ECOREGION North Sea
SUBJECT Joint EU–Norway request on TAC setting options for cod in the North Sea and Skagerrak

Advice summary

The current management plan is considered precautionary, assuming perfect implementation. The current plan implies further reductions in fishing mortality and catch advice in 2014, which will pose difficulties in a mixed fisheries context. Achieving such a reduction may require that additional effort reductions or equivalent cod avoidance measures are considered. In contrast, the new proposed harvest control rules (HCRs) would result in increased catch advice in 2014, but in lower medium-term catches than the current HCR.

ICES considers the new proposed HCRs not to be precautionary. Specifically, compared to the long-term phase of the current management plan they would delay the recovery of the SSB.

Request

The long-term management plan for cod has failed to achieve the successive reductions in fishing mortality required by the recovery phase of the plan. This has resulted in a growing discrepancy between the target fishing mortality of the plan and the real level of fishing mortality that is observed.

The plan requires that the TAC for 2013 be reduced by 20% compared to that for 2012. This corresponds to a 46% reduction in fishing mortality at a time when the cod stock is increasing and the TACs of the species associated with cod, such as saithe, haddock and whiting, have been substantially increased. Recognising that such a reduction in the cod TAC is likely to increase discard rates rather than decrease total catches, the EU and Norway have stated their intention to revise the cod plan to allow more flexibility in setting the TAC under such circumstances. In order to facilitate the selection of more appropriate TAC levels during the recovery phase of the cod plan, ICES is asked to evaluate the following options for the recovery of the cod stock:

1. *Maintaining a target fishing mortality of 0.4 when the SSB is between Blim and Bpa for as long as the resulting stock forecast indicates an increase in SSB, with no inter-annual TAC constraint. Where the stock is forecasted to decrease at a fishing mortality of 0.4, the fishing mortality should be fixed at a level that will maintain the current SSB.*

2. *Maintaining a constant TAC when the SSB is between Blim and Bpa, provided that the resulting fishing mortality does not exceed 0.4, with the level of the TAC being that corresponding to a fishing mortality of 0.4 in 2014.*

For the intermediate year, ICES is asked to assume a fishing mortality consistent with the linear trend of recent years.

ICES is asked to evaluate the consequences of each of the above options for the cod stock in terms of risk, spawning biomass, TAC levels and estimated discards.

Elaboration on ICES advice

Interpretation of the request and harvest control rules tested

Following clarification from the EC, ICES understands that the request was mainly concerned with the "recovery phase" of the cod plan (the phase where 10% annual reductions in F are implemented independently of stock biomass). However, according to the latest ICES assessment (June 2013 advice; ICES, 2013a), ICES now considers the plan to have moved into its "long-term phase", implying that the EU–Norway request may have been superseded by events. Nevertheless, the cod SSB in 2013 is estimated to be only just above B_{lim} (with still close to 50% probability of being less than B_{lim}) and well below B_{pa}. Therefore, the stock cannot be considered to have recovered yet, and ICES has performed the evaluation according to the request.

ICES has evaluated the performance of the harvest control rules (HCRs) proposed in the present request, based on a constant F of 0.4 (termed "F-based", first proposal in this request) and on a constant TAC ("TAC-based", second proposal in this request). Two other HCRs have additionally been evaluated, for comparison: the current HCR in the long-term phase of the cod management plan (as this is the phase of the plan that is relevant now), with or without application of a 20% constraint in interannual TAC changes.

The evaluation focuses on performance of the HCRs during the next ten-year period (2014–2023) and assumes that recruitment shows a limited response to increases in SSB, which leads to a slow increase in recruitment from the present very low values. This is considered an appropriate recruitment scenario for the evaluation because, so far, only little increase in the recruitment has been observed despite the substantial increase in SSB in the last six years.

Advice

The proposed HCRs (F-based and TAC-based) correspond to a probability of SSB being less than B_{lim} (70 000 t) of the order of 20% in the first few years, which then gradually decreases to around 10% towards the end of the evaluated period (Table 6.3.5.5.1 (a)). The current HCR (with or without TAC constraint) performs better in terms of stock biomass, with annual probabilities of SSB being less than B_{lim} that do not exceed 5% in any year (except for a single occasion, when 6% is obtained).

