Supplementary note to report Seine fishing on the Dutch and German parts of the Dogger Bank, 2013-2019

Overview of the economic importance and the ecologic impact of the Belgian, British, Danish, Dutch, French, German and Swedish fleets

Additional calculations to separate the impacts of Scottish seine and Danish seine

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Wageningen University & Research report C035/21

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This research project was carried out by Wageningen Marine Research and subsidized by the ministry of Agriculture, Nature and Food Quality for the purposes of Policy Support Research Theme 'Natuurinclusieve visserij' (project no. BO-43-119.01-000-WMR)

Wageningen Marine Research
IJmuiden, March 2021

Wageningen Marine Research report C035/21

WAGENINGEN
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Keywords: Dogger Bank, seine fishery, Natura 2000, ecological impact

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This report can be downloaded for free from https://doi.org/10.18174/544575
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Contents

1 Introduction

In the report of Hamon et al. (2020) on seine fishing on the Dutch and German parts of the Dogger Bank in the period 2013-2019, an overview is given of the economic importance and the ecologic impact of the Belgian, British, Danish, Dutch, French, German and Swedish fleets. The ecological impact of the two seine fisheries Danish seine (SDN) and Scottish seine (SSC) was combined in the presented results. On December 8th, 2020 this report was part of a discussion about the Joint Recommendation (JR) for the Dogger Bank in the ad-hoc expert Scheveningen Group meeting. In order to be able to decide on the Joint Recommendation, Denmark requested a separation between Danish seining and Scottish seining concerning the calculation of the potential impact on the benthic biomass. Therefore the Netherlands ministry of LNV commissioned Wageningen Marine Research to conduct such a study in order to produce the supplementary results.

The supplementary results for the impacts of the two seine fisheries: Danish seine (SDN) and Scottish seine (SSC) in different national and management parts of the Dogger Bank are presented separately for each of the seine fisheries in this note. Moreover the impact of two seine fisheries combined is also presented. The consequences of these additional results are discussed and conclusions will be drawn.

This note will describe the alterations and extensions in connection to particular parts of the report of Hamon et al. (2020). The connections are indicated in Table 1.

Table 1 Connections between this supplementary note and the report of Hamon et al. (2020) concerning the described topics.

This note (Beukhof et al., 2021)	Report of Hamon et al. (2020)		
Chapter	**Subsection**	**Section**	**Chapter**
2 Methodology of the impact assessment	2.2.2 Impact assessment	2.2 Defining the ecological impact of seine fishing on the Dogger Bank	2 Methodology to assess the economic importance and ecological impact
3 Results of the impact assessment	3.2.2 Impact assessment	3.2 Ecological impact of the seine fisheries on the Dogger Bank	3 Results
4 Discussion and conclusion on ecological impact		4.1 Ecological impact	4 Discussion
			5 Conclusion

2 Methodology of the impact assessment

The impact of seine fishery in the Dogger Bank area on the benthic biomass is assessed for the Scottish-(SSC) and Danish seine (SDN) separately, as well as for the two gears combined, using a method developed within the BENTHIS-project and described in Rijnsdorp et al. (2018). The impact by the seine fishery is calculated based on the full swept area of the gear, using the surface swept area ratio (SAR). We used here the surface, and not subsurface, SAR, because the surface SAR includes the entire surface area that is impacted, and not only the area that may experience a subsurface impact as in the case of the subsurface SAR. Moreover, the assumed subsurface impact of Scottish seining is limited and is even smaller and assumed to be zero for the Danish seine (Eigaard et al., 2016; Rijnsdorp et al., 2020).

