DRAFT OSPAR CEMP Guidelines

Area of Habitat Loss (BH4)

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Version of 15/09/2022

1 Introduction

1.1. General introduction to the indicator

The indicator aims to estimate the extent and proportion of each benthic habitat type that is lost due to human activities. Habitat loss is defined as a permanent change of the seabed which has lasted or is expected to last for 12 years or more (Commission Decision 848/2017). The definition of physical loss includes the loss of marine habitat area by sealing with structures or sediment as well as the permanent change of the seabed by human activities. According to the Commission Decision 848/2017, permanent changes relate to natural seabed substrate or morphology. The indicator uses EUNIS (2019) level 2 classifications as a basis for defining habitat changes: Physical loss means a shift in habitat type from one category to another, e.g. from circalittoral mud (MC6) to circalittoral sand (MC5).

The indicator distinguishes between three types of physical loss: sealed loss, unsealed loss and the historic loss of biogenic habitat (ICES 2019a). Sealed loss results from the placement of structures in the marine environment (e.g. foundations of wind turbines, platforms) and also from the introduction of substrates that seal off the seabed (e.g. dredge disposal). Unsealed loss results from permanent changes in physical habitat caused by human activities (e.g. bottom trawling, aggregate extraction) and by indirect effects of placement of man-made structures (e.g. a structure causing hydrological changes that ultimately change the habitat type at EUNIS level 2). Estimating loss of biogenic substrate relies on the availability of relevant historical records and / or the development of appropriate habitat suitability models in order to estimate historic distribution and the extent of biogenic habitats (ICES 2019a). The present methodology is limited to the assessment of selected activities causing sealed and unsealed loss (offshore structures, bottom trawling, aggregate extraction). Loss of historic biogenic habitat and other activities may be considered in a future assessment.

Loss of habitat extent is of most concern for habitats of special interest, often defined by long-lived and bio-engineering species such as reefs of the cold-water coral (*Lophelia pertusa*), horse mussels (*Modiolus modiolus*) or reefs of the ross worm (*Sabellaria spinulosa*), due to their specific habitat requirements, the long term restoration and their limited natural extent. Changes in the extent of these habitats may be caused not only by sealing but also by other anthropogenic physical influences such as bottom-trawl fisheries (Roberts et al. 2000, Strain et al. 2012). Despite the comparatively lower sensitivity of broad-scale benthic habitats towards physical disturbance, they are equally vulnerable to the construction of artificial structures such as foundations for platforms or offshore wind piles.

In principle, any habitat type can be assessed based with this indicator through the processing of spatial pressure data and information on the habitats. The distribution and extent of habitats can be based on survey data or on predictive habitat modelling. The indicator is applicable to broad- and small-scale habitat types across the North-East Atlantic region. The assessment is largely built on the modelling of habitats and spatial pressure data; this is cost-efficient because it minimises monitoring activities in the field. However, access to data on the spatial extent and intensity of licensed and other

[1] This is currently a candidate indicator

activities causing habitat loss is a necessary prerequisite to ensure the spatial footprint of activities is correctly assessed.

The assessment of habitat loss complements the assessment of physical pressures on benthic habitats together with the Common Indicator BH3 on the 'Extent of physical disturbance to benthic habitats'. While BH3 focuses on the response of the biological community to physical disturbance, BH4 targets on the change of the habitat type as defined by depth and sediment due to very intense disturbance (unsealed loss) or the placement of structures (sealed loss).

1.2. Components

MSFD criteria (COM Decision 2017/848): D6C1 'Spatial extent and distribution of physical loss' and D6C4 'Extent of habitat loss'

Biodiversity components:

- **Benthic broad habitat types including their associated biological communities according to COM Decision 2017/848:**

Broad habitat types	Relevant EUNIS (2019) habitat codes
Littoral rock and biogenic reef	MA1, MA2
Littoral sediment	MA3, MA4, MA5, MA6
Infralittoral rock and biogenic reef	MB1, MB2
Infralittoral coarse sediment	MB3
Infralittoral mixed sediment	MB4
Infralittoral sand	MB5
Infralittoral mud	MB6
Circalittoral rock and biogenic reef	MC1, MC2
Circalittoral coarse sediment	MC3
Circalittoral mixed sediment	MC4
Circalittoral sand	MC5
Circalittoral mud	MC6
Offshore circalittoral rock and biogenic reef	MD1, MD2
Offshore circalittoral coarse sediment	MD3
Offshore circalittoral mixed sediment	MD4
Offshore circalittoral sand	MD5
Offshore circalittoral mud	MD6
Upper bathyal rock and biogenic reef	ME1, ME2
Upper bathyal sediment	ME3, ME4, ME5, ME6
Lower bathyal rock and biogenic reef	MF1, MF2
Lower bathyal sediment	MF3, MF4, MF5, MF6
Abyssal	MG1, MG2, MG3, MG4, MG5, MG6

- **OSPAR List of threatened and/or declining habitats:**
  - Carbonate mounds
  - Coral Gardens
  - *Cymodocea* meadows
  - Deep-sea sponge aggregations

- Intertidal *Mytilus edulis* beds on mixed and sandy sediments
- Intertidal mudflats
- Littoral chalk communities
- *Lophelia pertusa* reefs
- Maerl beds
- *Modiolus modiolus* (horse mussel) beds
- Oceanic ridges with hydrothermal vents/fields
- *Ostrea edulis* beds
- *Sabellaria spinulosa* reefs
- Seamounts
- Sea-pen and burrowing megafauna communities
- *Zostera* beds

2 Monitoring

The method of the indicator is a modelling approach. The assessment is principally based on available pressure data on human activities (e.g., location and extent of offshore structures or extraction areas, VMS or EMS data) and on the extent and distribution of benthic habitats (see Chapter 3). No specific sedimentological or biological monitoring data are needed. However, the results could be calibrated and improved by ground truthing of sites with estimated high risk of loss or the evaluation of sediment changes due to different intensities of fishing or extraction.

3 Data Specifications

3.1 Data acquisition and preparation

Data are acquired from publicly available sources (see 3.2) and specified OSPAR data calls.