Based on these findings, and assuming perfect implementation, ICES concludes that the current HCR (with or without TAC constraint) is in accordance with the precautionary approach, whereas the new proposed HCRs are not precautionary (since the probability of SSB being below B_{lim} is > 5% in all years evaluated, 2014-2023), and they would delay the recovery of the SSB. Additional analyses have shown that if recruitment increases more rapidly towards the historical average recruitment than assumed in this evaluation, the new proposed HCRs could achieve a probability of SSB being below B_{lim} not exceeding 5% after some initial years.

The evaluated HCRs imply rather different trajectories for F and catch over time (Table 6.3.5.5.1 (c, d)), which may have consequences for implementation in the short term. The new proposed HCRs would result in increased catch advice in 2014, whereas the opposite happens for the current HCR (when compared with the assumed actual catch in 2013, i.e. the catch corresponding to $F_{2013} = 0.39$). On the other hand, the expected medium-term catches are lower with the new proposed than with the current HCR. Assuming that discard rates-at-age remain as in recent years, trends in landings and discards are similar to those found for catches (Table 6.3.5.5.1 (e, f)).

The clear differences between the effects of the HCRs in 2014 and 2015 should also be considered in a mixed fisheries context. The evaluation assumes that the large reduction in F in 2014 required with the current HCR is implemented. However, the mixed-fisheries analysis performed by ICES in 2013 (ICES, 2013b) shows that the fishing effort needed to catch the advised tonnage (28 809 t landings for cod based on the current management plan) in 2014 is considerably smaller for cod than for other demersal stocks caught in the same fisheries. Achieving such a reduction for F of cod in 2014 may require that effort reductions or equivalent cod avoidance measures are implemented; otherwise, the reduction in F may not occur and increased cod discards may be expected. This is in line with the 2012 ICES response to the EU–Norway request on North Sea cod discard rates (ICES, 2012). It should be noted that the evaluation conducted here does not take into account potential changes in discard practices or selectivity that may arise, for example, as a consequence of the future EU landing obligation.

Basis of the advice

Background

Previous evaluations of the cod management plan concluded that the current plan is considered precautionary, provided that it is adequately implemented. ICES evaluation in 2011 of the EU–Norway long-term management plan (ICES, 2011) concluded that objectives had not been met in terms of reductions of fishing mortality, highlighting a number of weaknesses in the design and implementation of the plan. The implementation did not follow the regulation, mainly because of significant discards and unallocated removals, and difficulties in estimating them accurately, inadequate control instruments, and insufficient coherence in the EU effort regime. In December 2012, ICES concluded that the fishing effort needed to catch the 2013 single-species fishing opportunities for cod was considerably smaller than for other demersal stocks caught in the same fisheries (ICES, 2012), and that reducing the cod TAC by 20% in 2013 would likely result in increased cod discards, unless effort reductions or equivalent reductions in cod catchability were implemented.

Results and conclusions

For the HCRs proposed in this request, the probability that SSB lies below B_{lim} varies between 10% and 23% (Table 6.3.5.5.1 (a)), and the HCRs are therefore not precautionary. In contrast, under the HCR of the current management plan (with or without TAC constraint), this probability does not exceed 5% in any year (except for a single occasion, when 6% is obtained; Table 6.3.5.5.1 (a)), and the HCR is in accordance with the precautionary approach. Additional analyses (De Oliveira, 2013) indicated that if recruitment were to increase more rapidly towards the historical average

recruitment than assumed in this evaluation, the new proposed HCRs could achieve a probability of SSB being below B_{lim} not exceeding 5% after some initial years.

In all cases, the probability that SSB is less than B_{pa} (150 000 t) is very high in the first few years, and decreases through time (Table 6.3.5.5.1 (b)). In the final year (2023), the probability that SSB < B_{pa} is less than 50% for all four HCRs, ranging from 39% for the F-based HCR to 2% for the current HCR with TAC constraint.

The evaluated HCRs imply rather different trajectories for F and catch over time. The two new proposed HCRs lead to F_{2014} = 0.41, which is quite close to the assumed F_{2013} (Table 6.3.5.5.1 (c)). After 2014, the F-based rule leads to values of F in the range of 0.33–0.42, whereas the TAC-based rule (aiming to keep a fixed TAC) produces continuously decreasing values of F. The F-based HCR leads to gradual increases in catch, already starting in 2014, whereas with the TAC-based HCR the catch stabilizes at around the 2013 value, after a peak in 2014 (Table 6.3.5.5.1 (d)).

