Ex-ante evaluation of Seasonal, Real Time and Move-on Closures.

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Contents

Contents....3

1. Summary & Conclusions....5

2. Introduction....5

3. Overall Dutch Cod-CpUE by year....6

4. Effect of spatio-temporal closures....6

5. Effects of move-on measures....7

Justification....10

1. Summary & Conclusions

An ex ante evaluation of the effect of closures on cod LpUE is executed by modelling spatial and temporal closures of two fleets (TR1 and TR2), based on previous year(s) landing and effort data. The change of cod CpUE is proportional to the change of cod LpUE and depends on the discarded fraction of the cod catches.

- Reductions in LpUE can be substantial when the current year is used to inform the choice of closures.
- Reductions in cod LpUE are much less, and can remain unchanged (TR1) on average, when the previous year is used to inform the choice of closures.
- Some reductions (15%) in cod LpUE by TR2 can be achieved even when closures are informed with previous year's data. Using the previous two year's data show similar reductions
- Reductions in TR1 (<120mm mesh) cod LpUE will not be achieved when choice of closures is informed with the previous year's data but would be substantial in the situation of real-time closures.
- The move-on measures seem to be potentially the most useful , leading to substantial LpUE reductions, but it all depends on the actual implementation of the measure.
- Setting a maximum cod-LpUE of 20-40 kg/2 hours, to trigger a move-on measure, has on average similar effects as limiting the cod fraction in the (2 hour) landings to 5%, but the variation is less.
- The effects of applying both closure and move-on measures are additive.

2. Introduction

The Ministry of EL&I asked IMARES to do an ex ante evaluation of temporal / spatial closures based on effort and cod catches by the Dutch demersal, TR1 (<120mm mesh) and TR2, fleets [1]. The background to the project is the planned transfer of approximately 6.6×10^6 KW-days of BT2 effort to TR1 and TR2 gear categories. This is because fishing with TR gears is believed to have less damaging environmental impacts. To facilitate the effort transfer a 'Cod Avoidance Plan' was developed which combined 'technical measures' such as gear modifications with various types of spatio-temporal closure. The ideas was that these measures should be able to reduce the Cod-CpUE, Catch per Unit of Effort, of TR1 and TR2. It was IMARES' job to ascertain whether the intended reductions in CPUE were actually achievable using the measures suggested by the Ministry

3. Overall Dutch Cod-CpUE by year

1 . Gear grouping is defined in Counsel Regulation(EU) No 1342/2008:

TR1	Bottom trawls of mesh equal to or larger than 100 mm and less than 120 mm
TR2	Bottom trawls of mesh equal to or larger than 70 mm and less than 100 mm
BT2	Beam trawls of mesh equal to or larger than 80 mm and less than 120 mm

The estimation of overall Cod-CpUE's by TR1, TR2 and BT2 , between 2006 and 2010, is based on landing- and effort information from logbooks and our best estimates of cod-discard fractions by weight and presented in Table 1. Discard fractions by weight are smaller than fractions by number because average size of discarded cod is smaller than the size of landed cod. The discard fraction of TR2 (0.21) is based on estimates of cod-catches of twinning trawl vessels presented by Helmond and Overzee (2009)[2] and is lower than (STECF) estimates. STECF discard estimates are used for the fractions of TR2 and BT2. To meet the requirement of an effort transfer from BT2 to TR of 3 to 1, the cod-CpUE [cod-landing (kg)/ effort (Kwdays)] should be less than 0.18 kg/Kwdays in 2011. The 2010 CpUE of the TR1 fleet is 1.5 times less and the 2010 TR2 CpUE is slightly lower (0.163 kg/Kwdays).

4. Effect of spatio-temporal closures

The decision on potential candidate areas and -periods for closure starts with identifying the area/period combinations with highest cod concentrations. The ex-ante evaluation is done by model calculation based on a landing database using the VISSTAT logbook database (2006-2010) combined with the VMS (geographical position) database of the individual vessel-trips from 2006 to 2010. The landings, partitioned to VMS positions every 2 hours of a trip, are assigned to subareas by dividing each ICES rectangle into (4x4=16) sub-squares. Since model calculations are based on landings, results in this report are presented as effects on LpUE values. Relative changes in LpUE's and CpUE's are equal in case one discard fraction per year and gear category is used. It should be noted that the model-data lack landing- and effort information from small vessels (<15m). Total effort is between 80 and 90 % of the total VISSTAT effort and total cod-landing is approximately 95%. LpUE estimates from model calculations are therefor higher then LpUE estimated from logbook data.