3.2 List of data sources

Listed below are data sources for habitat data and the human activities that have been assessed with the indicator at present.

Habitat data:

- Modelled Habitat Map – EMODnet EUSeaMap (2021), EUNIS (2019) classification https://www.emodnet-seabedhabitats.eu
- OSPAR Threatened and / or declining habitats in the North-East Atlantic (2020): https://www.emodnet-seabedhabitats.eu (Composite data products – OSPAR habitats)
- Data on historical distribution of biogenic habitats (could be added in the future)

Table 1: Data sources and information available for human activities currently assessed with BH4.

Activity	Data source	Information available
Extraction of oil and gas, incl. infrastructure - platforms	ODIMS Inventory of Offshore Installations (2019) EMODnet Oil and gas offshore installations (2020)	point data, foundation type, status (e.g. under construction / operational)
Extraction of oil and gas, incl. infrastructure - pipelines	EMODnet pipelines (2019)	extent (diameter and length) of pipeline, status (e.g. under construction / operational)
Renewable energy generation incl. infrastructure - wind farms	ODIMS Offshore renewable energy developments (2020) EMODnet Wind farms (2021)	polygon area of wind farm, no. of devices, foundation type, status (e.g. under construction / operational)
Extraction of minerals (rock, metal ores, gravel, sand, shell)	ICES WGEXT Report (2019) OSPAR data call (2021)	extent of licensed area, partly area dredged, amount extracted, information on methods used
Fish and shellfish harvesting (bottom trawling)	ICES Data for OSPAR request on the production of spatial data layers of fishing intensity/pressure (2021)	VMS data, Swept area ratio (surface abrasion), for métiers and gear groups, 0,05°x0,05° grid, time period 2009-2020

4 Assessment method

4.1. Parameters and metrics

The spatial extent of sealed loss caused by offshore installations (offshore wind farms, oil and gas platforms and pipelines) is assessed with the actual extent of the structure and / or a buffer that gives an estimate of the spatial footprint of habitat loss. Aggregate extraction and bottom trawling can be assigned to both loss and disturbance, depending on the intensity of the pressure and the probability of sediment changes. For these unsealed loss pressures, a risk assessment is carried out taking into account various factors in order to highlight areas where a habitat may have already changed or is subject to a higher risk of alteration.

4.2. Assessment criteria

- **Assessment unit/scale (Temporal and spatial)**

The pilot assessment is presented for the MSFD (Marine Strategy Framework Directive) sub-region 'Greater North Sea, including the Kattegat and the English Channel', which is similar to the OSPAR Region 'Greater North Sea'. Only the most northern areas of the OSPAR Region are not included in the MSFD sub-region. Five benthic assessment units have been distinguished in the Greater North Sea: These are the sub-regions Channel, Southern North Sea, Central North Sea, Kattegat and the Norwegian Trench.

The spatial assessment of this indicator is undertaken at EUNIS level 3 as classified by EMODnet EUNIS 2019 (EUSeaMap 2021) and for OSPAR threatened and / or declining habitats (OSPAR 2020). The spatial extent of habitat loss is calculated per assessment unit.

The assessment of human activities includes all offshore structures that are currently present in the North Sea. For bottom trawling, aggregated datasets for the time periods 2009-2014 and 2015-2020 are used. The assessment of aggregate extraction includes the present distribution of licensed areas and the areas and amounts dredged in 2019.

- **Baseline/ reference level**

Habitat loss should include all types of loss caused by recent and historic human activities within the marine environment at the current date of an assessment. The indicator assessment requires data on the natural spatial distribution of each habitat type as the baseline. For some biogenic habitats, a historic distribution may need to be derived from modelling approaches to be able to report on particular habitats that may have been more widespread and are now completely or partly lost. Estimating such loss relies on the availability of relevant historical records and/or the development of appropriate models of habitat suitability in order to estimate historic distribution and the extent of biogenic habitats. Following the identification of such baselines and corresponding loss estimates, historical loss can be incorporated into the assessment process (ICES 2019a). The assessment of physical loss also requires the incorporation of impacts that occurred before the current assessment period, e.g. where dredging or depositing has led to loss and the habitat has not (yet) recovered (GES_26-2022-02_Draft_Art.8_Assessment_Guidance).

- **Environmental target**

At present, no environmental target or threshold value is proposed for BH4. According to COM decision 2017/848, the extent of loss of a habitat type, resulting from anthropogenic pressures, shall not exceed a specified proportion of the natural extent of the habitat type in the assessment area. Member States shall establish the maximum allowable extent of habitat loss for MSFD criterion D6C4 as a proportion of the total natural extent of the habitat type, through cooperation at Union level, taking into account regional or sub-regional specificities. Coordinated threshold values for the maximum allowable extent of loss are currently developed in the EU Technical Group on Seafloor Integrity (TG Seabed). These proposals will be taken into account for a future BH4 threshold value.

4.3 Spatial Analysis and / or trend analysis

The final metric of this indicator is the area of a given habitat that is predicted to have been lost due to anthropogenic activities per assessment unit. The two mechanisms leading to loss, sealed and unsealed loss, require different assessment approaches (Figure 1). The components of the analysis for sealed loss are the extent and distribution of activities causing habitat loss and the extent and distribution of benthic habitat types. The placement of structures invariably leads to a loss of habitat area, regardless of the sediment and hydrodynamic characteristics. The spatial extent of sealed loss caused by offshore installations (offshore wind farms, oil and gas platforms and pipelines) is assessed with the actual extent of the structure and / or a buffer that gives an estimate of the spatial footprint of habitat loss.

The assessment of unsealed loss includes further information on the intensity of the activity, as only activities with a very high intensity and / or duration may cause severe sediment changes. In addition, the risk of habitat loss depends on the susceptibility of the habitat type to sediment alterations. Aggregate extraction and bottom trawling can be assigned to both loss and disturbance, depending on the intensity of the pressure and the probability of sediment changes. For these unsealed loss pressures, a risk assessment is carried out taking into account various factors in order to highlight areas where a habitat may have already changed or is subject to a higher risk of alteration.