The current HCR (with or without TAC constraint) implies a strong decrease in F in 2014 (F_{2014} = 0.23). After 2014, the current HCR with a 20% TAC constraint leads to further decreasing values of F. If no TAC constraint were applied, it would instead lead to increasing values of F after 2015, coming close to F = 0.4 from 2017 as SSB increases. This contrast is a known effect of TAC constraints in a situation of an increasing stock, as they may prevent catch increasing at the same pace as the stock biomass. The current HCR (with or without TAC constraint) leads to a strong reduction in catch in 2014 (when compared with the assumed actual catch in 2013, i.e. the catch corresponding to F_{2013} = 0.39). After 2014, catch continuously increases, with the catch at the end of the ten-year simulation period very substantially exceeding that in 2013.

In summary, the new proposed HCRs would result in increased catch advice in 2014, but in lower medium-term catches than the current HCR.

The F-based rule relies on forecasting assumptions to a greater extent than the TAC-based rule and the rule in the current management plan, and the uncertainty associated with these assumptions may be playing a role in the higher risks obtained. Under a strongly recovering stock, the TAC-based rule has the potential of leading to low Fs, with associated discarding problems; to a lesser extent the same issue can occur with the current HCR and a 20% TAC constraint.

Methods

A management strategy evaluation (MSE) was carried out to evaluate the HCRs in the request (De Oliveira, 2013). The operating model was conditioned on the 2013 SAM assessment, which is the most recent ICES assessment. A scenario taking into account the present low recruitment was assumed as the most relevant option on which to base the simulation of future recruitment, and a historical average recruitment scenario was included for comparison. The historical average recruitment scenario was modelled using a Ricker S–R relationship fitted to the whole series of data from 1963, and the low recruitment model was constructed by halving the resulting curve. Figure 6.3.5.5.1 shows the two stock–recruitment curves; future recruitment is simulated from a log-normal distribution with median given by the lower stock–recruitment curve and CV = 53%. This approach could potentially underestimate recruitment for biomasses below B_{lim} (lower curve in Figure 6.3.5.5.1 compared to the low recruitment data points from recent years). However, when SSB is above B_{lim} (which is the case in most iterations in the period 2014–2023, considering that median SSB was just above B_{lim} in 2013), such an approach offers a less pessimistic view than using the most recent years for recruitment, as is the case in the June 2013 cod advice (median of re-sampled recruitment 1998–2012 = 174 million). For SSBs in between B_{lim} and B_{pa}, the approach results in recruitment values around the medium-term geometric mean, which included higher historical biomasses (GM 1988–2012 = 288 million). Therefore, the recruitment model used in this evaluation is considered appropriate to capture the actual range of plausible recruitment in the short and medium terms (years 2014–2023), while still assuming a positive response of recruitment to increasing SSB. It should be additionally noted that recruitment is not simulated symmetrically around the stock–recruit curve, because of the assumption that recruitment is log-normally distributed, leading to values being further away above the curve than below. The resulting simulated recruitment can be seen in Figure 6.3.5.5.2.

Four HCRs were tested: the two specified in the request (i.e. the F-based and the TAC-based HCRs) and, for comparison, two HCRs as specified for the long-term phase of the current HCR, one with TAC constraints and one without constraints:

- "F-based HCR" (first option in the present EU–Norway request): Apply F = 0.4 to calculate the catch (and corresponding landings) advice, except when the forecast indicates this would lead to a decrease in SSB, in which case the F that keeps the SSB constant should be applied instead. The change in SSB was defined as the difference between the SSB at 1st January after the TAC year and the SSB at 1st January of the intermediate year, i.e. SSB(y+2)−SSB(y). No restriction on interannual TAC changes is applied.

- "TAC-based HCR" (second option in the present EU–Norway request): The catch (and corresponding landings) advice for 2014 should correspond to F = 0.4. For later years, the same fixed TAC is applied, except when the forecast indicates this would lead to an F higher than 0.4, in which case F = 0.4 should be applied instead. No restriction on interannual TAC changes is applied.
- "Current HCR with TAC constraint": HCR in the long-term phase of the cod management plan, including the 20% constraint on interannual TAC changes.
- "Current HCR without TAC constraint": HCR in the long-term phase of the cod management plan, without any restrictions on interannual TAC changes.

