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HELCOM request on the production of spatial data layers of fishing intensity/pressure

Service summary

ICES secretariat collected relevant VMS and logbook data to produce, as a technical service to HELCOM, updated spatial data layers on fishing intensity/pressure. Improved data quality control checks were implemented. Submitted data across the HELCOM area have improved in quality. Standardized methods were used to produce the requested data layers. Surface and subsurface abrasion maps for all gears used in the HELCOM area in 2016 are presented in the Annex. A link is provided for all requested data layers.

Request

To assess benthic impact, ICES is requested to produce updated spatial data layers on fishing intensity/ pressure within the HELCOM maritime area according to the details set out in the sections below. Following on from the format of the previous OSPAR requests; HELCOM requests ICES, to:

(a) Collect relevant national VMS and logbook data for 2014–2016 and update data layers from previous years (2011–2013) where this has not been successfully delivered.
(b) Prepare spatial layers for the HELCOM maritime area on the intensity of fishing using mobile bottom contacting gears. To ensure that 2014–2016 is backward compatible to previous year maps delivered to HELCOM as advice in 2014, ICES is requested to specifically produce fishing intensity/ pressure spatial layers containing the following information per c-square and per year:

Aggregated layers: total, beam trawl, dredge, demersal seine, otter trawl.

Métier layers: OT_CRU, OT_DMF, OT_MIX, OT_MIX_CRU, OT_MIX_DMF_BEN, OT_MIX_DMF_PEL, OT_MIX_CRU_DMF, OT_SPF, TBB_CRU, TBB_DMF, TBB_MOL, DRB_MOL, SDN_DMF, SSC_DMF.

This (the above) equals 19 layers per year with the following attributes included in each layer: Surface area in Km^2 (Swept area), Surface area ratio, Subsurface area in Km^2 (Swept area), Subsurface area ratio, Total Weight, Total value, Kw Fishing Hours, Fishing hours.

Elaboration on the service

The shapefile datasets are available at ICES (2017a): https://doi.org/10.17895/ices.pub.2860

Suggestions

ICES encountered some data quality issues during the 2017 process. Should ICES be asked to produce similar data layers in the future it would be helpful if HELCOM, as end user, would encourage its member countries to improve data submission pocedures.

Basis of the service

Background

From the HELCOM request:

Supplementary information to assist in the interpretation of the service.

The request is focused on the fishing abrasion. The fishing abrasion layers are used for spatial analysis combining habitat distribution and their associated sensitivity ranges for the calculation of cumulative impact on selected biotopes.

The output of this request will be used to support the further development of the pre-core indicator 'Cumulative impact on benthic biotopes' and as input layers for the updated version of the 'State of the Baltic Sea' report to be produced by mid-2018.

Intended use of the request output:

The output of this request will be used to support the further development of the HELCOM pre-core indicator 'Cumulative impact on benthic biotopes' and as input layers for the updated version of the 'State of the Baltic Sea' report to be produced by mid-2018.

Methods

Post-processing:

This technical service was completed using the methods established by ICES in its 2016 advice on the production of spatial data layers of fishing intensity/pressure (ICES, 2016a). The ICES secretariat and ACOM leadership prepared and guided the process, with the relevant ICES expert group (Working Group on Spatial Fisheries Data, WGSFD) reviewing the steps taken.

An ICES VMS/logbook data call, covering relevant HELCOM areas for the years 2009–2016, was issued to all ICES Member Countries (EU DCF contacts and all ACOM delegates) on 31 January 2017, with a deadline for response by 31 March 2017. The call followed the ICES VMS data policy (http://www.ices.dk/marine-data/guidelines-and-policy/Pages/ICES-data-policy.aspx). Countries were offered the opportunity to allow ICES to use previously submitted data for the years 2009–2015, thereby having only to additionally submit 2016 data.