The extent and proportion of loss or risk of loss per habitat type and assessment unit is obtained by spatially combining the different components of the analysis.

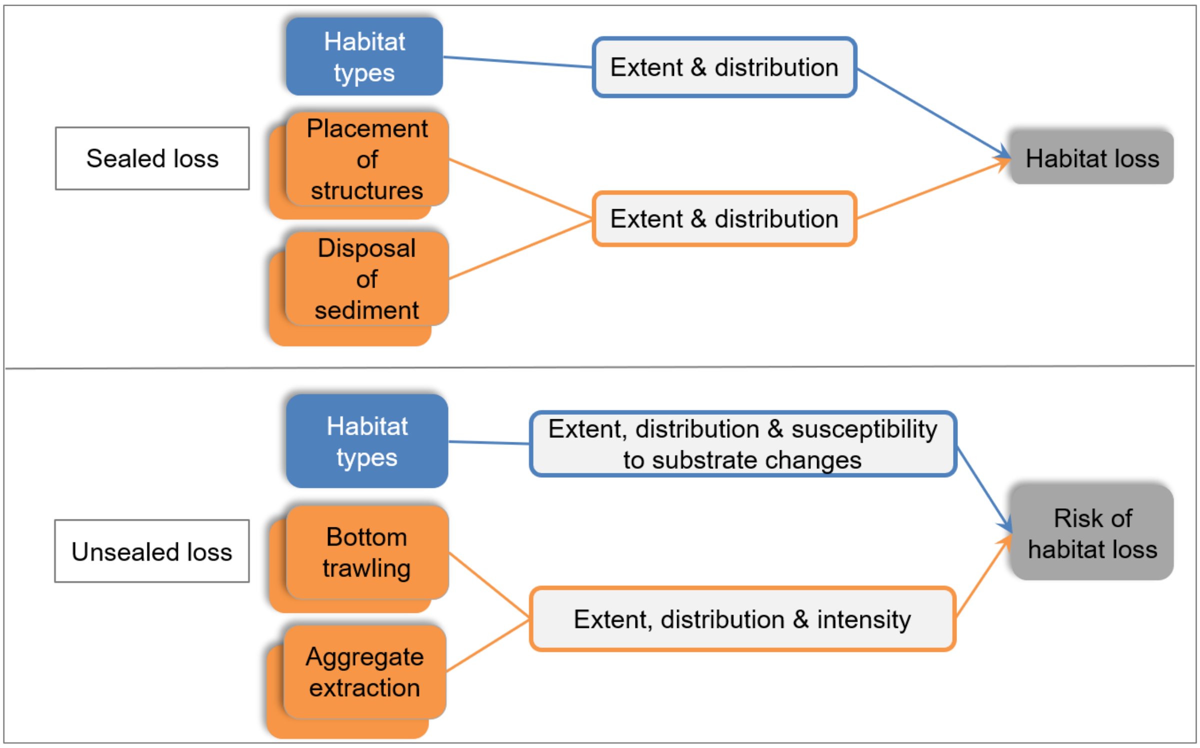


Figure 1: Assessment method for sealed and unsealed loss.

4.3.1 Offshore wind farms

The footprint of physical loss caused by wind farms includes the area sealed by the foundations of the turbines and supporting platforms as well as the area sealed by scour protection (e.g. by rock dumping, in order to prevent sediment scouring around the structure). The size of the area sealed depends on the type of foundation used. Monopiles have been chosen for more than 80% of the installed offshore wind farms to date (EWEA 2019). The diameter of a monopile depends on the water depth and may extend up to 7.8 m (e.g. wind farm Veja Mate, Germany). The average diameter of a monopile is approximately 5 m (Negro et al. 2017). Tripods or tripiles (three legs) and jackets (four legs) are anchored by driven or drilled piles, typically ranging from 0.8 to 2.5 m in diameter. These types of foundations are used with larger turbines and may be located in deeper waters (EWEA 2019). Gravity based structures have also been used on several projects. The diameter depends on the foundation type and varies between 16 m (e.g. Middelgrunden, Denmark) and 23.5 m (e.g. Thornton Bank, Belgium) and may reach a size of approximately 30 m diameter in future projects (Esteban et al. 2019). Gravity based structures can also vary in shape; they may be circular or rectangular. If the size of the foundation and the extent of scour protection is not known, a buffer has to be applied to account for the area lost. Buffers for pile foundations (including scour protection) used in scientific literature range from 15 m (e.g. Foden et al. 2011) to 30 m (HELCOM 2017). The type of the foundation is available from the ODIMS dataset on offshore renewable energy developments, therefore a buffer based on the foundation type can be applied (Table 2). As the exact locations of the piles are not known, the footprint of the foundations is added up per wind farm polygon and assigned to the prevailing habitat type.

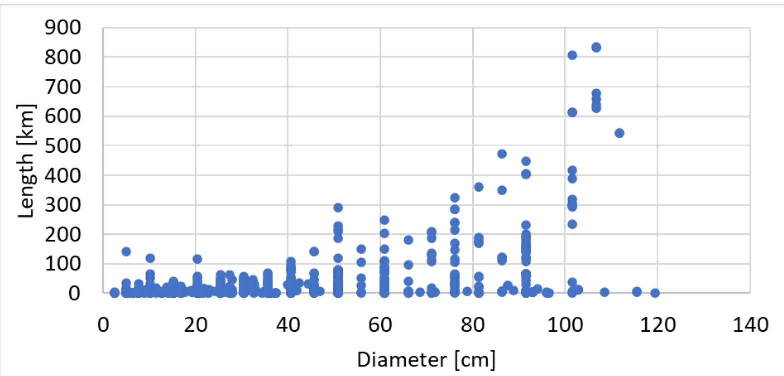
4.3.2 Oil and gas platforms

Platforms for the extraction of oil and gas are usually founded on jacket structures with mostly four legs and a diameter of 1-2 m each (Eastwood et al. 2007). The area sealed by the structure as well as scour protection is considered as loss. Information on oil and gas platforms is only available as point data, therefore a buffer for the area impacted has to be applied. In addition to the presence of fixed structures, physical loss is caused by the accumulation of drill cuttings around operational platforms. Activity footprints to account for the effects of drill cuttings vary from a radius of 100 m (Foden et al. 2011) to 500 m (Eastwood et al. 2007). However, most studies included also changes that were observed in benthic communities (e.g. reduced abundance or diversity) and not in sediment characteristics. According to Foden et al. (2011), the drill cuttings have been reported to reach approximately 100 m from the well, therefore this radius is used as a standard dimension for operational oil and gas platforms.

