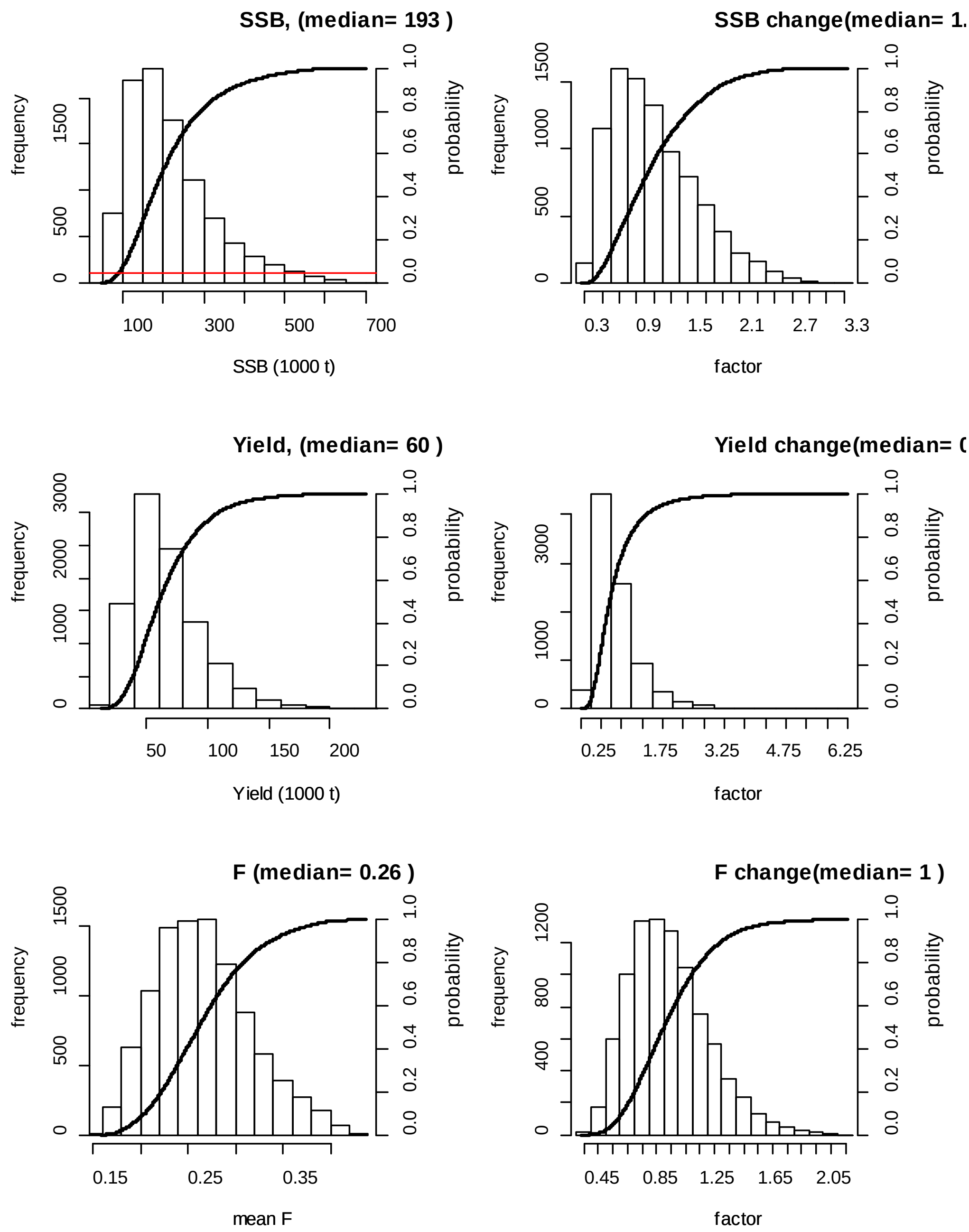

Figure 15. MS2. Distribution of SSB, yield and F, including cumulative probability in the years 2017-2026 from 1000 iterations. The relative change from one year to the next is shown in the right column. 70% of the predicted catch with F=0.35 is used for the second half year TAC. Fixed initial TAC at 25 kt.