After the submission deadline and prior to the WGSFD meeting (26 May 2017), the ICES secretariat, together with the expert group chairs, quality-checked the submitted data. This involved frequent correspondence with submitting countries to ensure that submission of data complied with the data call specifications. The process included generating a standard quality control (QC) report for the submission of each country, with checks undertaken by the expert group chairs. This is done upon submission and, where relevant, for any resubmission, with the aim of detecting discrepancies in the submitted data. Any feedback was communicated back to the data submitters, and countries were either congratulated on a good submission or asked to re-submit corrected data. No data were received from Russia. Estonia submitted data initially in an incorrect format; submission in the correct format was made at a late stage in the process. Estonian data could therefore not be subjected to the same QC rigour as other submissions, but were nonetheless used in generating the requested data layers.

An additional QC was undertaken on the full VMS dataset (all countries combined) to produce an overview QC report. All R scripts and SQL code used to access and process the VMS data are available on GitHub (https://github.com/ices-eg/wg_WGSFD). Once approved, the aggregated data from all countries were stored in a separate database.

Processing of VMS data:

Data that have passed the quality control checks were used to produce geographical files (shapefiles) and maps. The production of these spatial data layers of fishing intensity/pressure based on the fishing pressure estimated by métier, following the approach of Eigaard *et al.* (2016) at a resolution of c-squares (0.05 × 0.05 degrees).

ICES (2016a) defines the swept area as the cumulative area contacted by a fishing gear within a grid cell over one year. The swept area ratio (SAR, also defined as fishing intensity) is the swept area divided by the surface area of the grid cell. The area contacted by fishing gear is provided by geographically distinct Vessel Monitoring System (VMS) points for which speed and course are available at intervals of maximum 2 hours, coupled with information on vessel size and gear used derived from EU logbooks (ICES, 2017b; Eigaard *et al.*, 2016).

Vessel speeds representing fishing activity are assigned to a 0.05 × 0.05 degree grid, about 15 km² at 60°N latitude, the spatial resolution adopted by ICES known as the c-square approach (Rees, 2003).

Estimates of total SAR within each grid cell were calculated by métier. In addition to total surface and subsurface SAR, another four higher level métiers groupings (beam trawl, dredge, demersal seine, otter trawl) and fourteen lower level BENTHIS gear groupings (*OT_CRU, OT_DMF, OT_MIX, OT_MIX_CRU, OT_MIX_DMF_BEN, OT_MIX_DMF_PEL, OT_MIX_CRU_DMF, OT_SPF, TBB_CRU, TBB_DMF, TBB_MOL, DRB_MOL, SDN_DMF, SSC_DMF*) were specifically considered.

Table 2 Glossary of terms and BENTHIS métier groupings used to define higher level métiers groupings (ICES, 2017b; Eigaard *et al.*, 2016).

Surface	< 2 cm penetration depth of the gear components.
Subsurface	≥2 cm penetration depth of of the gear components.
beam trawl (TBB)	For a beam trawl (TBBs) the footprint is separated into two components: (i) the shoes of the beam, and (ii) the groundgear, and before that by the tickler chains of the trawl, if such chains are deployed.
dredge (DRB)	For dredges (DRBs) the ground gear component defines the footprint which is homogenous across the entire width of the dredge, even if teeth are used.
demersal seine (DS)	For seines (DSs) two main types of footprint occur (i) from the seine rope, and (ii) from the seine groundgear.
otter trawl (OT)	For otter trawls (OTs), the footprint is composed of the (i) the otter boards, (ii) the sweeps, and (iii) the trawl groundgear.
BENTHIS métier	14 standard BENTHIS métiers groupings (see below) that have similar gear footprints, and can be aggregated up to describe higher level gear groupings (beam, dredge, demersal seine, otter trawl).
OT_CRU	Otter trawl for *Nephrops* or shrimps
OT_DMF	Otter trawl for cod or plaice
OT_MIX	Otter trawl for other species
OT_MIX_CRU	Otter trawl for a mixture of species with focus on shrimp (note: no data were submitted for this gear category)
OT_MIX_DMF_BEN	Otter trawl for mixed benthic fish
OT_MIX_DMF_PEL	Otter trawl for bentho-pelagic fish (note: no data were submitted for this gear category)
OT_MIX_CRU_DMF	Otter trawl for *Nephrops* and mixed fish
OT_SPF	Otter trawl for sprat or sandeel
TBB_CRU	Bottom trawl for crangon
TBB_DMF	Bottom trawl for sole and plaice
TBB_MOL	Bottom trawl for molluscs
DRB_MOL	Dredge for scallops and mussels
SDN_DMF	Danish seine for plaice and cod (note: there is no subsurface component for this gear)
SSC_DMF	Scottish seine for cod, haddock, other flatfish