The request asks ICES to assume a fishing mortality during the intermediate year consistent with the linear trend of recent years. The evaluation conducted assumes that F in the intermediate year equals the F value estimated for the preceding year, as this is considered the most realistic intermediate year assumption at this stage, in line with that currently implemented for the ICES annual catch advice for this stock.

An XSA approximation to the SAM assessment model was used for the assessment error part of the MSE. The evaluation assumed perfect implementation of the catch advice. The analyses were performed in R, using the library FLR.

Sources

De Oliveira, J.A.A. 2013. North Sea cod evaluations, Summer/Autumn 2013. ICES CM 2013/ACOM:72.

ICES. 2011. Joint EU–Norway request on the evaluation of the long-term management plan for cod. *In* Report of the ICES Advisory Committee, 2011. ICES Advice 2011, Book 6, Section 6.3.3.3.

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ICES. 2013a. Cod in Subarea IV (North Sea) and Divisions VIId (Eastern Channel) and IIIa West (Skagerrak). *In* Report of the ICES Advisory Committee, 2013. ICES Advice 2013, Book 6, Section 6.4.3.

ICES. 2013b. Mixed-fisheries advice for Subarea IV (North Sea) and Divisions IIIa North (Skagerrak) and VIId (Eastern Channel). *In* Report of the ICES Advisory Committee, 2013. ICES Advice 2013, Book 6, Section 6.3.2.

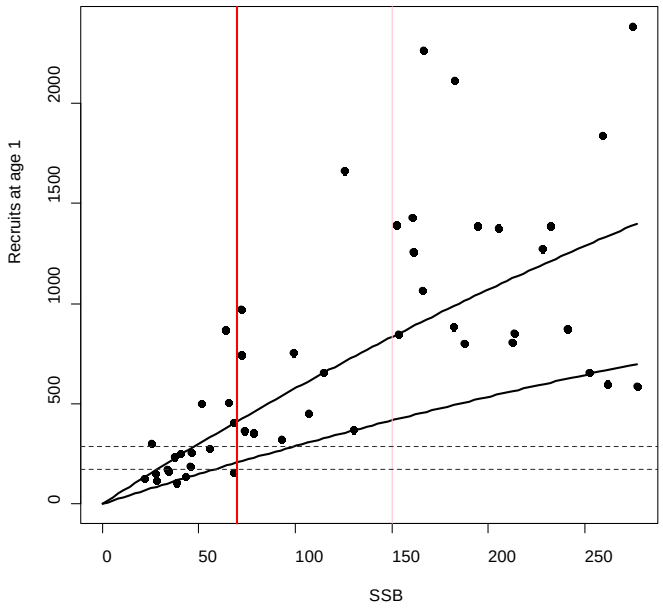

Figure 6.3.5.5.1 Historical stock–recruitment estimates (data points), stock–recruitment curve fit to the whole data set (upper curve), and stock–recruitment curve obtained by halving the upper curve (lower curve). Also shown are B_{lim} (70 kt; red vertical line) and B_{pa} (150 kt; light pink vertical line), along with the recruitment value used for the short-term forecasts in the 2013 WGNSSK North Sea cod assessment (median of re-sampled recruitments from 1998–2012 = 174 million; bottom hashed horizontal line), and the geometric mean recruitment calculated over the period 1988–2012 (= 288 million; top hashed horizontal line). In the evaluation, recruitment is simulated from a log-normal distribution with median equal to the lower stock–recruitment curve, leading to simulated values being further away above the curve than below. Most of the SSB values during the simulation period (2014–2023) are above B_{lim}.