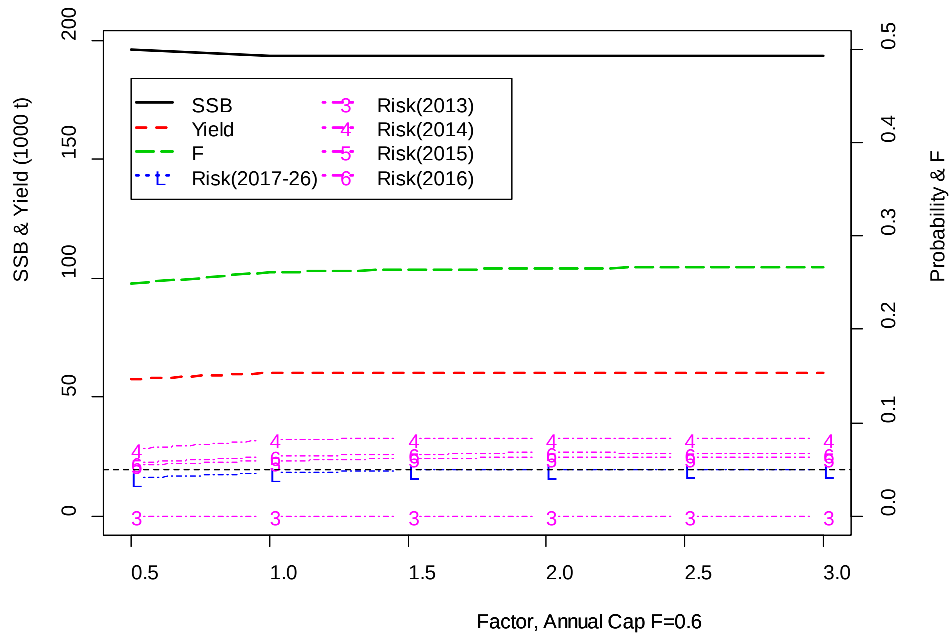

Figure 16. MS2. Sensitivity analysis: Cap F. As default a cap F at 0.13 for the first half-year and 0.47 for the second half year are used (Cap F=0.60). The x-axis shows the given factor used to multiply the default Cap F values. 70% of the calculated TAC for the second half-year is used for the final second half year TAC. Fixed initial TAC at 25 kt.

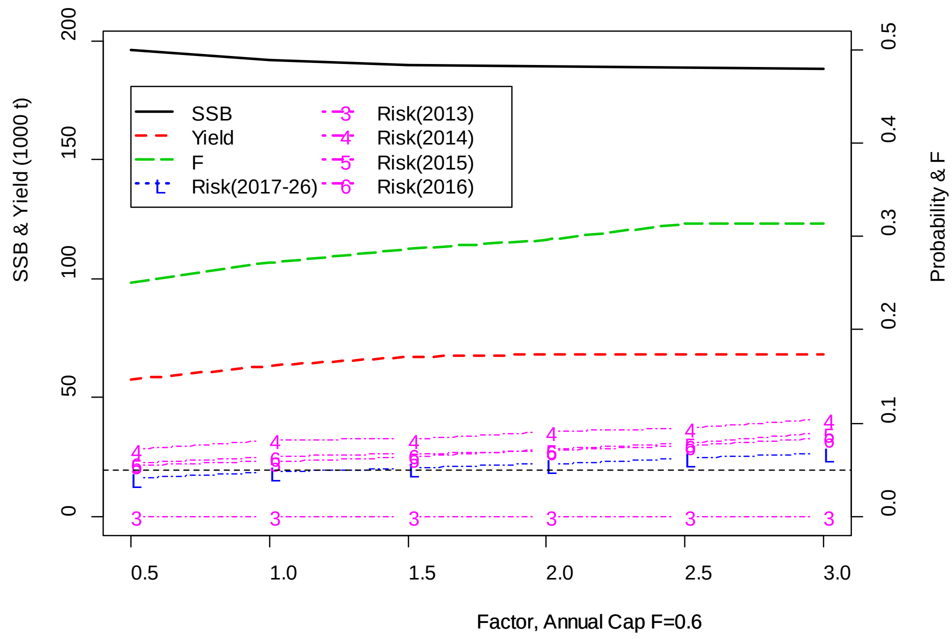

Figure 17. MS2. Sensitivity analysis: Cap F Fixed initial TAC at 50 kt.