Landings values (Euros) and weights (kg) were calculated from logbook data by each country prior to supplying to ICES.

The production of spatial data layers of fishing intensity/pressure are discussed in detail in ICES (2016a, 2016b, and 2017b).

Data outputs:

Selected example maps of total surface and subsurface SAR for 2016 are provided for the HELCOM areas (Annex 1), and all requested VMS-derived data outputs for this technical service are published and available at ICES (2017a). Included here are maps of surface and subsurface abrasion pressure on the seafloor from mobile bottom-contacting fishing, for the years 2009 to 2016.

Caveats:

Several caveats, listed below, should be taken into account when considering this technical service and its data. These caveats relate to issues concerning the provision of vessel data and its interpretation, and the scale at which data are informative.

- Data on fishing locations for vessels less than 12 m is not available and are therefore not included in the technical service. This introduces a bias in the assessment that is expected to be strongest in coastal areas.
- VMS data from Russia were not supplied, introducing a downward bias in pressure in areas fished by Russia. The greatest bias will be in Russian waters.
- Fishing pressure (SAR, swept area reatio) depends on the spatial resolution of the fishing pressure data. Pressure is calculated at a resolution of 0.05 × 0.05 degrees.
- It is possible that the valuation of landings has been treated differently by different countries, potentially introducing bias.
- Data outputs represent vessels over 15 m (2009–2011) and vessels over 12 m (2012–2015).
- Data outputs in this technical service assume a uniform distribution of trawling within each c-square. When using the data products of this technical service it should be noted that the above assumption will apply when trawling is evaluated over longer time periods (e.g. 2012–2015). However, at shorter, yearly time scales the proportion of the sea floor trawled will be overestimated because trawling is randomly distributed at small spatial scales (Rijnsdorp *et al.*, 1998; Ellis *et al.*, 2014; Eigaard *et al.*, 2016).

Additional information

VMS and logbook data quality control checks

A quality control (QC) template (coded in SQL and R) was run on the agreggated dataset to calculate and check the most important variables (number of submitted records, fisheries effort, landings, etc.) for each year, so that any questionable deviations could be identified. Secondly, maps were created from the aggregated data, showing any differences for each c-square (VMS data) or ICES rectangle (logbook data). The values for the most recent year 2015 that were submitted in this year's Data Call were compared with the data for the year 2014, as well as against the mean of all years. The underlying data was then checked in more detail in areas that showed larger deviations.

The QC template was also used to produce two quality check reports on the aggregated data, one on the data submitted in 2017 and the other on the data submitted in 2016. These reports were compared by WGSFD experts, using the values of the year 2015 to check for any larger deviations between the two datasets for the same year. The procedure helped detect and resolve an issue that occurred while aggregating the submitted data in the main database.

Additionally, based on the VMS data aggregated for all submitted national data, two sets of maps for each main gear group (BENTHIS métiers) were produced.

a. Presence–absence of data for each c-square.
b. Difference in surface abrasion values for each c-square between the years 2015 and 2016.

A third set of maps was created to search for differences in surface abrasion values for each c-square for the year 2015, comparing the data submitted in 2016 with the data submitted in 2017.

All maps were checked for any deviations by ICES Working Group on Spatial Fisheries Data (WGSFD) experts.