As in this analysis surface SAR is used instead of subsurface SAR, a new model needed to be constructed that models the longevity composition as observed in the benthic samples against longevity, habitat and surface SAR. A range of models was fitted to the dataset to test which combination of covariates and interactions between them has most explanatory power. Following the Bayesian Information Criterion (BIC) to determine the model with the best combination of model fit and complexity, the model with the lowest BIC (i.e. the best model according to BIC) did not include surface SAR and was not significantly better than the same model that included surface SAR (chi-squared test, p=0.512). Furthermore, in the latter model, surface SAR was not a significant variable (p=0.513). These results suggest that surface SAR might as well be left out of the model as a covariate. However, as having surface SAR included in the model is crucial for calculating the Relative Benthic State (RBS), the best model according to BIC could not be used. It was therefore decided to subsequently look at the Akaike Information Criterium (AIC) of all constructed models and follow this criterion to select the best model. AIC works similar to the BIC, but it is less strict in penalizing models with a high number of variables and it often favours more complex models than BIC does.

Once the best model was found, the separate and combined effect of the flyshoot and Danish seine fisheries could be calculated using the RBS function that makes use of the model outcome described above. By taking the parameters of the model and the habitat data, we calculated the potential biomass of the benthic community for each grid cell in the in the case of no seining (i.e. the K parameter in RBS = B/K). The calculation of the longevity-biomass composition of the benthic community *with* fishing effort (i.e. the B parameter in RBS = B/K) takes besides the trawling frequency (i.e. the surface SAR) and the depletion value (0.009 for Danish seines, 0.016 for Scottish seines; Rijnsdorp et al., 2020) also the recovery rate of the benthos into account. Calculations were done for the flyshoot and Danish seine fishery separately, as well as for the two fisheries combined.

3 Results of the impact assessment

The model fitting procedure, described in Section 2.1.1 following now the AIC, resulted in the following model predicting the benthic biomass by habitat parameters and surface trawling intensity (including seine fisheries):

Cumulative biomass ~ intercept + longevity class + surface effort + mud + gravel + orbital + longevity class : gravel + surface effort : orbital + [random effect on station/year]

Table 2 Parameter estimates of the fixed effects including their interactive terms.

Co-variates	Estimate	Std. Error	Pr(>|z|)
Intercept	-5.263	0.329	<0.001
log(longevity)	3.408	0.163	<0.001
log(surface effort)	0.203	0.095	0.032
Mud	0.013	0.004	0.001
Gravel	0.018	0.012	0.128
Orbital	-5.164	2.721	0.058
log(longevity):gravel	-0.018	0.006	0.006
log(surface effort):orbital	-2.858	1.214	0.019

Note that in the final model, surface effort is a significant variable (Table 2). Moreover, the model includes orbital velocity (a form of natural disturbance on the seabed) and an interaction between surface effort and orbital velocity as additional covariates compared to the model based on subsurface effort (Hamon et al., 2020).

It turned out that next to the Dutch fleet there was seine activity in the Dogger Bank area in the period 2013 until 2019 for the Danish, Belgian and British fleets (see also Section 3.3). There was no seine fishery for the French, Swedish and German fleets. The type of gear used by the different national fleets on the Dogger Bank has been very stable, with Denmark operating with Danish seines (SDN) and Belgium and The Netherlands operating with Scottish seines (SSC). Great Britain operates almost entirely with Scottish seine (SSC) except for the year 2015 were also Danish Seine was used.

The model and RBS function were used to estimate the impact of the Scottish- and Danish seine fishery types on the (relative) benthic biomass. The combined (SSC and SDN together) fishing effort was provided by the different countries per year and grid-cell and was used as input for the model. Because the seine fleet of Great Britain used both gear types in 2015 a distinction in the benthic biomass impact between SSC and SDN could not be made. The remaining years (2013, 2014, 2016, 2017, 2018 and 2019) were separately analysed for both SSC and SDN impacts.