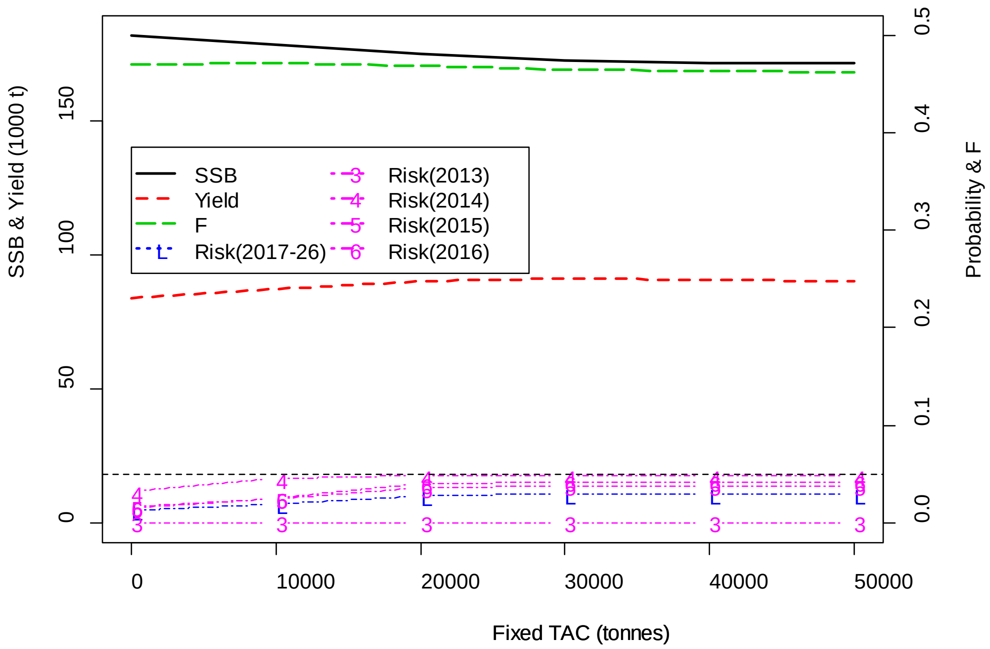

Figure 18. MS3. Sensitivity analysis: Minimum TAC. The graph shows the median value of SSB, yield and F in the years 2017–2026 from 1000 iterations for each value of fixed TAC shown on the X axis. The probabilities (Risk) of SSB below B_{lim} are shown for individual years and a long-term period. 100% of the calculated TAC for the second half-year is used for the final second half year TAC.

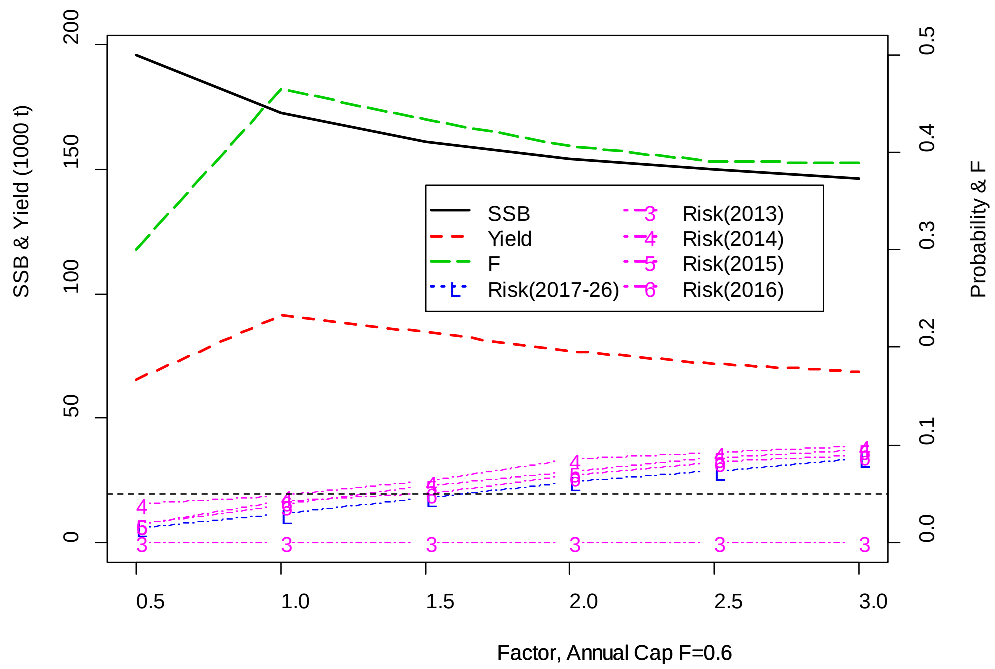

Figure 19. MS3. Sensitivity analysis: Cap F. As default a cap F at 0.13 for the first half-year and 0.47 for the second half year are used (Cap F=0.60). The x-axis shows the given factor used to multiply the default Cap F values. 100% of the calculated TAC for the second half-year is used for the final second half year TAC. Fixed initial TAC at 25 kt.

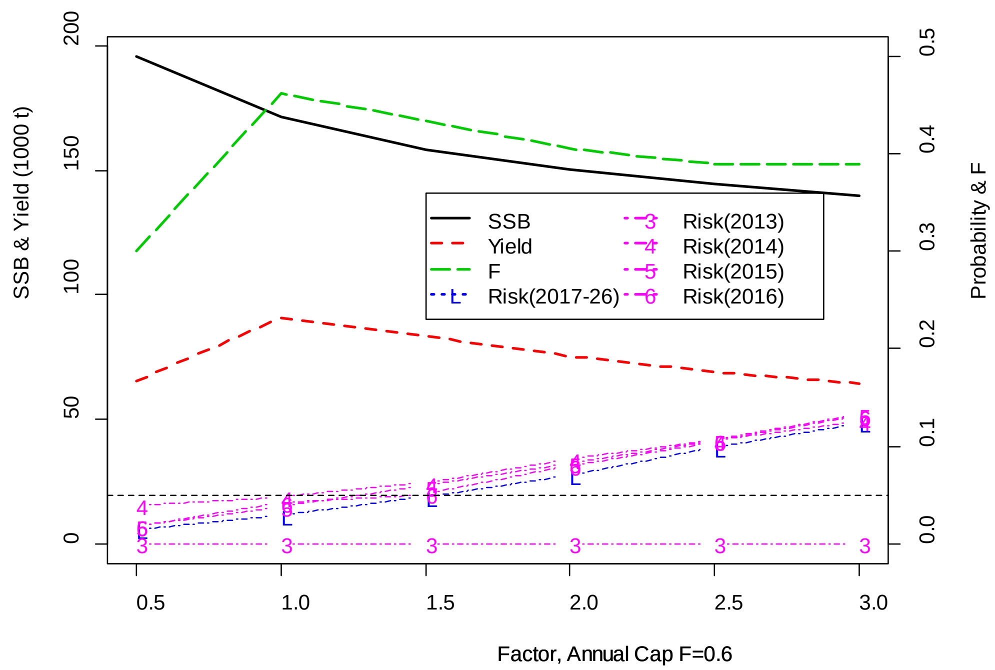

Figure 20. MS3. Sensitivity analysis: Cap F. Fixed initial TAC at 50 kt.