Other platforms, e.g. for accommodation or processing, were assigned a buffer according to the dimensions of the foundation and similar to those used for offshore wind farms (Table 2). If the type of the foundation is not known, it is assumed that a jacket with four legs is used, as this is the most frequently installed structure. This applies to 13% of the dataset. Platforms that are classified as 'decommissioned' or 'derogation' are included in the assessment, as generally the subsea structures remain in place and continue to cause physical loss. The effect of drill cuttings is not assessed for closed down platforms, however, as the date of decommissioning is generally not available, there may still be areas that have not yet recovered from these impacts.

4.3.3 Oil and gas pipelines

Pipelines are usually laid directly on the sea floor without further coverage. The area lost includes the pipeline itself as well as a buffer for sediment changes occurring around the structure. Published pressure assessments accounting for loss by pipelines either used the exact dimensions of the pipelines without considering alterations of the sediment around (e.g. Eastwood et al. 2007, Foden et al. 2011) or applied a buffer with a radius of up to 15 m (HELCOM 2017). Data on the length and for the majority (92.5%) of pipelines in the North Sea also the exact diameter is available from EMODnet. If the exact dimensions of a pipeline are not known, the size can also be estimated from the length of the pipeline, as with increasing pipeline length the diameter also increases (Figure 2). For the remaining 7.5% of pipelines without size information, a standard diameter is calculated according to the length of the pipeline, based on the median value of 8 length classes. The exact dimensions or dimensions estimated from length are used to assess sealed loss due to the structure of the pipeline. In order to account for sediment changes by scouring, the diameter of the pipeline is used as a buffer on each side (Table 2).



Length (km)	Standard diameter (cm)
0-1	15
>1-10	20
>10-20	25
>20-50	30
>50-100	51
>100-200	76
>200-500	84
>500	107

Figure 2: Relationship between the length and the diameter of pipelines in the assessment area (left) and the standard diameter derived for length classes (right).

Table 2: Activity footprints for the assessment of offshore structures.

Activity	Structure	Buffer	Footprint for physical loss	Data source
Offshore wind farms	Monopile	15 m	707 m²	ODIMS Offshore renewable energy developments (2020) EMODnet Wind farms (2021)
	Tripod / tripile / jacket	20 m	1 257 m²	
	Gravity-base / suction bucket	30 m	2 827 m²	
Oil and gas plat-forms - operational	Physical structures and impacts by drill cuttings	100 m	31 416 m²	ODIMS Inventory of offshore installations (2019) EMODnet Oil and gas offshore installations (2020)
Oil and gas plat-forms – inactive or infrastructure	Monopile	15 m	707 m²	
	Jacket with 3 or 4 legs	20 m	1 257 m²	
	Jacket with 6 or 8 legs	25 m	1 963 m²	
	Jacket with 12 legs / gravity-base	30 m	2 827 m²	
Oil and gas pipelines	Pipelines resting on the surface of the seabed	3 x diameter	dependent on size	EMODnet Pipelines (2019)

4.3.4 Bottom trawling

Intense bottom trawling may lead to a change in sediment type by abrasion and resuspension of sediment. The main factors determining the impact on the physical habitat are trawling intensity, prevailing sediment type and the hydrodynamic regime (Jennings & Kaiser 1998, Mengual et al. 2016, Oberle et al. 2016).

Physical loss as a result from bottom trawling may occur when biogenic substrates are affected by abrasion (e.g. *Ostrea edulis* beds, *Sabellaria* reefs, *Lophelia* reefs, mussel beds). Depending on the life-history traits and distribution of the affected species, recovery of the reef structures may take several decades or may not take place at all (e.g. Farinas-Franco et al. 2014, Kaiser et al. 2018, Perry et al. 2020, Tillin 2016, Tillin et al. 2020, Tyler-Walters et al. 2019). Biogenic reefs display the highest vulnerability of all substrate types to trawling and low intensities of trawling may suffice to result in severe disturbances and physical loss (Table 3).

Another impact from bottom trawling is the resuspension of sediments that can lead to a change in the grain size composition of soft sediments (Table 3). Both coarsening and fining of trawled areas have been described, depending on the affected sediment and the hydrodynamic setting in the fished area and its surroundings (Mengual et al. 2016, Oberle et al. 2016, Trimmer et al. 2005). Fining of the sediment occurs when the top layer of the sediment is reworked by fishing gear and fine sediment particles settle on top of the heavier, coarser particles resulting in a changed vertical sediment distribution. Fining also occurs when trawl marks and scars are filled up with fine sediment that are transported by currents from adjacent areas. A coarsening of the sediment has been reported for muddy sediments when bottom trawling stirs up the silt fractions of the sediment which get transported away from the trawled area by bottom currents (Mengual et al. 2016, Oberle et al. 2016). Depending on the fishing intensity and the hydrodynamic setting in the area, these changes in the sediment structure may lead to long term alterations of the habitat classification indicating physical loss of the initial habitat.

Geogenic hard substrates are not assumed to suffer a substantial loss of rocky habitat area, as they are relatively resistant to physical damage from fishing gears. Steep and rocky substrata are unsuitable for trawling and are generally avoided by fishermen (Roberts et al. 2010, Hintzen et al. 2021). Towed gears may displace or overturn rocks and lead to a reduced habitat complexity, but a change of habitat type at a larger scale is considered unlikely.

Table 3: Impact by bottom trawling and probability of loss per substrate type.

