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Simulations of the potential consequences of using a square-mesh-panel in the *Nephrops* fishery of the Bay of Biscay (sub-area VIII) on the Northern hake fishery and stock.

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Data and method

Basic data used for the simulations are from the Northern hake assessment conducted by the ICES working group WGHMM (ICES, 2007). However, this working group did not take discards into account in the assessment process while accounting for discards is crucial for the current simulations. It was thus not possible to directly use the result of this assessment in our analysis.
An ad-hoc rebuilding of historical discards data has however been performed during another working group from the STECF, addressing the issue of long term management plans for Northern hake (STECF, 2007). During that working group, since recent information from sampling on board the *Nephrops* vessels in the Bay of Biscay have shown that the past series of discards estimated for this fishery (based on a scientific survey) was largely underestimated, the whole series was corrected using the ratio of the mean estimates of discards in the past and in the recent years. Historical data (prior to 1990) were kept unchanged. Since 2003, discards for other fisheries were calculated using the mean ratio Nephrops / Others over the period 1990-2002.
In the present analysis we used, as the basis for medium term projections, the assessment with discards carried out during this second working group. The square mesh panel was implemented in 2006. We thus chose 2005 as the reference year and started the simulations in 2006.

The simulation are carried out using the same rationale as in ICES. It is age-structured. Average fishing mortality (*F*) over the three last years of the assessment and stock numbers at age obtained from the assessment are used to estimate abundance and catch trends under various hypothesis of gear selectivity. $GM_{1990\text{-}2004}$ is used for future recruitment. Input data are presented in table 1. The simulations have been implemented in Excel.

Table 1. Basic data for simulations (from ICES, 2007 and STECF, 2007)

Age	Fishing mortality	Average weight (kg)	Stock numbers in 2005 ('000)	Natural mortality	Maturity ogive
0	0.214	0.03	238463	0.2	0.00
1	0.132	0.06	141686	0.2	0.00
2	0.112	0.21	127006	0.2	0.00
3	0.247	0.33	102291	0.2	0.23
4	0.224	0.60	52344	0.2	0.60
5	0.311	0.98	30624	0.2	0.90
6	0.421	1.44	17628	0.2	1.00
7	0.411	1.89	9748	0.2	1.00
8+	0.411	2.66	16551	0.2	1.00

To simulate changes in the exploitation pattern of the *Nephrops* trawl fishery following the adoption of a square-mesh panel (SMP), each *F* at age *a* from table 1 has to be split into a fraction "*Nephrops* fishery" and a fraction "other fisheries". This was carried out using the

ratio of catch of the *métier* FU09 (which corresponds, in the ICES working group, roughly to the *Nephrops* trawl fishery analyzed in the present study) over the total catch :

$$F_a^{Neph} = F_a \cdot \frac{C_a^{FU09}}{C_a^{FU09} + C_a^{others}} \quad \text{et} \quad F_a^{others} = F_a \cdot \frac{C_a^{others}}{C_a^{FU09} + C_a^{others}}$$

Fishing mortality at age used for the *Nephrops* trawl fishery (F_a^{Neph}) are given in Table 2 (as F_a(ref)). Medium term projections of the catch are then carried out for each group separately.

Length distributions of a reference trawl and a trawl with a square mesh panel obtained from an experiment carried out during the "ASCGG" project were then used to estimate the *F* at age of the *Nephrops* trawl fishery under the hypothesis that all the fishery would adopt the SMP. First, the ratio R_l between the number of fish caught by the reference trawl and the SMP trawl in the ASCGG experiment are calculated for each length class *l*.

$$\hat{R}_l = \frac{N_l^{SMP}}{N_l^{ref}}$$

These ratios are then used to estimate the number of fish by length class a fleet equipped with SMP could catch knowing the number of fish by length class caught by the same fleet not equipped with SMP. This has been done using the length distribution of the catch from FU09.

$$\hat{N}_l^{SMP} = \hat{R}_l \cdot N_l^{ref}$$

Knowing the length distribution of the *Nephrops* trawl fishery under SMP hypothesis, it is then possible, with the age length key from 2005 to estimate the corresponding age distribution. Changes in the exploitation pattern (*F* at age) is then estimated using the ratio between the catches at age under both gear hypothesis. It is important to note here that this assumes that all the fish escaping because of the SMP would survive. The ratios by age between both trawls and the new exploitation pattern are given in table 2.

Table 2 Calculation of the new exploitation pattern

Age	Ratio	F_a (ref)	F_a (SMP)
0	0.76	0.128	0.097
1	0.77	0.074	0.057
2	0.78	0.018	0.014
3	0.82	0.021	0.017
4	0.92	0.005	0.005
5	1.02	0.002	0.002
6	1.00	0.002	0.002
7	0.98	0.002	0.002
8+	1.04	0.002	0.002

Three types of simulations are carried out:

1. No change in the exploitation pattern.
2. Adoption of the SMP by the *Nephrops* trawl fishery. F_a(SMP) from Table 2 is applied to the *Nephrops* fishery. The F at age for the "other fisheries" is kept unchanged

3. No catch of undersized fish in the Nephrops fishery. Fa of the *Nephrops* fishery is modified to avoid any catch of undersize hake.