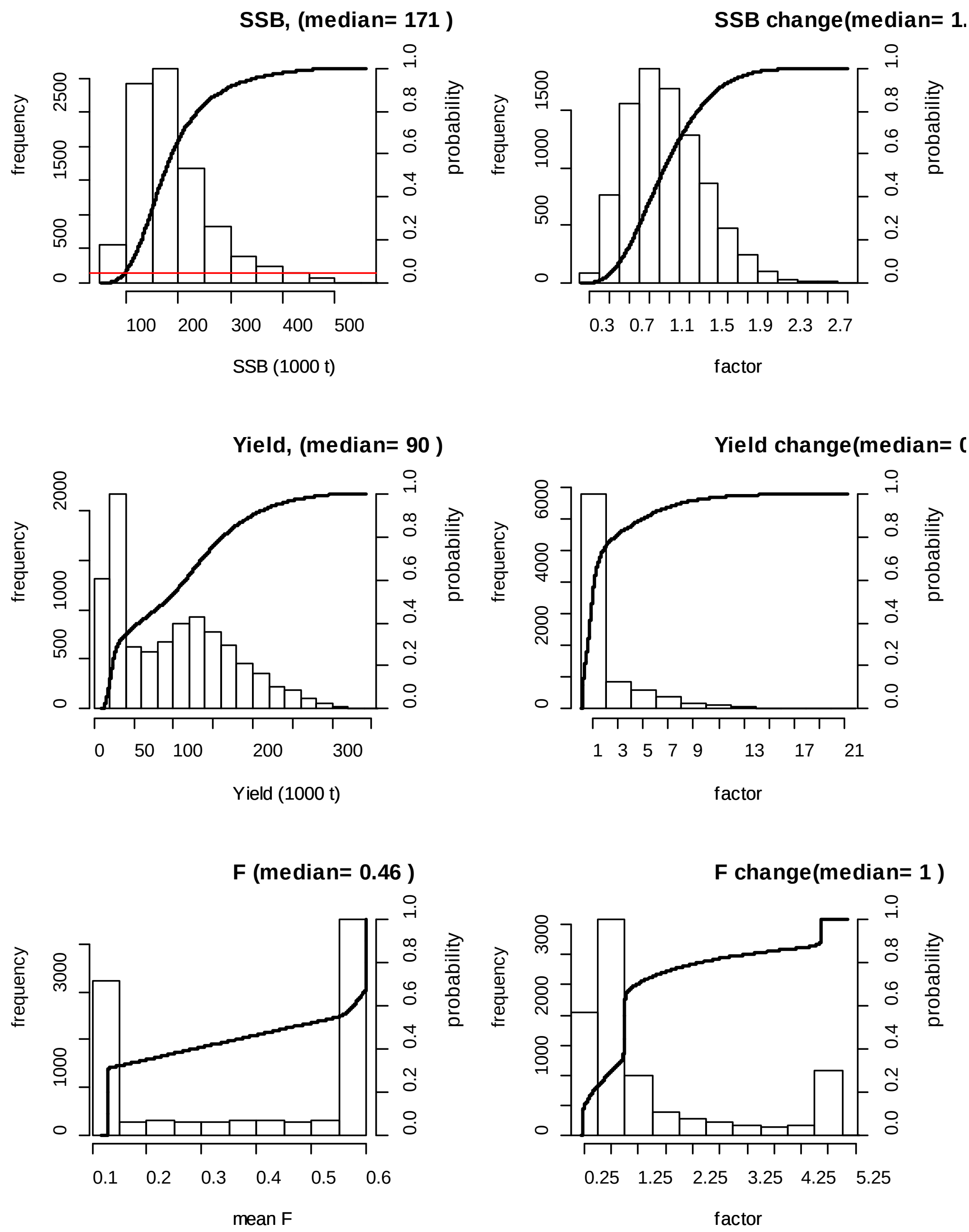

Figure 21. MS3. Distribution of SSB, yield and F, including cumulative probability in the years 2017–2026 from 1000 iterations. The relative change from one year to the next is shown in the right column. 100% of the calculated TAC for the second half-year is used for the final second half year TAC. Fixed initial TAC at 25 kt.

3 Discussion and conclusion

The MSE simulations presented are based on a long row of assumptions of constant values for key parameters such as the fishing pattern, mean weights, maturity and natural mortality at age. Likewise, it is assumed that the estimated stock recruitment relationship is valid for future recruitments. However, this represents the normal ICES procedure to MSE and we have not made additional sensitivity analyses. Given these assumptions the presented scenario results should be regarded more as a sensitivity analysis than as absolute performance in relation to e.g. the probability of SSB above B_{lim}.