Differences detected during these checks were analyzed in more detail. In some cases, a reasonable explanation for the difference (e.g. known changes in fishing effort) could be found. In other cases, errors were identified so that data could be corrected and re-submitted. Based on the analyses run during the meeting, WGSFD finally concluded that the data for all BENTHIS métiers are as correct as possible (Table 3). The rigorous quality control procedures imposed on the submitted VMS and logbook served to increase the reliability of data used to produce the requested data products, as well as reliability of any future advice outputs.

Table 3 Results of quality checks carried out on aggregated datasets. Gear groups based on BENTHIS-métiers (see Table 2 for abreviations).

Gear group	Presence–absence per c-square	Differences in SA-values 2015 to 2016
DRB_MOL	✓	✓
OT_CRU	✓	✓
OT_DMF	✓	✓
OT_MIX	✓	✓
OT_MIX_CRU_DMF	✓	✓
OT_MIX_DMF_BEN	✓	✓
OT_SPF	✓	✓
SDN_DMF	✓	✓
SSC_DMF	✓	✓
TBB_CRU	✓	✓
TBB_DMF	✓	✓
TBB_MOL	✓	✓

Sources and references

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ICES. 2016a. OSPAR request for further development of fishing intensity and pressure mapping. *In* Report of the ICES Advisory Committee, 2016. ICES Advice 2016, Book 1, Section 1.6.6.4. 27 pp.

ICES. 2016b. Interim Report of the Working Group on Spatial Fisheries Data (WGSFD), 17–20 May 2016, Brest, France. ICES CM 2016/SSGEPI:18. 244 pp.

ICES. 2017a. Spatial data layers of fishing intensity/pressure per gear type for surface and subsurface abrasion, for the years 2009 and 2016 in the HELCOM area. Available as shapefile datasets at: https://doi.org/10.17895/ices.pub.2860.

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Rees, T. 2003. "C-squares", a new spatial indexing system and its applicability to the description of oceanographic datasets. Oceanography, 16(1), 11–19.

Rijnsdorp, A. D., Buys, A .M., Storbeck, F., and Visser, E. G. 1998. Micro-scale distribution of beam trawl effort in the southern North Sea between 1993 and 1996 in relation to the trawling frequency of the sea bed and the impact on benthic organisms. ICES Journal of Marine Science, 55: 403–419.

Annex

This Annex contains total surface (Figure 1) and subsurface (Figure 2) for 2016 for all fishing gears in the swept area ratio of the HELCOM area. The complete set of data outputs has been published electronically (ICES, 2017a). The shapefile datasets are available at: https://doi.org/10.17895/ices.pub.2860.

The electronic data outputs include the following:

a) Aggregated layers: total, beam trawl, dredge, demersal seine, otter trawl.
b) Métier layers: OT_CRU, OT_DMF, OT_MIX, OT_MIX_CRU, OT_MIX_DMF_BEN, OT_MIX_DMF_PEL, OT_MIX_CRU_DMF, OT_SPF, TBB_CRU, TBB_DMF, TBB_MOL, DRB_MOL, SDN_DMF, SSC_DMF.

This leads to 19 layers per year, with the following attributes included in each layer: Surface area in km^2 (Swept area), Surface area ratio, Subsurface area in km^2 (Swept area), Subsurface area ratio, Total weight, Total value, kW fishing hours, and Fishing hours. For SDN_DMF gear there is no subsurface component. For OT_MIX_CRU and OT_MIX_DMF_PEL none of the submitted VMS data were associated with these gear categories.

Note that caveats described in this technical service apply when interpreting these products.