In *Figure 1* the modelled grid-cell average change in relative benthic biomass due to SSC, SDN and both fisheries types combined is shown for the Dogger Bank area (Dutch and German part combined). The change in biomass is expressed as the year-averaged percent benthic biomass reduction of the grid cells that are located inside the Dogger Bank. The percentage of benthic biomass mortality caused by the two fishery types individually fluctuates between zero (for the year 2016) and 0.21% (for Danish seine in the year 2014), see Figure 1. In one year (2016) there was no seine fishing in the area. Although there are some years with somewhat more SDN impacts (2013 and 2017) and one year with some more SSC impact (2019) period, average impacts seem to be comparable between the two fishing types. Combined seine impacts are higher than the impact of one of the separate seine fisheries and with a decrease of 0.40% in relative benthic biomass, the impact of both gear types combined is highest in 2014, see *Figure 1*.

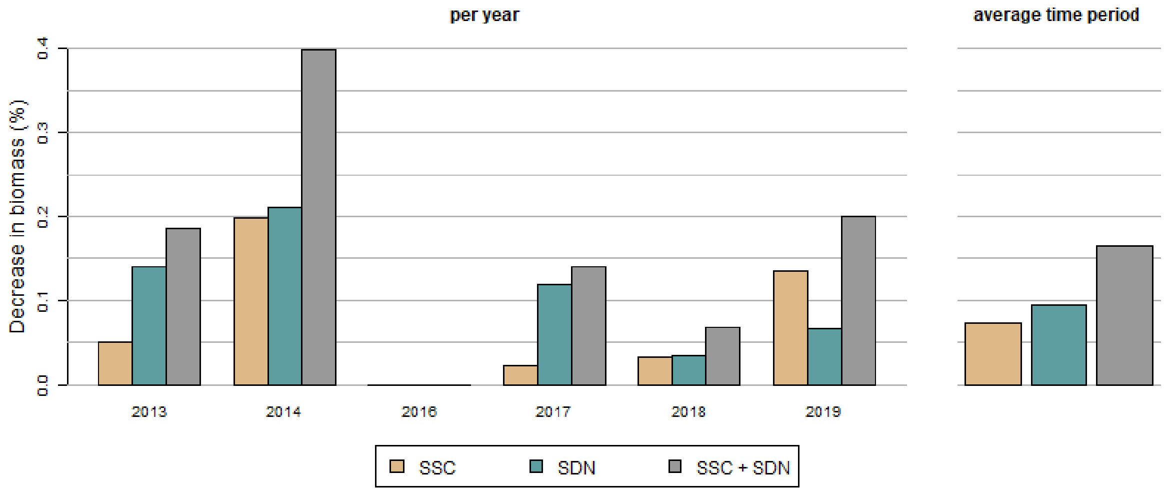

Figure 1 *Modelled effect of the Scottish- and Danish seine fisheries of the Belgian, British, Danish and Dutch fleets in the Dogger Bank (Dutch and German part) expressed as the grid cell average percent reduction for the years 2013, 2014, 2016, 2017, 2018 and 2019. On the right panel the time period average impact.*

In Figure 2 the spatial distribution of the benthic impact due to the Scottish seine and Danish seine fisheries in the Dogger Bank area is shown. The figure shows the grid cell average impact over the investigated period and is expressed as percentage decrease in benthic biomass. For both fishing types impacts on the benthic biomass were mainly found in the central areas of the Dutch part of the Dogger Bank, see Figure 2. In the German part of the Dogger Bank, Scottish seine (SSC) is mostly found in the North and East parts, while Danish seine (SDN) is mostly found in the central area, see Figure 2. Scottish seine fishery is a bit more scattered out and the Dutch-German border area seems to be used to a lower extent when compared to Danish seine. In large parts of the Dutch and German part of the Dogger Bank no fishery took place in the investigated period.