Some general conclusion from the evaluation of the options can, however, be made in relation to sustainability according to the precautionary approach for the different management strategies. The applicability of the fixed TAC within the precautionary framework depends on the assumption on when the fishery will actually cease due to low catch rates (and stock size). This is implemented as a Cap F option in the MSE scenarios. The sensitivity to the value of CAP F is in general low for the different presented options, but it is obvious that if the fleet makes a determined attempt to catch the full minimum TAC even though the catch rates are low and the state of the stock is poor, then the MS will not be precautionary.

Norway pout is a semi-pelagic species which is widely and rather evenly distributed in the Northern North Sea (Lambert *et al.*, 2009; Nielsen *et al.*, 2012; Spartholt *et al.*, 2002; ICES, 2012a incl. Stock Annex) and it does not show very dense schooling behavior. The fact that the stock does not occur in large, very dense schools lower the risk for continuation of the fishery at low stock size, i.e. it is likely impossible to maintain high catch rates at low stock size. This indicates that the fishery will stop at low stock size.

The present fishery regulation will also contribute to maintain a low fishing mortality at low stock sizes. The Norway pout box in the North-Western part of the North Sea (closure to reduce by-catch rates of other gadoids) contains a large proportion of the Norway pout stock which is out of reach of the fishery. In addition, the present by-catch regulation to protect other species including maximum by-catch rates of other gadoids will be difficult to obey with low stock size of Norway pout and probably bring the fishery to an end in such situations.

The main fishery for Norway pout is a targeted fishery where Norway pout constitutes the main catch (ICES, 2012a, incl. Stock Annex). Even though Norway pout is caught together with blue whiting in deep waters in some years in the Norwegian fishery, the by-catches of Norway pout has not been high in the Blue whiting fishery historically (including years when the Norway pout fishery has been closed) (ICES, 2012a). By-catch of the species can therefore be ignored.

The sensitivity analyses presented for the escapement strategy (MS1 and MS3) show in general that SSB is maintained above B_{lim} with a high (95%) probability. This is partly because the assumed assessment uncertainty is lower than the uncertainty used to set B_{pa} from B_{lim}. The ratio between B_{lim} and B_{pa} reflects that given a CV at 30% of the estimate of SSB, there will be less than 5% risk that the real SSB is below B_{lim} for an assessment estimate of SSB at Bpa. This is a rather high uncertainty margin given the very stable assessment with limited retrospective noise (ICES, 2012a). Assessment results using the SMS models shows that SSB in the first year after the terminal year can be estimated with a CV at 20%. This value was used in the simulations and is lower than the assumed 30% CV.

The limited time gap between the most recent assessment estimates and the TAC period contributes also to the robustness of the scenarios. Most TAC advices from ICES make use of one so-called "intermediate year", which is the time period between the last assessment year and the TAC year. For Norway pout the TAC advice is mainly given with a shorter delay between the terminal year of the assessment and the TAC period.

Advice summary

The proposed Management Strategies (or HCR for Options 1, 2 and 3) are in accordance with the sustainability criteria under the precautionary approach given a minimum TAC of maximum 27 kt and an assumption about future fishing mortality or fishing effort within the range of the values observed for the last decade.

Management Strategy 1 (MS1) and Management Strategy 3 (MS3) are both based on the escapement strategy and they provide very similar long-term values of F, SSB and yield. The minimum TAC can however be larger for MS3 (e.g. 50 kt) than for MS1 (27 kt). The difference between MS1 and MS3 is mainly the use of the initial fixed TAC. In MS3 the minimum TAC is assumed to be taken (or possible lost) within the first six months of the year. However, it is assumed that the minimum TAC from MS1 is valid for the whole calendar year, irrespective of the May assessment results. With the assumption of a Cap F (total Cap F=0.6, with 0.13 for first half-year and 0.47 for second half-year) there is a higher risk that the minimum TAC will actually be taken with MS1 as this strategy allows the use of second half-year Cap F (fishery) in cases with a very poor stock state.

The management strategy evaluations and simulations confirm the general observation that a fixed F strategy will provide a lower long term yield than an escapement strategy for such a short lived species like Norway pout. The "cost" of the escapement strategy is a much more variable fishing mortality (and fishing effort) from one year to the next. Stability in landings is also lower for the escapement strategy.

4 References

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Nielsen, J.R., Lambert, G., Bastardie, F., Sparholt, H., and M. Vinther. 2012. Do Norway pout (*Trisopterus esmarkii*) die from spawning stress? Mortality of Norway pout in relation to growth, maturity and density in the North Sea, Skagerrak and Kattegat. ICES J. Mar. Sci. 69(2): 197-207. Authorship equal; [1]Corresponding author. Doi:10.1093/icesjms/fss001

Sparholt, H., L.I. Larsen and J.R. Nielsen. 2002. Verification of multispecies interactions in the North Sea by trawl survey data on Norway pout (*Trisopterus esmarkii*). ICES J. Mar. Sci. 59: 1270-1275.

5 Appendix

This Appendix gives a detailed description of the methods for the individual HCR as requested. A more general description of the methodology can be found in ICES WKMAMPEL (ICES 2009).