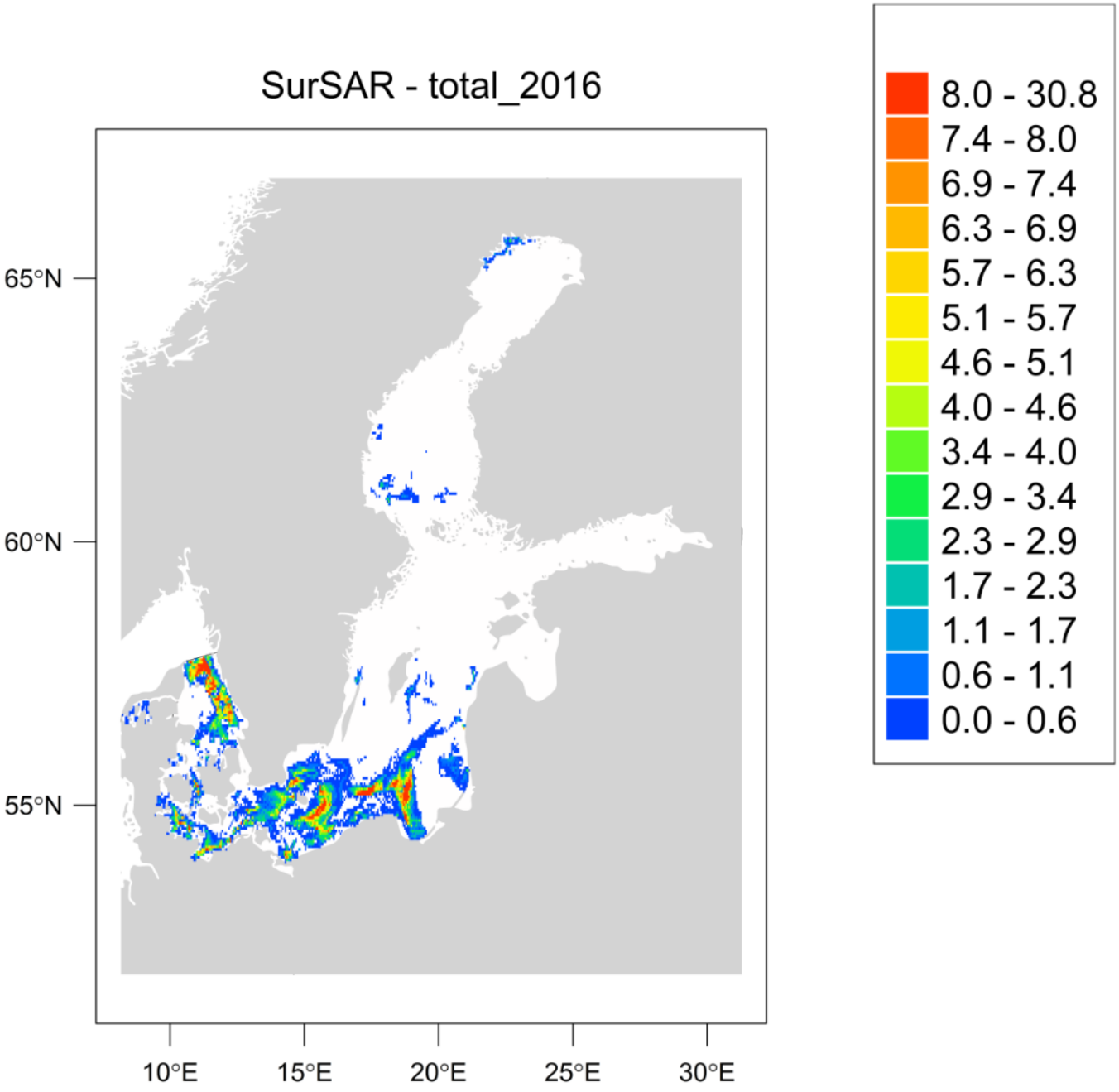

Figure 1 All fishing gears (i.e. total) surface swept area ratio for 2016 in the HELCOM area. Note that caveats described in this advice apply when interpreting maps.