Substrate type	**Trawling impact**	**Probability of habitat loss**
Rock	Displacement, overturning of rocks, reduction of complexity	Unlikely to affect larger areas
Biogenic reef (in general)	Destruction of reef structure	Loss may occur already at low trawling intensities, recovery of reef-forming species is generally low due to slow growth rate and / or sporadic recruitment
• *Lophelia pertusa reefs*	*Fragmentation, break up of reef structure, disintegration of the coral matrix*	*Lophelia reefs have a high vulnerability to physical damage and a low growth rate of 6 mm/year. There is no evidence from case studies that show reefs can recover from damage.*
• *Maerl beds*	*Fragmentation, compaction and smothering by sediment plumes*	*Maerl beds have no resistance to physical disturbance. Due to their extremely slow growth, full recovery may take up to 25 years.*
• *Modiolus modiolus beds*	*Tearing up of mussel clumps, destabilisation and disintegration of reef structure*	*Horse mussel beds have a high intolerance to physical damage. The long-lived species has a low and sporadic recruitment. It may take many years for a population to recover from damage, if at all.*
• *Ostrea edulis beds*	*Damage to individual oysters, flattening of beds, loss of reef structure*	*Oyster reefs have disappeared mainly due to over-exploitation. Recoverability is considered to be very low due to the sporadic recruitment that is dependent on local hydrographic conditions and presence of suitable substratum. Substantial removal of an existing bed reduces suitable settlement areas for subsequent generations.*
• *Sabellaria spinulosa reefs*	*Damage and break-up of tube aggregations, leading to loss of the reef*	*Sabellaria reefs are estimated to have no resistance to physical damage. Trawling seems to have reduced the extent of reefs and some are considered to have disappeared due to trawling, but on the other hand Sabellaria spinulosa is likely to recover quickly if an adequate supply of larvae is maintained.*
Coarse sediment	Trawl marks, overturning and removal of stones and cobbles, siltation	Fining (refilling of trawl marks with finer sediment) may occur at very high trawling intensities and low current velocities at seabed Slow recovery, as coarse sediment particles are less likely to be transported by currents from adjacent areas
Mixed sediment	Removal of stones and cobbles, increase of sediment sorting	Loss of habitat may occur when the heterogeneity of the sediment is reduced by e.g. removal of coarse fraction
Sand	Trawl marks, fining of sediment due to siltation processes	Disturbed sandy areas may be refilled by similar particles in a short time span Sediment particle size distribution may shift to finer particle sizes but a permanent change of sediment classification is unlikely
Mud	Winnowing of the silt fraction of the sediment, coarsening of sediment	Fine sediments are resuspended and transported away by currents, larger particles remain Coarsening may occur at very high trawling intensities and increased sediment transport

Based on a literature review of the impacts of bottom trawling on different substrates (Table 3), the probability of habitat loss of the main sediment types has been defined (Table 4). Particularly for coarse sediments and mud, the hydrodynamic regime has been identified as essential with regard to the likelihood of sediment changes. In order to estimate the intensity of hydrodynamic conditions, the energy classification for habitat types from EMODnet EUSeaMap (2021) is used which combines both current and wave energy data, producing three grades of exposure (Populus et al. 2017).

Table 4: Assessment of probability of habitat loss to trawling by combining substrate types with energy at the seabed.

Probability of loss	**Substrate type**					
Energy at the seabed	Biogenic reef	Coarse sediment	Mud	Mixed sediment	Sand	Rock
Low energy	very high	high	medium	medium	low	none
Moderate / high energy	very high	medium	high	medium	low	none

Trawling disturbance is assessed as 'swept area ratio' (SAR) or proportion of cell area swept per year. The swept area is calculated as the width of the fishing gear multiplied by the average vessel speed and the time fished. The SAR is then calculated by dividing the swept area by the grid cell area. Studies on the physical impact indicate that sediment disturbances altering the substrate type only become visible at SAR > 8 (Mengual et al. 2016, Oberle et al. 2016, Schratzberger & Jennings 2002). Therefore, it is assumed that habitat loss is unlikely to occur at trawling intensities of SAR < 8. At trawling intensities higher than that value, first signs of habitat alterations can become apparent and especially for biogenic reefs, destruction of reef structures can lead to habitat loss. At SAR > 16 the risk of habitat loss is assumed to be further increasing, depending on the susceptibility of the habitat type to sediment changes. Oberle et al. (2016) and Mengual et al. (2016) observed high or very high sediment alterations, leading to a change of substrate type, at SAR values > 16. Based on these findings, a matrix has been produced that determines four categories for risk of habitat loss (none, low, moderate and high) by combining probability of loss and trawling intensity (Table 5).

Table 5: Matrix showing the risk of loss due to bottom trawling by combining probability of loss and trawling intensity (SAR = Swept area ratio).

Risk of loss	**Probability of habitat loss**			
Trawling intensity	**Low**	**Moderate**	**High**	**Very high**
SAR = 0	none	none	none	none
SAR ≤ 8	none	none	low	moderate
SAR > 8-16	none	low	moderate	high
SAR > 16	low	moderate	high	high

For the assessment of loss by bottom trawling, data provided by ICES (Data for OSPAR request on the production of spatial data layers of fishing intensity/pressure 2021) were used. The average SAR values were calculated per c-square (grid cell) for the time periods 2009-2014 and 2015-2020. The average values were used as only constant high fishing pressures are assumed to lead to sediment changes. Variance in fishing intensity is calculated as the standard deviation and results are shown as grid cells with constant pressure (standard deviation is within class range) or varying pressure (standard deviation exceeds class range).

Sweden additionally provided a spatial layer for a fishery exclusion area in the Kattegat, where it is despite VMS records assumed that no fishing occurs. In fact, SAR values in this area where consistently below 8.

4.3.5 Aggregate extraction

Extraction of sand and / or gravel is considered as physical loss when the dredging activity changes the sediment type. An alteration of the sediment may take place by several mechanisms, depending on the method used or the intensity of the impact.

Stationary or anchor dredging creates local depressions of 5-10 m or more in depth that remain visible after decades. Backfilled material is generally composed of finer material than previously existed in the area (Mielck et al. 2021, Newell & Woodcock 2013, Petersen et al. 2018). This type of dredging can therefore lead to considerable alterations in seabed topography, hydrodynamics and sediment classification.