5.1 Option 1

Request: *Whether a management strategy is precautionary if TAC is constrained to be within the range of 20,000 - 250,000 tonnes, or another range suggested by ICES, based on the existing escapement strategy;*

This option includes 2 assessment/advice per year and TAC constraints (minimum and maximum TAC for the full calendar year). The assessment made in May estimates the population size 1st January and is used to set the TAC for the second half-year. This TAC plus the best estimate of the realized catch from first half-year must be within the TAC constraints. The September assessment gives stock sizes (incl. recruitment the 1st July) and is used as basis for a TAC for the following full year.

Step 1, the initial stock size at start of year Y-1:

"True" stock numbers at age, F and M are assumed known (from historical assessment) without errors in the start of year Y-1. Stock numbers are taken from the SMS estimate.

Step 2, the real stock size at the start of the year Y:

Increment the year index by 1. This step projects the true stock forward one year using the F and M for year Y-1. This will produce the true stock for 1st January, year Y.

Recruitment (in quarter 3) is estimated from SSB at 1st January, a specified stock recruitment relationship (f(x)) and a log normal distributed noise term with standard deviation, std.

$$R_{true} = f(x) * e^{(std * NORM(0,1))}$$

NORM(0,1) is a number drawn from a normal distribution with mean=0 and standard deviation 1.

Step 3, simulate the May assessment:

This step simulates the assessment made in May used for setting the TAC in second half-year of year Y.

Implementation: The "observed" or perceived stock the 1st Jan in year Y is obtained from the true stock and an observation noise and bias:

$$N(a)_{obs} = N(a)_{true} * Bias * e^{(std * NORM(0,1))} * e^{(-(std^2/2))}$$

The bias factor (default=1) and the standard deviation (std) are given as input. The same random number drawn from NORM(0,1) are used for all ages (correlated observation errors).

The result is observed stock numbers for all ages at 1st January, while the ICES May assessment gives the stock number by the beginning of the second quarter of year Y. This discrepancy is however ignored.

Step 4, calculate the realised TAC and update the true stock size to 1st July:

This step mimics that the TAC uptake in the first half year will actually depend on the size of the stock. In cases with rather low stock sizes, it is not realistic that effort (F) will increase significantly to actually take the initial TAC. The input exploitation pattern for the first two quarters is assumed fixed.

Use the true stock numbers 1^{st} January, the exploitation pattern, and the TAC for the first half-year to calculate true F for the first half-year of year Y and the true stock number (including recruits) 1^{st} July. Don't let the true F exceed Cap F, and adjust TAC if needed. Update the true stock numbers by true F and recruitment.

Step 5, calculate the observed F the first half-year and update the observed stock size to 1st July:

This step mimics the first parts of the short term forecast.

Implementation: Use the observed stock numbers 1^{st} January, the exploitation pattern and the adjusted initial TAC for the first half-year to calculate observed F for the first half-year and the observed stock number 1^{st} July. The adjusted TAC from step 4 (instead of the unadjusted!) is used to reflect that the assessment working group will most likely have a good estimate of the realised fishery until May within the assessment year and use that information to update the stock size from 1^{st} January to the first July. Catches from the first quarter of the year are actually used as input to the assessment in the ICES May assessment. However this is not possible to simulate in the present framework.

Recruitment for the observed stock is estimated as a point estimate from the observed SSB and the specified stock recruitment relation.

Step 6, calculate the TAC for the second half-year:

This step mimics the forecast done at the May WG:

Implementation: Scale the observed (long-term) exploitation pattern for quarter 3 & 4 such that observed SSB at the next spawning time becomes Bpa (the escapement strategy). Calculate yield from such F and adjust the TAC (if needed), such that the TAC for the full year is within the TAC constrains.

Step 7, calculate the true F for the second half-year and adjust the "true" TAC for second half-year:

This step mimics that the TAC uptake in the second half year will actually depend on the size of the stock. In cases with rather low stock sizes, it is not realistic that effort (F) will increase significantly to actually take the initial TAC.

Implementation: Use the true stock numbers 1^{st} July (including recruitment), the exploitation pattern for the second half-year to adjust the TAC from step 6 if the true F to take this TAC exceeds the input cap F for the second half-year. Recalculate F and adjust the (realised) $TAC_{second\ half\text{-}year}$ if needed.

Step 8, simulate the September assessment:

Step 6 simulates the assessment made in September used for setting the TAC in the first half-year of Y+1. The "observed" stock the 1^{st} July in year Y is made on the basis of the true stock 1^{st} July and an observation noise and bias similar to step 3. The observed stock includes a recruitment estimate based on observations of the true recruitment, as research survey data (back-shifted from Q3 to Q2) exists to estimate this in the assessment. The result is observed stock numbers for all ages at 1^{st} July.

Step 9, update the observed stock to 1st Jan year Y+1 and calculate the TAC for Y+1:

This step mimics the forecast made at the September Working Group meeting.

Implementation: Scale the observed exploitation pattern for quarter 3 and 4 such that observed yield reaches the TAC for the second half-year. Update the observed stock number to year Y+1 by observed F. Calculate the TAC for year Y+1 such that SSB at the next spawning time becomes Bpa (the escapement strategy). Adjust the TAC (if needed), such that the TAC for the full year is within the TAC constraints.