Results and discussion

Results of the projections are presented in Table 3 and Figure 1 and 2. The results of the two scenarios (SMP and No catch of undersized fish) are compared to the 'reference' (no change in the selection pattern).

Table 3: Results of the simulation at $F_{status\ quo}$

	Yield (% compared to reference)		SSB (% compared to reference)	
	SMP	No catch of undersized hake	SMP	No catch of undersized hake
2005	0.0	0.0	0.0	0.0
2006	4.5	2.8	11.7	11.7
2007	4.0	2.5	13.2	13.2
2008	5.4	4.9	16.7	16.9
2009	7.9	9.1	18.2	19.5
2010	7.8	11.0	17.6	21.5
2011	7.5	13.4	17.7	25.4
2012	7.8	16.4	17.9	29.0
2013	7.7	18.3	17.8	31.3
2014	8.0	20.0	18.3	33.5
2015	8.2	21.0	18.5	34.7

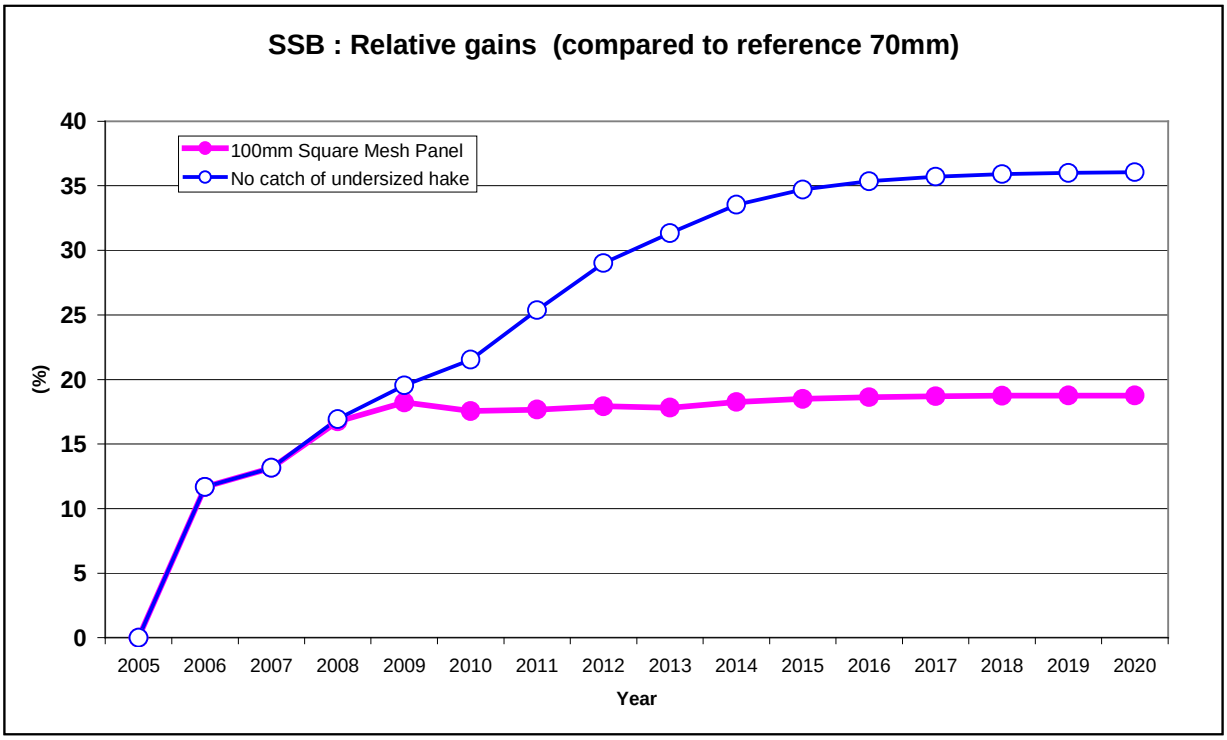

Figure 1. Relative gains (%) in SSB for two assumptions in exploitation pattern compared to reference trawl (70mm).