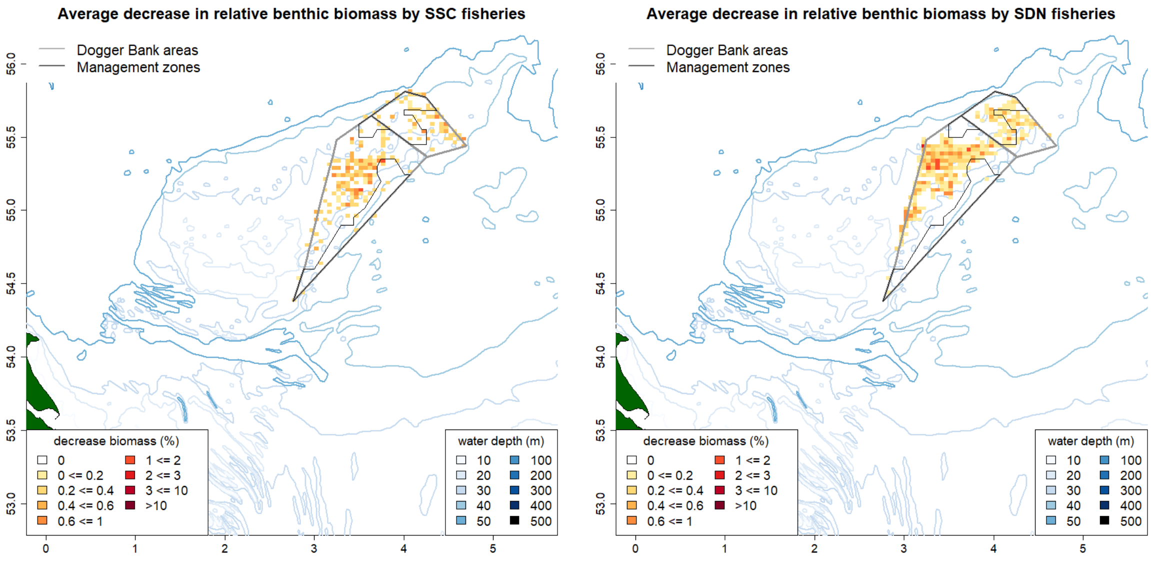

Figure 2 *Modelled impact of the seine fisheries of the Belgian, British, Danish and Dutch fleets in the Dogger Bank area (both Dutch and German part) expressed as the grid cell average decrease in biomass of the years 2013, 2014, 2016, 2017, 2018 and 2019. Impact in percentage decrease of the benthic biomass. Impact due to Scottish seine (SSC) fishery in the panel on the left, and due to Danish seine (SDN) fishery in the panel on the right.*

In Table 3 the grid cell average and maximum decreases in relative benthic biomass for the years considered here are tabulated for both the Dutch and German Dogger Bank areas (in- and outside management zones) caused by the Scottish and Danish seine fisheries separately and combined.

Table 3 Grid cell average impact, standard deviation (between brackets), grid cell maximum impact and impact values that 75% of grid cells with impact (all grid cells with impact values >0) do not exceed. Impact as decrease in relative benthic biomass (%) and due to solely Scottish-, solely Danish and both seine fisheries combined and calculated over the years 2013, 2014, 2016, 2017, 2018 and 2019 for the Dutch and German Dogger Bank areas and for areas located in- and outside management zones separately.

Country and area	Type	Grid cell mean (%)	Grid cell maximum (%)	Grid cell impact values for which 75% of the impacted areas (grid cell impact >0) do not exceed
The Netherlands outside management zones	SSC	0.098 (0.101)	4.2	1.58
The Netherlands inside management zones	SSC	0.034 (0.045)	3.7	1.79
Germany outside management zones	SSC	0.097 (0.175)	4.9	1.50
Germany inside management zones	SSC	0.064 (0.059)	3.7	1.52
The Netherlands outside management zones	SDN	0.175 (0.191)	13.2	1.63
The Netherlands inside management zones	SDN	0.012 (0.012)	3.2	0.64
Germany outside management zones	SDN	0.060 (0.066)	2.7	1.75
Germany inside management zones	SDN	0.064 (0.098)	3.9	1.10
The Netherlands outside management zones	SSC + SDN	0.266 (0.255)	13.2	1.78
The Netherlands inside management zones	SSC + SDN	0.046 (0.040)	3.7	1.53
Germany outside management zones	SSC + SDN	0.156 (0.159)	4.9	1.93
Germany inside management zones	SSC + SDN	0.127 (0.137)	5.8	1.52