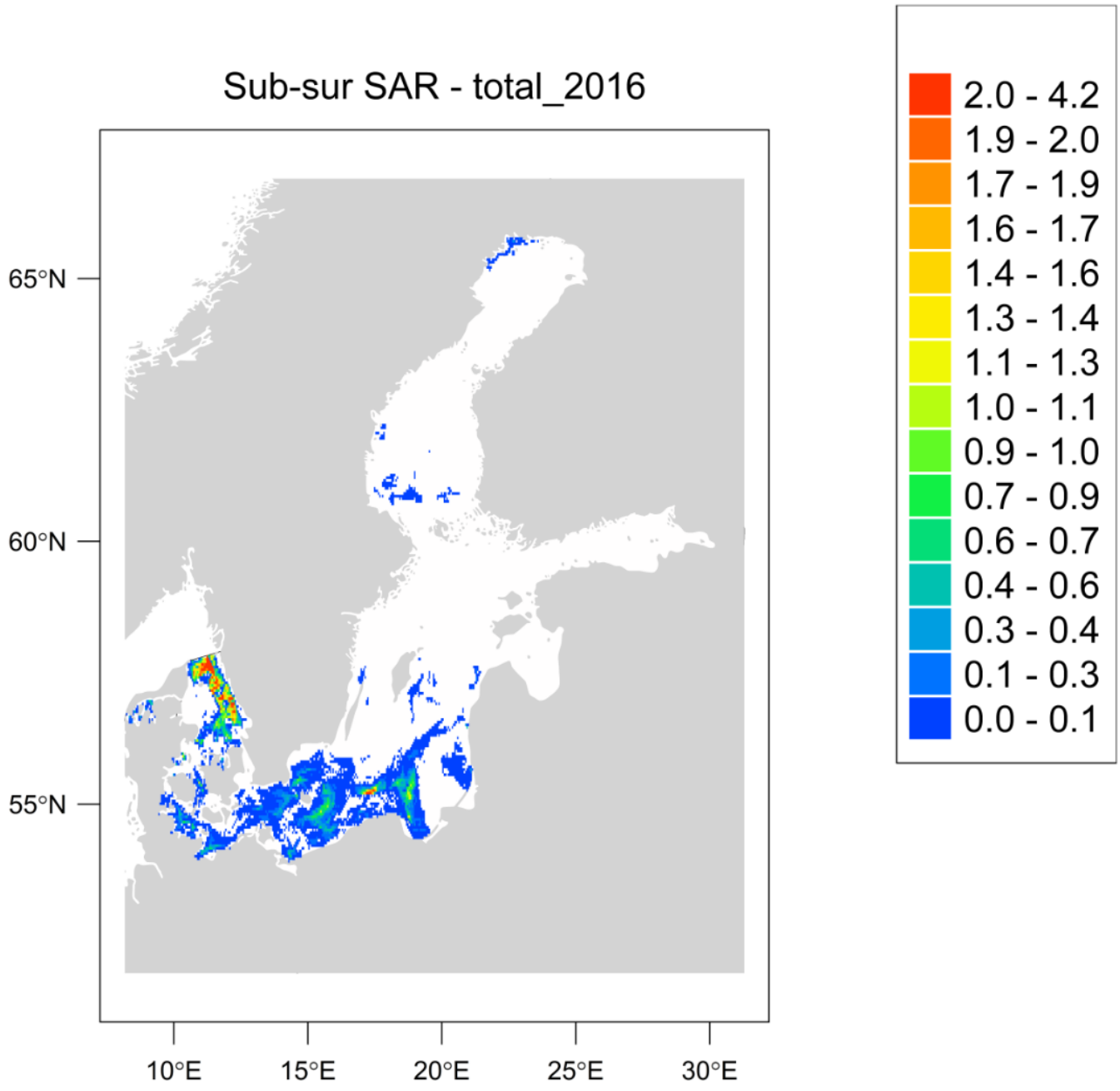

Figure 2 All fishing gears (i.e. total) subsurface swept area ratio for 2016 in the HELCOM area. Note that caveats described in this advice apply when interpreting maps.