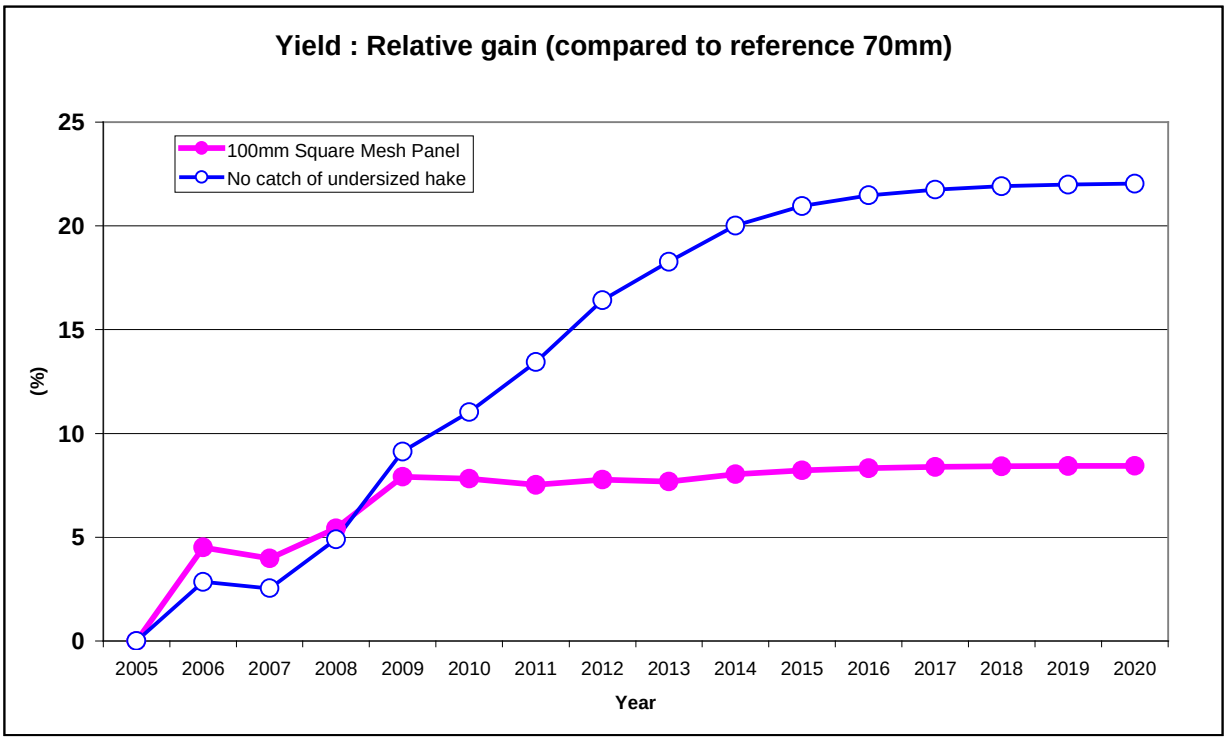

Figure 2. Relative gains (%) in yield for two assumptions in exploitation pattern compared to reference trawl (70mm).

It appears from those results that the use of a square mesh panel would give a SSB in the long term 18-19% higher than it would be if using a trawl without SMP. Similarly, the expected yield (at $F_{status\ quo}$) would be 8% higher.
With a (theoretical) fishery able to avoid any catch of undersized hakes, the gain would be 35% and 21% for SSB and yield respectively.

The use of a 100mm square mesh panel, allowing a 26% extra escapement of undersized hakes, goes to the 'right' direction (higher SSB and yield) on the way to MSY …
Some other steps are certainly needed to improve more the selection pattern.

It is important to note that those results have to be taken with caution and only as indicative of trends:

- The rebuilding of historical series of discards is very speculative, based on few data, while a good knowledge of discards is essential in such an analysis.

- The current model is spatially aggregated and thus does not account, neither for the spatial dynamics of the hake population nor for the spatial distribution of the fleets.

- The simulations have been carried out under a slow growth hypothesis and an assumed natural mortality of 0.2. It has been shown that the impact of an improvement of the selection pattern could be more important if an hypothesis of a faster growth is used, in accordance with the results of several tagging experiments (ICES, 2005; de Pontual *et al*., 2006; Bertignac & de Pontual, 2007).

References

Bertignac, M., and de Pontual, H. 2007. Consequences of bias in age estimation on assessment of the northern stock of European hake (Merluccius merluccius) and on management advice. – ICES Journal of Marine Science, 64: 981–988

de Pontual, H., Groison, A. L., Pineiro, C., and Bertignac, M. 2006. Evidence of underestimation of European hake growth in the Bay of Biscay, and its relationship with bias in the agreed method of age estimation. ICES Journal of Marine Science, 63: 1674–1681

ICES. 2005. Report of the Working Group on the Assessment of Southern Shelf Stocks of Hake, Monk and Megrim. ICES Document CM 2005/ACFM: 02

ICES. 2007. Report of the Working Group on the Assessment of Southern Shelf Stocks of Hake, Monk and Megrim. ICES Document CM 2007/ACFM: 02.

STECF, 2007. Northern Hake Long-Term Management Plans Lisbon, 4-8 June 2007 STECF/SGBRE-07-03. 128p.