Regardless of the fishing type or area considered, average impacts over the time period considered are limited to tenths of a percent decrease in relative biomass, see Table 3. In the Dutch part of the Dogger Bank the highest average impacts are found outside the management zone regardless of the fishing type considered. In the German part of the Dogger Bank this is only the case for impacts due to Scottish seine fishery and the difference between both fishing types are smaller compared to the Dutch part of the Dogger Bank, see Table 3.

In Figure 3 the distribution of the fisheries impact on the benthic biomass on the level of individual grid cells is shown per year and for both in- and outside the management zones of the Dutch and German Dogger Bank. The bars add up to 100% as in many grid cells there is no impact due to seine fishing. These are not shown in order to obtain more detail. As can be seen, and has been observed earlier, large parts of the Dogger Bank area (100-58% of the grid cells) are not impacted by any of the fishing types. From the distribution shown in Figure 3 it can be seen that Danish seine fishery leads to a higher proportion of impacted grid cells, but usually with lower impact than when Scottish seine fishery is considered, where fewer grid cells are impacted but to a higher extent.

Due to aggregation of fishing activities, local impacts are higher than area-averages but even then, the impact is limited in most grid cells to a few percent. In all situations analysed here, impact levels in areas with impact (all grid cells with impact >0) remain below a decrease in relative benthic biomass of 1.93% for 75% of the impacted grid cells, see Table 3. When comparing both fishing types it can be seen that for Scottish seine fishing the highest impact-value on a grid cell level was 4.9 % reduction, which was found in the German Dogger bank area outside the management zone in 2014. So even on a spatial scale of individual grid cells, SSC impacts remain in all cases analysed below 5 percent. For Danish seine fishing four values (grid cells) exceeded an impact value of 5% reduction of the relative benthic biomass, and one grid cell exceeded a value of 10% reduction. The Danish seine maximum impact value (13.2 % reduction) was found in the year 2014 in the Dutch EEZ of the Dogger Bank and outside the management zone, see Table 3 and Figure 3.