Cod-landings and fishing-effort are aggregated to month/sub-area combinations. These aggregated records are sorted on the absolute level of landings, revealing the areas with the highest cod-landing per month. Depending on the selected boundaries of the closure period and the number of sub-areas to be closed in each month of the period, the actual months/area closures are defined and merged with the landings database. Database records that meet the closure criteria are selected and the cumulative fishing effort of this selection is re-distributed among the records that are outside the closure criteria during the same trip. The cod-landings realized in that particular location are reduced to 0 while the effort is redistributed over the non-closures. The landings that might be realized in the non-closure part of a trip are 'corrected' by multiplying the cod-landings with the ratio of effort, after and before, the redistribution. This correction, based on the increase of effort, assumes that cod-LpUE of non-closures remains the same. The savings reached by the selected closure scenario is expressed as a (relative) value (%) of the average cod-LpUE after modeling the scenario.

Different scenarios are possible with respect to merging the closures with the landing database. The most realistic procedure is to aggregate cod-landings and fishing-effort in year Y and merge the selected closure areas-months with the landings-database of year Y+1 because then closure selection is based on the best available information. The Ministry asked us to extend this scenario, in conformity with the English system, by aggregating cod-landings and fishing-effort over 2 years to determine closure selection, so information gathered during years Y & Y-1 is applied in year Y+1.

In the case of Real Time Closures (RTC's), where fishers supply managers directly with information on their actual cod landings per haul, showing temporal and spatial cod concentrations, a scenario where closure criteria are gathered and applied to the landings-database in the same year Y is applied.

2[Helmond, A.T.M. Van Overzee, H.M.J. Van (2009) Discard sampling of the Dutch Nephrops fishery in 2007-2008 IJmuiden : Centre for Fishery Research, (CVO report 09.007)]

When 120 closures are selected, by defining 10 closed areas for each month of the year, the largest LpUE reductions are attained when closure selection is based on aggregated landings in the current year. TR1 LpUE's reduced on average to 22% (SD=11%) of its original value, which is a reduction of 78%. TR2 LpUE was reduced to 48% (SD=1%). When previous years' data are used, the mean LpUE of TR1 remains unchanged (average=102% and SD=11%) while the LpUE of TR2 reduced to 85% of its original value (SD=8%).
In case the closure (sub-)area-month matrix is reduced to fewer month and/or areas combinations, the reduction of LpUE is proportionally lower. A scenario of applying closures in winter (4 months, Dec-Mar) and 9 areas per month the (TR2) cod-LpUE is reduced to approximately 95% of the original value (SD=7%), using previous years' data. The use of two years of aggregated data results in a slightly lower reduction to 96%.

5. Effects of move-on measures

Additional to the closure scenarios described above possible move-on measures are modelled by using the options of maximizing cod landings per hour and applying a limitation on the percentage of cod in the landings to 5% of the total 2 hours landings.

The impact of these cod limits are modelled by using levels of 20, 40 and 80 kg cod/2hours fishing.
In case on of these trigger values is reached in a landing database record, the next sequential record is removed from the database.