Step 10, make a new simulation loop:

Start a new simulation loop from step 2.

5.2 Option 2

Request: *A management strategy with a fixed initial TAC in the range of 20,000 - 50,000 tonnes. The final TAC is to be set by adding to the preliminary TAC around (50%) of the amount that can be caught in excess of 50,000 tonnes, based on a target F of 0.35;*

Step 1 and 2:

Identical to the corresponding steps in the previous section 6.1.

Step 3, adjust the initial fixed TAC:

This step mimics that the TAC uptake in the first half year will actually depend on the size of the stock. In cases with rather low stock sizes, it is not realistic that effort (F) will increase significantly to actually take the initial TAC.

Implementation: Use the true stock numbers 1st January, the exploitation pattern and the initial fixed TAC for the first half-year to calculate the true F for the first half-year. If this F exceeds the input Cap F for the first half-year, the realised initial TAC will be adjusted such that mean F for the first half-year does not to exceed this maximum F.

Step 4, simulate the May assessment:

This step simulates the assessment made in May used for setting the TAC in the second half-year of year Y.

Implementation: The "observed" or perceived stock the 1st Jan in year Y is made on the basis of the true stock and an observation noise and bias as described for option 1. The result is the observed stock numbers for all ages at 1st January, while the ICES May assessment gives the stock number by the start of the second quarter of the year Y. This discrepancy is however ignored.

Step 5, calculate observed F the first half-year and update the observed stock size to 1st July:

Implementation: Use the observed stock numbers 1st January, the exploitation pattern and the adjusted initial TAC for the first half-year to calculate observed F for the first half-year and the observed stock number 1st July. The adjusted initial TAC (instead of the unadjusted!) is used to reflect that the assessment working group will most likely have a good estimate of the realised fishery until May in the assessment year and use that information to update the stock size from 1st January to the first July. Catches from the first quarter of the year are actually used as input to the assessment in the ICES May assessment. However this is not possible to simulate in the present framework.

Step 6, calculate the TAC for second half-year:

This step mimics the forecast done at the May Working Group meeting:

Implementation: Scale the observed (long-term) exploitation pattern for quarter 3 and 4 such that SSB at the next spawning time becomes Bpa (the escapement strategy). Calculate the yield for such a scaling and multiply this yield by an input precautionary factor to calculate the TAC for the second half-year ($TAC_{second\ half\text{-}year} = TAC_{escapement\ second\ half\ year}$ * factor.

Step 7, calculate the true F for the second half-year and adjust the TAC for the second half-year:

This step mimics that the TAC uptake in the second half year will actually depend on the size of the stock. In cases with rather low stock sizes, it is not realistic that effort (F) will increase significantly to actually take the initial TAC.

Implementation: Use the true stock numbers 1st July (including recruitment), the exploitation pattern for the second half-year to adjust the TAC from step 6 if the true F to take this TAC exceeds input cap F for the second half-year. Recalculate the F and adjust the $TAC_{second\ half\text{-}year}$ if needed.

Step 8, shift one year ahead:

Increment the Year index by 1 and start a new simulation loop from step 2.

5.3 Option 3

Request: *A management strategy with a fixed initial TAC in the range of 20,000- 50,000 tonnes. The final TAC is to be set by adding to the preliminary TAC around (50 %) of what can be caught in excess of 50,000, based on the escapement strategy.*

Step 1 and 2:

Identical to the corresponding steps for option 1 and 2.

Step 3–5:

Identical to the corresponding steps for option 2

Step 6, calculate TAC for second half-year:

This step mimics the forecast done at the May Working Group meeting:

Implementation: Scale the observed exploitation pattern for quarter 3 and 4 such the mean annual F (including the observed F values for quarter 1 and 2 from step 5) meets the target F of 0.35. The mean F is calculated on the basis of the sum of quarterly F values. Calculate the yield for such scaling and multiply this yield with an input precautionary factor to calculate the TAC for the second half-year ($TAC_{second\ half\text{-}year} = TAC_{escapement\ second\ half\ year}$ * factor.

Step 7 and 8

Identical to the corresponding steps for option 2.

Annex 1 - Technical minutes

Review of ICES Report: Evaluation of management strategies for Norway pout in the North Sea and Skagerrak.

September 26-28, 2012 (by correspondence)

Reviewers: Carmen Fernández (chair)

Massimiliano Cardinale (reviewer)

Norman Graham (reviewer)

Asgeir Aglen (ADG member)

Morten Vinther (ADG member)

Secretariat: Poul Degnbol, Michala Ovens

The sequel provides a summary of several points initially raised by the RG and then discussed via WebEx in a meeting of the RG/ADG.

General Comments

The input data in the MSE simulations are generally consistent with the assessment data and they are conducted in accordance to the three different scenarios included in the EU-Norway request on management measures for Norway pout. The results are adequately summarised and the text contains the necessary details information for evaluating the outcome of the different scenarios and for providing a response to the request by EU and Norway.

Review of the Evaluation of the Joint EU-Norway request on management measures for Norway pout

Management Strategy 1: The correct definition should be "…and a higher than 5% long term probability for SSB below Blim is estimated for a minimum TAC at or above 27 kt."