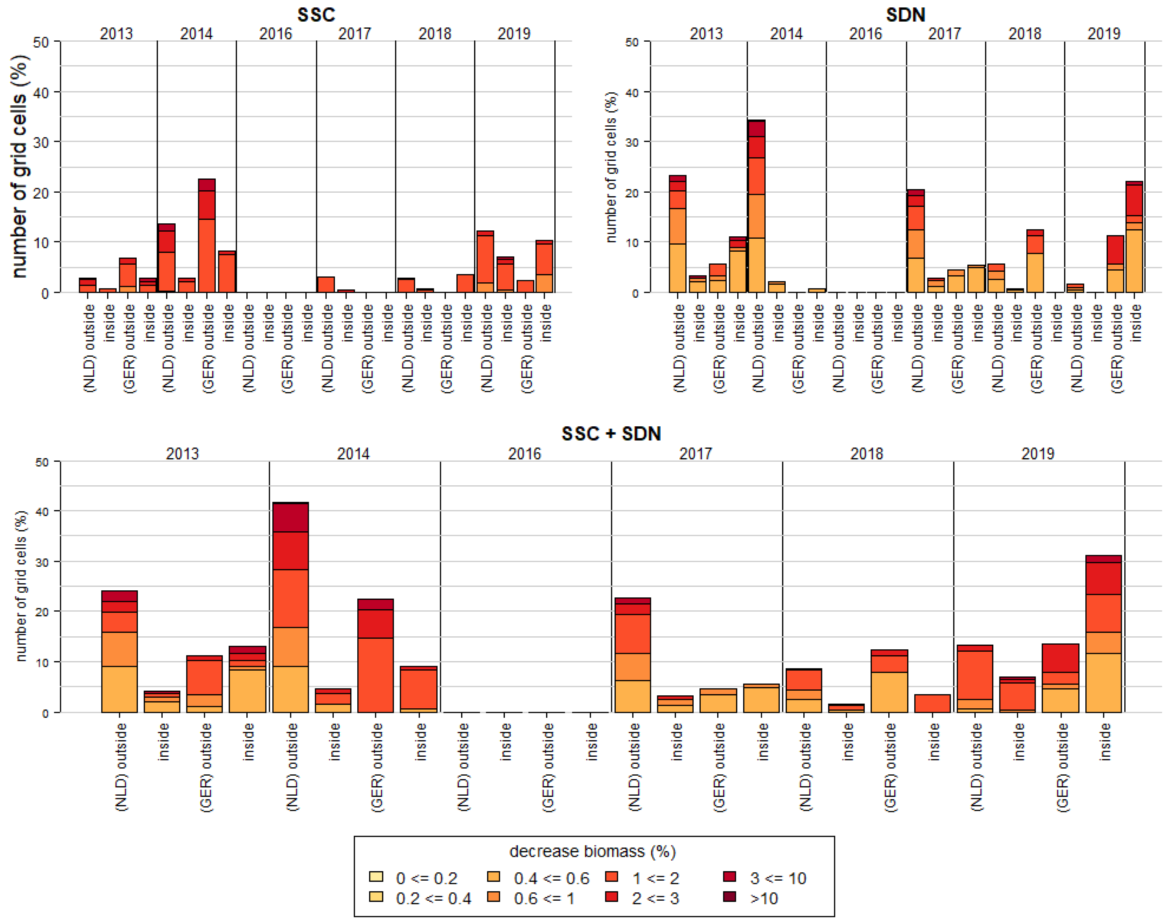

Figure 3 *The distribution in biomass decrease for grid cells in- and outside the management zones of the Dutch (NLD) and German (GER) Dogger Bank area shown for the Scottish seine (SSC) fishery at the top left-hand panel and for Danish seine (SDN) fishery at the top right-hand panel and for both types combined in the lower panel. Grid cells with no impact are excluded from this graph but complement bars to values of 100%.*

4 Discussion and conclusion on ecological impact

The results of the assessment carried out in this supplementary note confirm the conclusions for the ecological impact of seine fisheries on the Dutch and German parts of the Dogger Bank drawn in the report of Hamon et al. (2020). However it produces values for the impact of the combined seine fisheries on the relative benthic biomass that are somewhat higher due to the choice for another model that can be preferred as is explained in chapter 2. The average impact of the individual and combined Scottish- and Danish seine fisheries in the Dogger Bank area on the relative benthic biomass is, however, limited to tenths of a percent. Locally there were some areas within the Dogger Bank that experience more frequent (most years considered here) aggregated fishing effort that resulted in higher impact values. In most cases the impact stays limited to 1-2 percent even when both Scottish and Danish seine fishing are combined. The average impact on the combined Dutch and German parts of the Dogger Bank seems to be comparable for the two seine fisheries.

5 Quality Assurance

Wageningen Marine Research utilises an ISO 9001:2015 certified quality management system. This certificate is valid until 15 December 2021. The organisation has been certified since 27 February 2001. The certification was issued by DNV GL.

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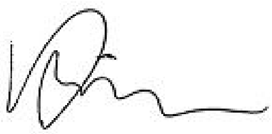
Justification

Report C035/21
Project Number: 4318100348

The scientific quality of this report has been peer reviewed by a colleague scientist and a member of the Management Team of Wageningen Marine Research

Approved: Ir. N.T. Hintzen
Colleague scientist

Signature: 

Date: March 31, 2021

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