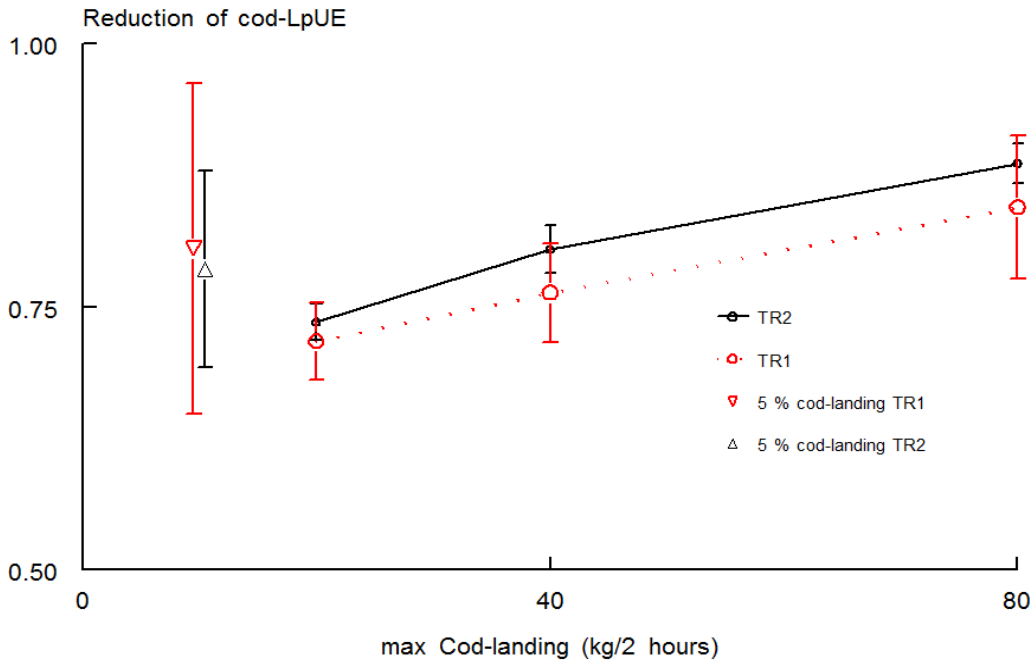

Figure 1. Reductions of cod-LpUE (fraction of the original values) after applying move on measures based on cod landings limitation from 20 to 80 kg/2hours (lines) or 5% rule (scatter). Error bars are SD's.

Results of applying move-on measures are presented in Fig 1. Cod-LpUE is reduced to between 71 and 88% of its original value, depending on the gear category and the cod-landing trigger used. In case TR1 is used as gear, the LpUE reduction is higher, ranging between 71 and 84% of its original values. The

result of applying the 5% rule results in reductions of LpUE to 80 %(TR1) and 78%(TR2), similar as applying a cod landing limitation of 40 kg for both gears but the variation of TR1 results is higher (SD=15%).
When combining two measures, closures based on last years aggregated data and move on measures, results show that the effect of the measures is additive. The additional reduction of applying the 5% rule was an average CpUE of 79 % of the original values for TR2

Discarding of Cod occurs for reasons related to fishing regulations e.g. the cod caught are below the minimum landing size or the fisher holds insufficient quota for cod. Since information of discard fractions on a temporal and spatial scale is lacking, discards are assumed to be proportional to registered landings. Estimated LpUE reductions based on a temporal and spatial differences of cod landings are equal to CpUE reductions

Table 1. Summary of Effort, Landings and Catch realized by gear categories BT2, TR1 (mesh-sizes<120mm) and TR2.

Effort (year)	**BT2 Kwdays/10^6**	**TR1 (Kwdays/10^3)**	**TR2 (Kwdays/10^3)**
2006	35.54	375.20	1322.03
2007	34.98	467.80	1530.12
2008	25.54	1027.19	2061.82
2009	26.46	768.81	1740.72
2010	26.39	684.39	1808.36
Landings	**(tons)**		
2006	921	5.42	121.8
2007	923	12.18	218.7
2008	1056	48.51	234.8
2009	1421	52.60	268.9
2010	1365	56.26	244.0
Discard	**(fraction)**		
2006	0.16	0.21	0.21
2007	0.11	0.39	0.21
2008	0.26	0.55	0.21
2009	0.17	0.38	0.21
2010	0.17	0.38	0.21
Catch	**(tons)**		
2006	1070	6.54	147
2007	1011	16.88	265
2008	1335	75.28	284
2009	1667	72.68	325
2010	1602	77.73	295
CpUE	**kg cod/Kwdays**		
2006	0.03	0.017	0.111
2007	0.03	0.04	0.173
2008	0.05	0.07	0.138
2009	0.06	0.1	0.187
2010	0.06	0.11	0.163

Justification

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

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