Management Strategy 2: the text states: "This option is not sensitive to the actual choice of Cap F for a minimum TAC at 25 kt, but very sensitive for a minimum TAC at 50 kt." However, it is not possible to see such a difference in figure 16 and 17.

- Response during RG/ADG meeting: Figures 16 and 17 show risks (probability of SSB below Blim). The long-term risks are quite stable in Figure 16, whereas they increase with increasing values of cap F in Figure 17.

Input data

The use of the mean over the entire period might be only justified by a lack of trend in weight. However, stock weights at age are highly variable and an average of the previous 8 years is used in the assessment. Given that the year estimates are highly variable and the stock is characterised by occasionally periods of very high recruitment i.e. 2012, it is possible that density dependent growth can in part explain the variance in under-annual stock weights. This relationship should be explored and used in future MSE. Also, considering the large variability in weight and the fact that the time series is rather long (1983–2011), it would be more appropriate to use the last 5 or 10 years, especially considering that changes in the zooplankton communities and SST have occurred in the last decades that can also affect the weight at age of the stock.

- Response during RG/ADG meeting: good point. It is noted that the current ICES assessment of this stock uses constant values of weight-at-age in the stock over the whole time series since 1983, as decided during the Inter-benchmark carried out in spring 2012. Weights-at-age in the catch take different values per year in the ICES assessment. Taking the long-term average (since 1983) was a pragmatic solution for the MSE, but other options could be considered.

It is rather unclear which selection pattern has been used. Is it simply the last year of the assessment? The constant exploitation patter is a crucial assumption, for example, would be more appropriate to change the selection pattern with declining TAC in the MSE to mimic seasonal effects linked to dwelling catches.

- Response during RG/ADG meeting: The exploitation pattern in the simulations is based on an SMS estimate with a constant configuration over the full assessment period (excluding close seasons). This choice was also taken for pragmatic reasons, because the exploitation pattern in the fishery has been variable over the years but with no obvious trends that could be used in the MSE. It is also the same exploitation pattern used in this year’s short term forecast for the ICES advice. The RG, however, remarked that random variability in the selection pattern would have been a useful feature to explore in the MSE.

It is true that the trends are very similar between SXSA and SMS but the major difference is just in the last year, which is the crucial one in the MSE as it dictates numbers in the stocks and selection pattern. Are any reason why SMS output was chosen or any sensitivity analysis on how it affects the results? The difference is not small, about 70 kt of SSB. Fortunately, the SMS estimate is more conservative, and thus it would not affect the results of the MSE in terms of risk estimates.

- Response during RG/ADG meeting: The SMS output was chosen partly because SMS allows quantifying uncertainty in SSB estimates, and this uncertainty has been used to simulate assessment error during the MSE projections. Differences are not believed to affect the conclusions of this analysis.

Stock recruitment

It is unclear which SR function has been used and which years in the historical assessment range. Also for the 30% CV the rationale of the choice is not fully documented.

- Response during RG/ADG meeting: A hockey- stick relationship has been fitted to the historic stock and recruitment values from the assessment, with log-Normal errors. The fit, with the estimated recruitment variability around it, is then used to generate recruitment values during the projection period. Therefore, recruitment during the projection period replicates the general situation estimated for the historic period (since 1983).

F Cap

Also here the text is not clear on the choice of the F Cap. Is the effort today at a level that will not generate more than F=0.6 and this is why this value was chosen? Or it is simply the maximum observed level in the time series? The F Cap should be related to estimated risk derived from the MSE simulations.

- Response during RG/ADG meeting: The estimated F values have been below 0.6 for over a decade. Additionally, there is a strong relationship between (standardised) effort and F, as shown in Figure 4. For this reason, effort management is proposed as a complement to the harvest control rules, to avoid exceeding values of F of around 0.6. The F cap value has been related to risk in several figures of the report.

Results

As the risk in the first years is basically dependent on the stock status in the first year of simulations, the conclusions of the MSE in the text should be based mainly on the long term risk results. This should have been better highlighted in the Results.

- Response during RG/ADG: agreed. For the final advice, short-term risks were also considered, but based on the current recruitment in 2012, which has been observed to be very high. This means that short-term risks (with this high recruitment value in 2012) are lower than long-term risks and this has been noted in the ICES advice. But most of the elaboration is based on long-term risks.

Advice summary

Are the conclusions in the first sentence valid also for MSE 2? Or only for MS1 and 3? The figure 12 shows a risk larger than 5% for any year after 2013 and for the long term at any level of fixed TAC for MS2 scenario. Also, if the fishery is opened in Q4 2012, the MSE might not be valid any longer, especially for the estimated risk in 2013 and 2014, and it would need to be updated accordingly.

- Response during RG/ADG: The conclusions of the first sentence do not hold for MS2 directly, a reduction to about 70% of the catch that MS2 would give is required for the conclusion to hold. This is explained in the report and will be made clear in the ICES advice.
- Response during RG/ADG: It is noted that none of the options, as they were tested, considers the possibility of re-opening the advice for Q4 of the year.