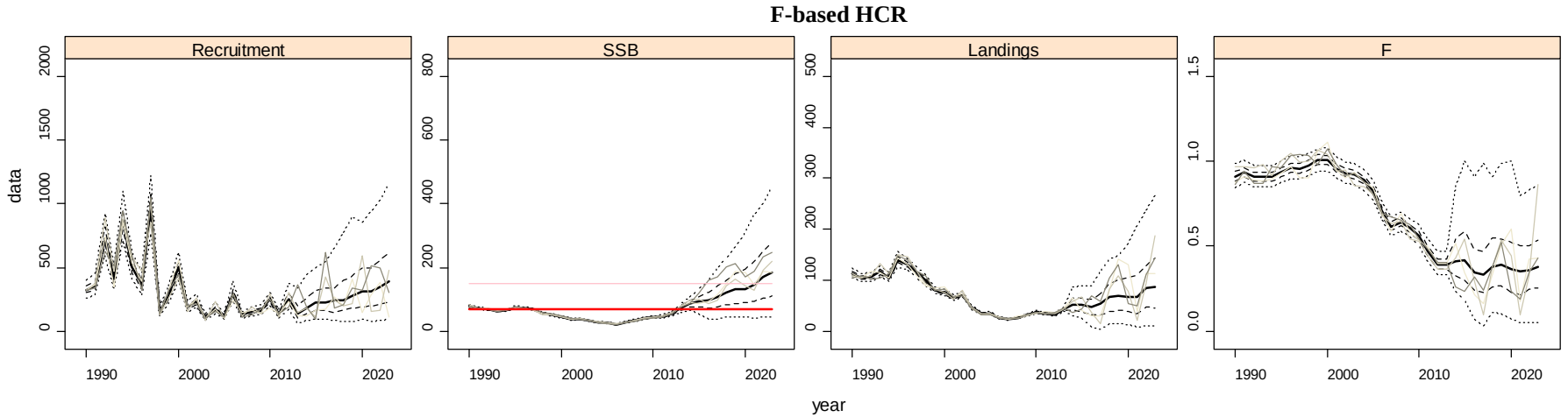

Figure 6.3.5.5.2 (a) Results for F-based HCR. The graphs show the estimated historical period since 1990 and simulated years 2014–2023 (solid line: median; dashed lines: 25 and 75 percentiles; dotted lines: 5 and 95 percentiles; lighter grey lines: examples of individual trajectories). The SSB graph also shows B_{lim} (70 kt, thick red line) and B_{pa} (150 kt, thin pink line).

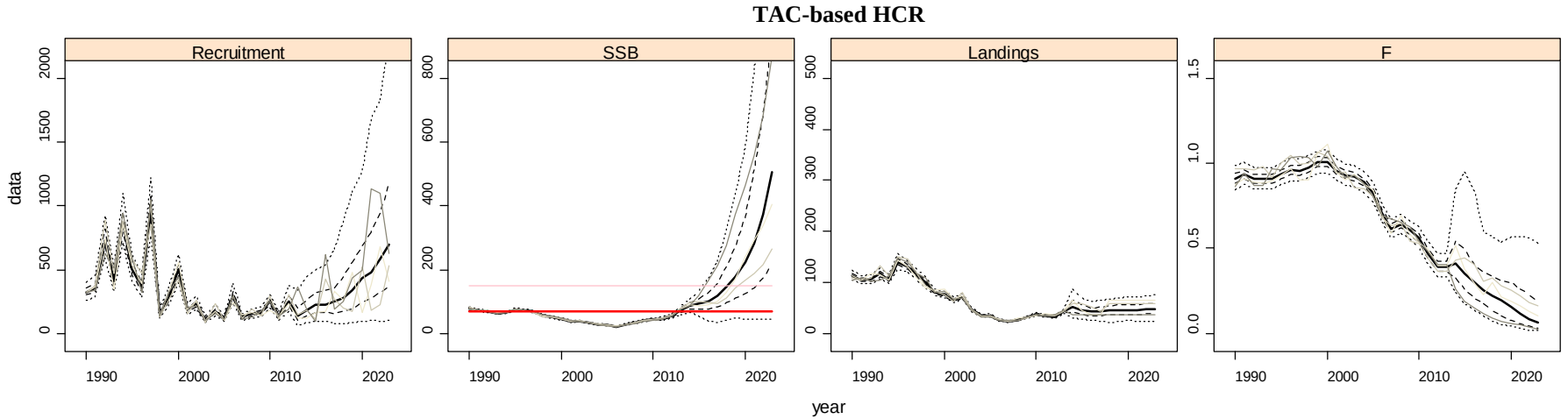

Figure 6.3.5.5.2 (b) Results for TAC-based HCR. The graphs show the estimated historical period since 1990 and simulated years 2014–2023 (solid line: median; dashed lines: 25 and 75 percentiles; dotted lines: 5 and 95 percentiles; lighter grey lines: examples of individual trajectories). The SSB graph also shows B_{lim} (70 kt, thick red line) and B_{pa} (150 kt, thin pink line).