The sediment type may also change if on-board screening is applied: The dredged material is passed over a mesh screen and a proportion of the finer sediment is returned to seabed, while the coarser sediment is retained on board the dredger. It has been estimated that in order to obtain a gravel:sand ratio of 60:40 from a typical North Sea deposit with a relatively low gravel content, it is necessary for the operating vessel to return approximately 60% of excess sand to the seabed (Newell & Woodcock 2013). Still, water currents may remove these fine sediments so that the seabed will become coarser again over time (Tillin et al. 2011). The extent to which this occurs depends on the prevailing hydrodynamic regime and the degree of natural mobility of sediment particles or larger-scale bedforms.

Long term intense dredging may also lead to physical loss of the sediment type. The most commonly used dredging method in the North Sea is trailer suction dredging. This method creates shallow furrows that are generally 2-3 m wide and initially approximately 0.5 m deep. Over time however, the seabed may be lowered by up to 3 m (Tillin et al. 2011). The changed seabed topography and dredge furrows often reduce current velocity so that the deposition of fine particles increases (Hill et al. 2011).

Physical recovery at aggregate sites where dredging had ceased is generally reported to be dependent on dredging intensity, substrate type and the hydrodynamic regime (Foden et al. 2009, Hill et al. 2011, Desprez 2012). The fastest restoration occurs in sandy deposits with strong tidal streams, where physical recovery was observed to last 1 to 3 years. Reported rates for coarser deposits that are mainly targeted for aggregate extraction were amongst the slowest to recover, with a recovery time for the physical substrate of as much as 20 years (Foden et al. 2009). Hill et al. (2011) predict a slow recovery (years to decades) for coarse sediments in a low or moderate energy environment and where dredging intensity is high and affects a larger area. Desprez (2012) expects physical recovery times of more than 10 or even 20 years in sites with stationary dredging and also with intensive trailer suction dredging in coarse sediments and low energy sands.

Sediments that are subject to aggregate dredging are predominantly coarse and sandy substrates and additionally mixed sediments. Vulnerable habitats such as biogenic reefs and rocks may occur in the vicinity of extraction sites and may be impacted by sedimentation and increased turbidity. Sedimentary changes have been detected at distances up to 2 km from dredge sites after sediment remobilisation by strong local tidal currents (ICES 2019b). However, these effects are regarded as temporary and not causing long-lasting impacts. The indicator assesses therefore only habitats directly impacted by extraction.

Based on the described impacts and recovery times from literature, the risk of loss for the habitats concerned in relation to the dredging method and its intensity (where relevant) is estimated (Table 6).

Table 6: Matrix showing the risk of loss due to aggregate extraction by combining probability of habitat loss due to sediment type and intensity and / or method of dredging.

Risk of loss	**Sediment type**					
	Sand		Mixed sediment		Coarse sediment	
Dredging method / intensity	low/moderate energy	high energy	low/moderate energy	high energy	low/moderate energy	high energy
Trailer suction dredging / low	none	none	none	none	none	none
Trailer suction dredging/moderate	low	none	low	none	moderate	none
Trailer suction dredging / high	moderate	low	moderate	low	high	moderate
Screening	-	-	high	moderate	high	moderate
Anchor dredging	high	high	high	high	high	high

The intensity of trailer suction dredging can be defined by the time dredged or by the amount extracted per area. Assessing the risk of loss by aggregate extraction requires detailed information on the method employed, the area dredged and the intensity. As these data are only partly available at present, the assessment is currently confined to a description of dredging activities and an estimation if loss by extraction is probable. Thresholds for the intensity of dredging cannot be determined at this stage.

4.3.6 Combining pressures and habitat types

The pressure layers for offshore structures, bottom trawling and aggregate extraction are spatially combined with the habitat map in a Geographical Information System (GIS) in order to indicate the area and proportion per habitat type that is lost or subject to a higher risk of loss. As a basis for the assessment of broad-scale habitats, the EMODnet EUSeaMap (2021) EUNIS 2019 habitat classification is used. Additionally, the assessment is carried out for OSPAR Threatened and / or declining habitats (2020). The extent of area lost or with a higher risk of loss is summed up in terms of surface area (km²) and as a proportion (%) of the total surface of the assessed habitat type per assessment unit.

4.3.7 Confidence

Confidence in the indicator assessment is reported qualitatively based on recommendations from the QSR 2023 Guidance Document (Table 7, Table 8). The confidence assessment is carried out for the methodology and the pressure data. The EMODnet habitat classification map is accompanied by a confidence assessment, which is used for the BH4 confidence as well.

Table 7: Description of high, moderate and low data availability.

Data availability (spatially and temporally)	Description
High	There are no significant data gaps identified, for example: • The assessment is undertaken using data with sufficient spatial coverage within the area being assessed. • The assessment is undertaken using sufficient temporal data collected over a period pertinent to the assessment.
Moderate	Some data gaps are evident, but this does not impact the overall outcome of the assessment, for example: • The assessment is undertaken using data with a mostly sufficient spatial coverage for the area assessed, but gaps are apparent in certain areas. • The assessment is undertaken using data with a mostly sufficient temporal coverage collected over a period pertinent to the assessment. Although some gaps are apparent.
Low	Significant data gaps have been identified (both spatially and temporally), for example: • The assessment is undertaken using limited data with poor spatial coverage within the area assessed. • The assessment is undertaken using limited data collected over a period that is limited (and therefore not pertinent to the assessment) or the assessment is largely informed by expert judgement.

Table 8: Description of high, moderate and low consensus in methodology / maturity of methodology.

Consensus in methodology / maturity of methodology	Description
High	The assessment methodology requires only limited further development and updating for future assessments, for example: • The methodology used is widely accepted and is used in published international assessments. The methodology has been in use for a number of years. • There is a strong consensus within the scientific community regarding this methodology / approach to assessment.
Moderate	The assessment methodology could benefit from some further development for future assessments, for example: • The methodology presented is often used to assess this indicator and has been used previously in published assessments, but it is acknowledged that one or two aspects require further development. • There is consensus within the scientific community regarding this methodology, but there remain some questions around the methodology.
Low	The assessment methodology requires further development for future assessments, for example: • The methodology used has been developed specifically for this assessment and has not been used in a previously published assessment. • There is limited consensus within the scientific community regarding this methodology.

As a measure of uncertainty of the fishing pressure analyses, the standard deviation is calculated for each c-square and assessment period. Fishing pressure is regarded as constant, if the mean SAR value of a c-square in an assessment period and the standard deviation are in the same SAR category as defined by the indicator methodology (e.g. SAR >0-8). A low variability means that the mean SAR value and either the positive standard deviation or the negative standard deviation are in different SAR categories. Variability is classified as high, if the mean SAR value, the positive and the negative standard deviation are all in different categories.

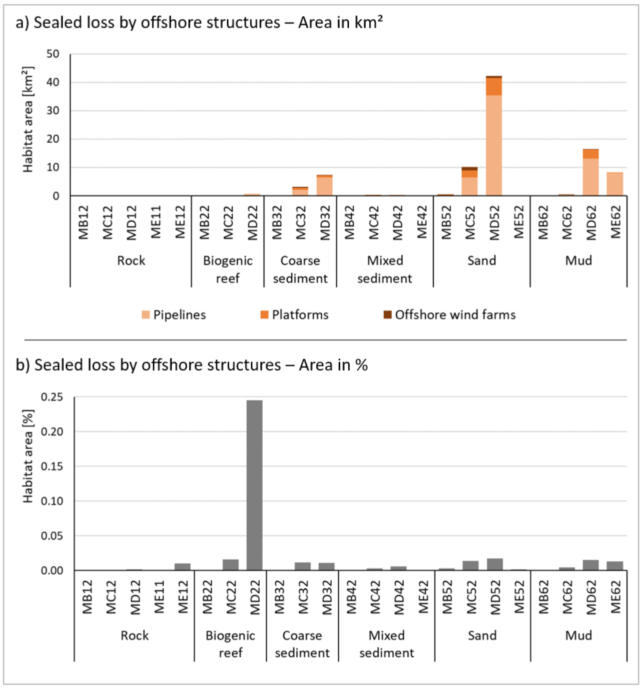
4.4 Presentation of assessment results

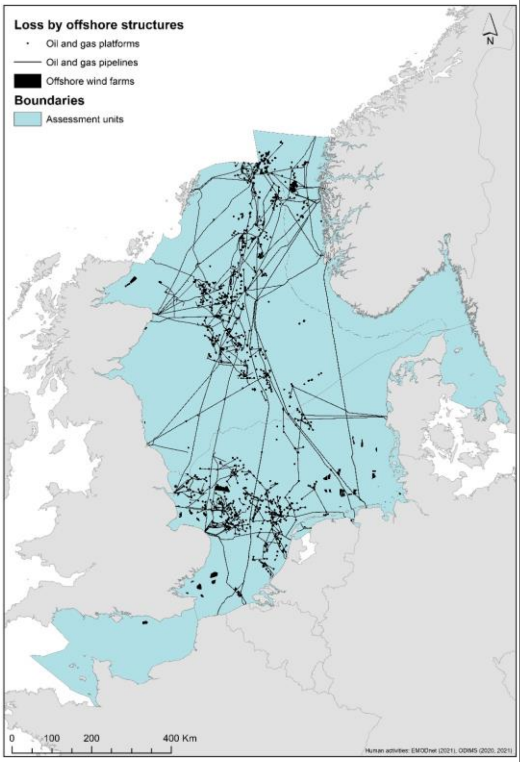
A pilot assessment has been produced for the Quality Status Report 2023. Selected pressures (offshore structures, bottom trawling, aggregate extraction) have been assessed in the MSFD sub-region of the Greater North Sea and OSPAR assessment units. Below are given some examples of the outputs.

Offshore structures – Offshore wind farms, oil and gas platforms, oil and gas pipelines

Loss by offshore structures is given as area (km²) and proportion (%) of habitat type per MSFD sub-region and per OSPAR assessment unit. The distribution of installations is shown in a map.

Example outputs for the MSFD-subregion:





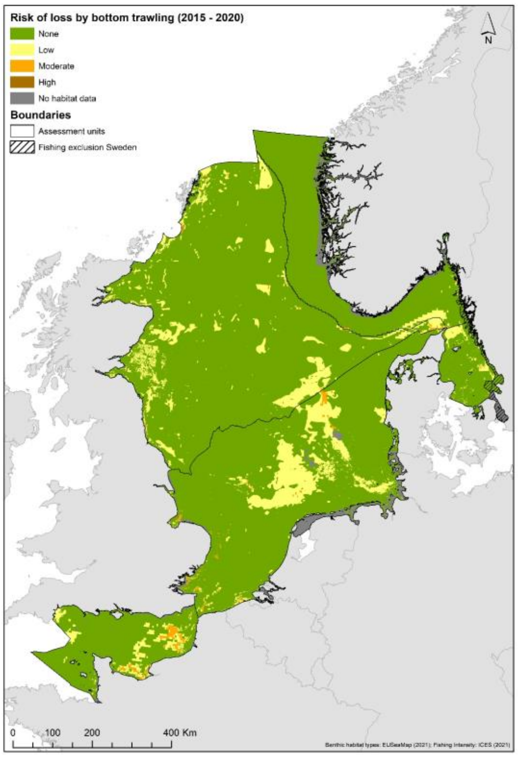
Habitat type	Total area km²	Offshore wind farms km²	%	Oil and gas platforms km²	%	Pipelines km²	%	Estimated total loss km²	%
MB12	1 729	<0.01	0.0001	-	-	0.01	0.0003	0.01	0.0004
MB22	93	-	-	-	-	-	-	-	-
MB32	3 195	-	-	-	-	0.01	0.0002	0.01	0.0002
MB42	1 340	-	-	-	-	-	-	-	-
MB52	14 326	0.02	0.0002	0.25	0.0017	0.21	0.0015	0.49	0.0034
MB62	2 092	-	-	-	-	0.01	0.0004	0.01	0.0004
MC12	2 886	-	-	-	-	0.02	0.0008	0.02	0.0008
MC22	693	0.09	0.0131	-	-	0.02	0.0027	0.11	0.0159
MC32	27 825	0.37	0.0013	0.65	0.0023	2.20	0.0079	3.22	0.0116
MC42	6 144	-	-	0.06	0.0010	0.13	0.0022	0.20	0.0032
MC52	72 263	1.29	0.0018	2.49	0.0034	6.48	0.0090	10.26	0.0142
MC62	8 476	0.04	0.0004	<0.01	<0.0001	0.34	0.0040	0.38	0.0044
MD12	5 046	-	-	-	-	0.10	0.0021	0.10	0.0021
MD22	326	-	-	-	-	0.80	0.2451	0.80	0.2451
MD32	67 790	0.21	0.0003	0.67	0.0010	6.46	0.0095	7.34	0.0108
MD42	6 659	-	-	-	-	0.38	0.0057	0.38	0.0057
MD52	239 978	0.78	0.0003	6.17	0.0026	35.33	0.0147	42.28	0.0176
MD62	105 938	0.09	0.0001	3.14	0.0030	13.16	0.0124	16.39	0.0155
ME11	24	-	-	-	-	-	-	-	-
ME12	2 277	-	-	-	-	0.24	0.0105	0.24	0.0105
ME42	1	-	-	-	-	-	-	-	-
ME52	279	-	-	<0.01	0.0004	<0.01	0.0013	<0.01	0.0017
ME62	60 969	-	-	0.06	0.0001	8.06	0.0132	8.12	0.0133
No habitat data	23 863	<0.01	<0.0001	0.08	0.0003	1.18	0.0050	1.26	0.0053
Total	**654 210**	**2.89**	**0.0004**	**13.57**	**0.0021**	**75.14**	**0.0115**	**91.60**	**0.0140**