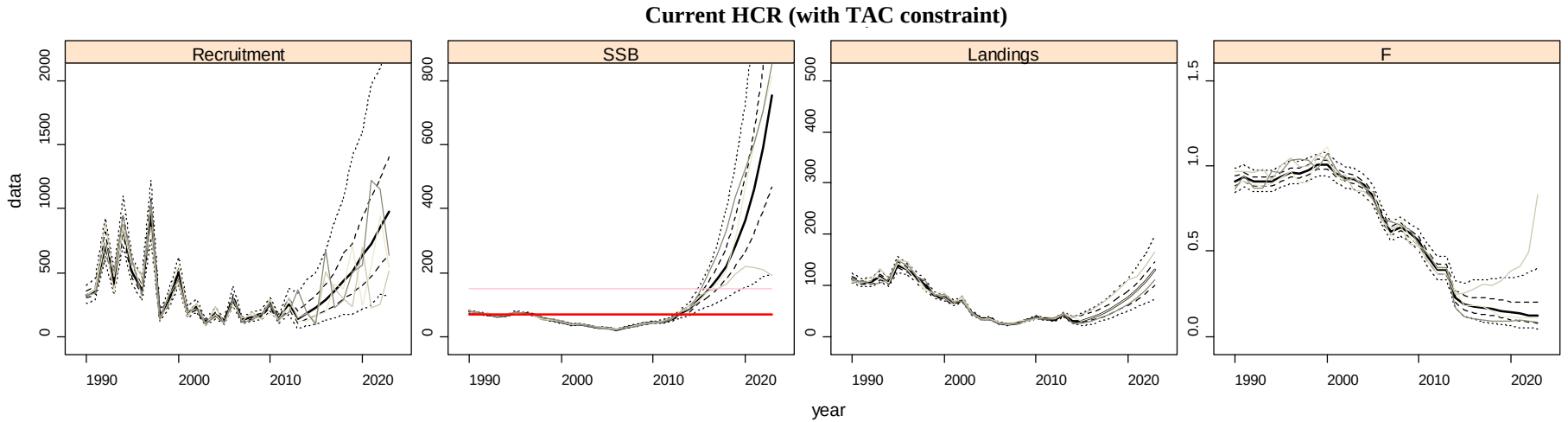

Figure 6.3.5.5.2 (c) Results for current HCR with 20% TAC constraint. The graphs show the estimated historical period since 1990 and simulated years 2014–2023 (solid line: median; dashed lines: 25 and 75 percentiles; dotted lines: 5 and 95 percentiles; lighter grey lines: examples of individual trajectories). The SSB graph also shows B_{lim} (70 kt, thick red line) and B_{pa} (150 kt, thin pink line).

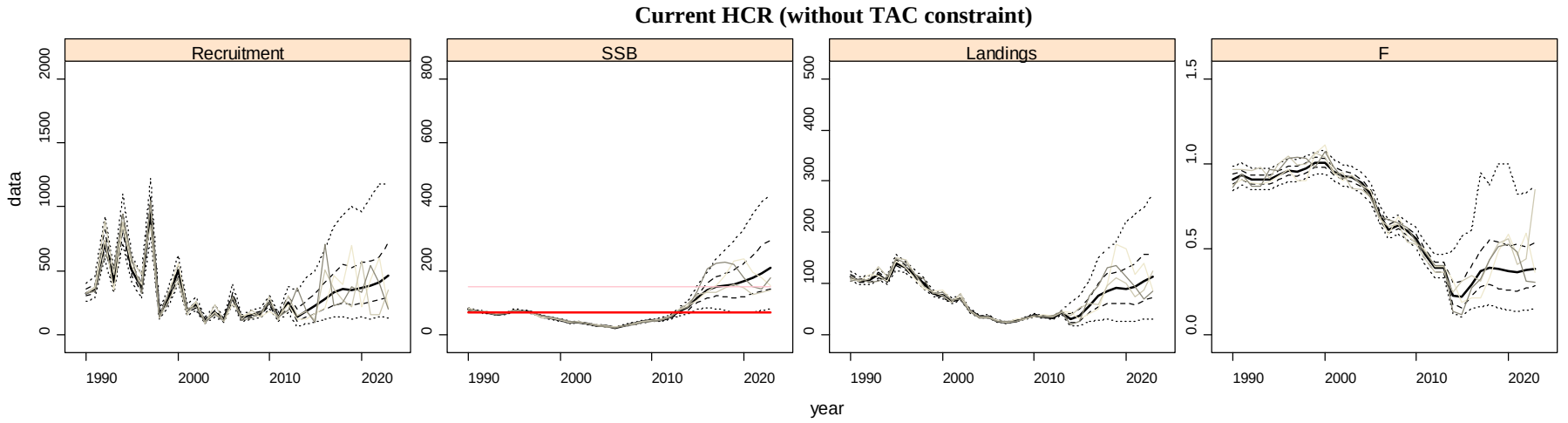

Figure 6.3.5.5.2 (d) Results for current HCR without TAC constraint. The graphs show the estimated historical period since 1990 and simulated years 2014–2023 (solid line: median; dashed lines: 25 and 75 percentiles; dotted lines: 5 and 95 percentiles; lighter grey lines: examples of individual trajectories). The SSB graph also shows B_{lim} (70 kt, thick red line) and B_{pa} (150 kt, thin pink line).

Table 6.3.5.5.1 Summary results of the North Sea cod evaluation. HCR refers to the four different rules evaluated: the two HCRs proposed in this request (F-based and TAC-based) and the current HCR (with or without TAC constraint). A 20% constraint on interannual TAC variability is applied only for the current HCR with TAC constraint, with no TAC constraint applied in the other cases.

(a)											
		$P(SSB < B_{lim})$ (expressed as a percentage)									
	HCR		**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
	F-based HCR		10	18	23	22	17	17	15	14	13	11
	TAC-based HCR		10	18	20	18	14	13	11	10	10	10
	Current HCR with TAC constraint		10	1	0	0	0	0	0	0	0	0
	Current HCR without TAC constraint		10	2	3	4	5	6	5	5	5	5
(b)		**$P(SSB < B_{pa})$ (expressed as a percentage)**									
	HCR		**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
	F-based HCR		100	99	93	82	69	60	59	51	44	39
	TAC-based HCR		100	99	87	70	52	39	31	26	21	19
	Current HCR with TAC constraint		100	92	57	26	15	7	5	3	3	2
	Current HCR without TAC constraint		100	94	64	48	49	45	42	36	32	29
(c)		**median F(ages 2–4)**									
	HCR	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
	F-based HCR	0.39	0.41	0.42	0.35	0.33	0.38	0.39	0.37	0.35	0.36	0.38
	TAC-based HCR	0.39	0.41	0.36	0.3	0.25	0.22	0.19	0.15	0.12	0.09	0.07
	Current HCR with TAC constraint	0.39	0.23	0.19	0.18	0.17	0.16	0.15	0.14	0.13	0.13	0.12
	Current HCR without TAC constraint	0.39	0.23	0.22	0.3	0.38	0.39	0.39	0.37	0.37	0.38	0.39
(d)		**median Catch (in thousands of tonnes)**									
	HCR	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
	F-based HCR	54	64	64	61	66	81	85	84	83	101	107
	TAC-based HCR	54	64	57	53	52	54	55	56	56	56	55
	Current HCR with TAC constraint	54	37	38	45	53	63	75	89	105	124	147
	Current HCR without TAC constraint	54	37	43	66	93	107	113	113	117	130	138
(e)		**median Landings (in thousands of tonnes)**									
	HCR	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
	F-based HCR	42	52	52	49	53	67	70	67	67	85	87
	TAC-based HCR	42	52	46	43	43	45	45	46	46	47	47
	Current HCR with TAC constraint	42	31	31	37	44	53	63	76	91	109	130
	Current HCR without TAC constraint	42	31	36	56	76	85	90	90	94	104	112
(f)		**median Discards (in thousands of tonnes)**									
	HCR	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
	F-based HCR	11	11	12	11	12	14	15	15	15	17	20
	TAC-based HCR	11	11	11	10	9	9	9	9	9	8	8
	Current HCR with TAC constraint	11	6	6	7	9	10	12	14	15	17	20
	Current HCR without TAC constraint	11	6	7	11	17	21	22	21	22	23	25