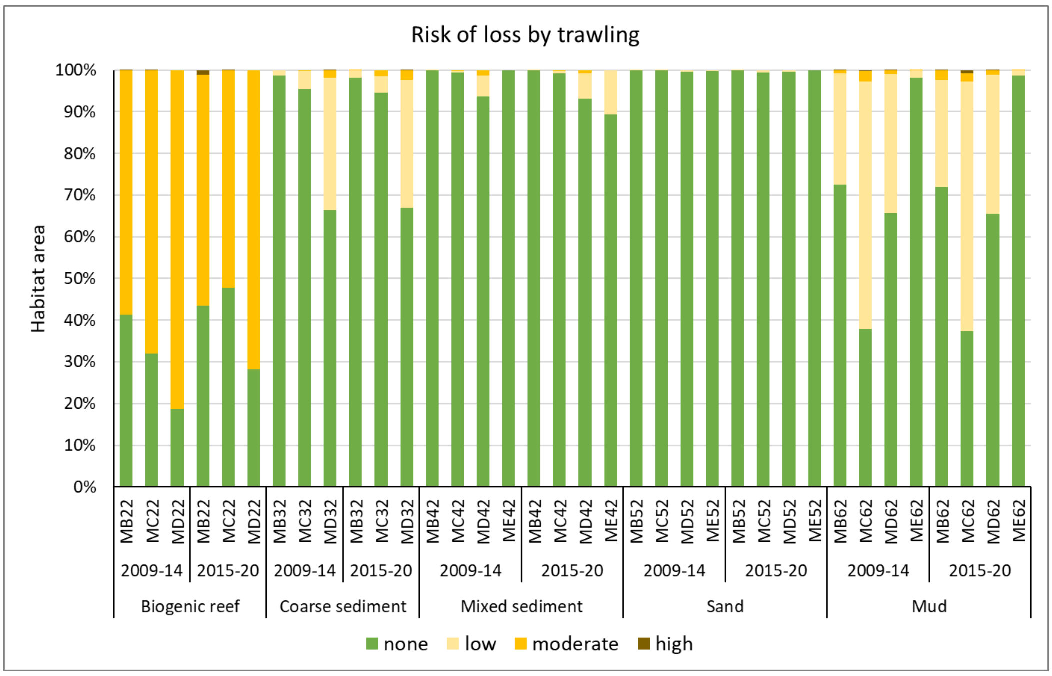
Risk of loss by bottom trawling

The risk of loss by bottom trawling is assessed in four categories (none, low, moderate, high). For each risk category the area (km²) and proportion (%) of habitat type per MSFD sub-region and per OSPAR assessment unit is calculated. The data available enabled for the assessment of two time periods (2009-2014, 2015-2020). The distribution of the different categories of loss is shown in a map.

Example outputs for the MSFD-subregion:

Habitat type	Total area (km²)	Risk of loss (2015-2020) in km²			
		none	low	moderate	high
MB12	1 729	1 729	-	-	-
MB22	93	40	-	51	1
MB32	3 195	3 133	59	2	-
MB42	1 340	1 339	0.3	-	-
MB52	14 326	14 309	17	-	-
MB62	2 092	1 506	535	48	3
MC12	2 886	2 886	-	-	-
MC22	693	331	-	362	0.2
MC32	27 825	26 316	1 065	444	-
MC42	6 144	6 096	35	13	-
MC52	72 263	71 849	414	-	-
MC62	8 476	3 170	5 077	166	62
MD12	5 046	5 046	-	-	-
MD22	326	92	-	234	-
MD32	67 790	45 341	20 827	1609	13
MD42	6 659	6 204	397	58	-
MD52	239 978	238 829	1 149	-	-
MD62	105 938	69 466	35 327	1123	21
Total	**654 210**	**560 441**	**65 651**	**4153**	**101**





5. Change Management

Actions required to update the CEMP guideline are described in section 4 of the OSPAR Coordinated Environmental Monitoring Programme (Agreement 2016-01).

The OSPAR subsidiary body responsible for monitoring and assessment of biodiversity is OSPAR's intersessional correspondence group on coordinated biodiversity assessment and monitoring (ICG-COBAM) which should periodically consider the implementation of the CEMP guideline, for those aspects where the indicators have been agreed as common. This consideration should track the progress of these programmes, e.g. collating data, producing assessment reports and initiating new programmes as and when opportunities arise.

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