# WORKSHOP ON SCOPING OF PHYSICAL PRESSURE LAYERS CAUSING LOSS OF BENTHIC HABITATS D6C1– METHODS TO OPERATIONAL DATA PRODUCTS (WKBEDLOSS)

VOLUME 1 | ISSUE 15

ICES SCIENTIFIC REPORTS

RAPPORTS
SCIENTIFIQUES DU CIEM

ICES INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA
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ISSN number: 2618-1371 I © 2019 International Council for the Exploration of the Sea

# ICES Scientific Reports

Volume 1 | Issue 15


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### Recommended format for purpose of citation:

ICES. 2019. Workshop on scoping of physical pressure layers causing loss of benthic habitats D6C1– methods to operational data products (WKBEDLOSS).
ICES Scientific Reports. 1:15. 37 pp. http://doi.org/10.17895/ices.pub.5138



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# Contents

# i Executive summary

The workshop on scoping of physical pressure layers causing loss of benthic habitats D6C1–methods to operational data products (WKBEDLOSS) is part of a stepwise process to delivering advice on sea-floor integrity for the Marine Strategy Framework Directive (MSFD). In collaboration with its strategic partners, the high level objectives undertaken by ICES within the project were: 1) to identify benthic physical disturbance pressure layers available within ICES and the European and wider marine community across the four EU (MSFD) regions – including the mapping of pertinent data flows and the establishment of criteria needed to ensure the practical use of the data in assessing benthic impact – in the workshop WKBEDPRES1 (ICES HQ 24–26 October 2018); 2) to identify physical pressure layers causing loss of benthic habitats across the four EU regions, including mapping of data flow and establish guidance to ensure the practical use of the data in assessing benthic impact - in the workshop WKBEDLOSS (ICES HQ 11–13 March 2019); 3) to collate physical pressure layer data causing loss or disturbance (October 2018–Aug 2019), using identified sources and targeted data calls; and 4) to evaluate and operationally test the application of compiled physical pressure layer data causing loss or disturbance (WKBEDPRES2, 30 September–2 October 2019).

WKBEDLOSS focused on objective 2, the requirement of MSFD GES Commission Decision (EU) 2017/848 criterion D6C1 to assess the spatial extent and distribution of physical pressure layers causing loss of benthic habitats, within each ecoregion and subdivision. Where information on activities was missing, or where the data collected was not suitable for this task, data requirements were highlighted by workshop participants. The process necessitated input from many sources, bringing together research science, marine spatial planning, management experts and indicator developers, all components required for the delivery of MSFD. The resultant collated information needs to be appropriate for the assessment of benthic habitats (D1) and seafloor integrity (D6C3-C5) as set out in the Commission Decision.

WKBEDLOSS defined physical loss as any human-induced permanent alteration of the physical habitat from which recovery is impossible without further intervention.

Alteration of the physical habitat refers to a change in the EUNIS level 2 habitat type. Loss can be given as extent in square kilometres, or percentage loss per EUNIS level 2 habitat. Human interventions facilitating recovery (e.g. removal of man-made structures from the seabed, restoring the original substrate by depositing materials or re-introducing species in the case of loss of biogenic habitat) refer to actions allowing the physical habitat to return to its original EUNIS level 2 habitat type.

WKBEDLOSS distinguished between three types of physical loss: sealed physical loss, un-sealed physical loss and the loss of biogenic habitat. Sealed loss, in general, arises where structures or substrates have been introduced which in and of themselves change the physical habitat. Unsealed loss results from changes in physical habitat due to alterations in physical habitat resulting from an activity or activities and from the indirect effects of placement of man-made structures. This distinction is necessary as data flows recording physical loss differ according to these types.

WKBEDLOSS identified and listed the anthropogenic activities (physical pressure layers) causing physical loss by region. Activities were grouped into those resulting in sealed loss (introduction of structures or substrates) and those potentially resulting in unsealed loss.

For some activities, the physical loss may be only a part of the licensed zone for the activity. Unsealed loss-causing activities seldom cover the entire licensed extent of the activity (e.g. aggregate extraction). Likewise, sealed physical loss may cover only a proportion of a li-censed zone (e.g. wind turbines within the entire wind farm area).

Physical loss can be mapped based on the actual footprint of an individual structure (i.e. sealed loss). Around these structures, a buffer zone (area of potential impact that extends beyond the footprint) can apply to both loss (e.g. scouring leading to change of EUNIS level 2 habitat type) and disturbance (e.g. scouring not leading to change of EUNIS level 2 habitat type). Hence, mapping unsealed loss requires further qualification following the compilation of activity data to ascertain if loss has occurred.

Assessing sealed and unsealed physical loss comprises five generic steps: (1) to identify the MSFD-competent authorities who may hold or have access to suitable physical loss data, (2) to request spatial data and attribute information for each physical loss-causing activity, (3) to assess the surface area of physical loss, (4) to assess and document the level of confidence for each feature in the attribute table, and (5) to manage data according to the FAIR principles.

To distinguish unsealed physical loss from physical disturbance, unsealed loss requires further qualification (i.e. in situ observation of habitat change) following the compilation of activity/pressure data to ascertain if loss rather than disturbance has occurred. Data provisioning to determine if loss has occurred may either become part of the operating obligation for the licensed activity or, a targeted monitoring approach may be adopted. In situations where limited monitoring hampers ascertaining changes in EUNIS level 2 habitats, the severity of the activity on the habitat may be modelled and used to infer loss, though such approaches should be supported by clear scientific validation. Data requirements for unsealed loss are similar to those noted in WKBEDPRES1.

Assessing the loss of biogenic habitat comprises three steps: (1) to identify the present and historic biogenic habitat-forming species, (2) to assess the natural spatial distribution and extent of the biogenic habitat and (3) to assess the loss of biogenic habitat. Note that in case of historical (poor geographically referenced) loss, the historic extent baseline can be estimated based on e.g. regional reviews or habitat suitability mapping.

During the data collection phase, it is important to identify a level of confidence in the positional and spatial accuracy of the data.

# ii Expert group information

| | |
|---|---|
| **Expert group name** | Workshop on scoping for physical pressure layers causing loss of benthic habitats D6C1 - from methods to operational data product (WKBED-LOSS): |
| **Expert group cycle** | NA |
| **Year cycle started** | NA |
| **Reporting year in cycle** | NA |
| **Chair(s)** | Steven Degraer |
| **Meeting venue(s) and dates** | 11–13 March 2019, Copenhagen, Denmark, 20 participants |

# 1 Introduction

**Background and context**

The Marine Strategy Framework Directive (MSFD) sets out the broad requirement under Descriptor 6 that sea-floor integrity is at a level that ensures that the structure and functions of ecosystems are safeguarded and that benthic ecosystems, in particular, are not adversely affected (Directive 2008/56/EU). Under the D6 criteria of Commission Decision (EU) 2017/848, the spatial extent and distribution of physical loss (D6C1) and disturbance (D6C2) pressures for each MSFD broad habitat type, within each ecoregion or subdivision, must be assessed. To meet this requirement, EU funded projects have made advances in the cataloguing of human activities and their associated pressures on the benthic environment.

Considering this, the EU (DG ENV) has requested guidance from ICES to identify which human activities are responsible for the physical disturbance to, and loss of, the seabed within MSFD marine waters, and, to collate pressure data layers in order to assess and define suitable methods. The data collected need to be appropriate for the assessment of benthic habitats (D1) and seafloor integrity (D6C3-C5) as set out in the Commission Decision (EU) 2017/848.

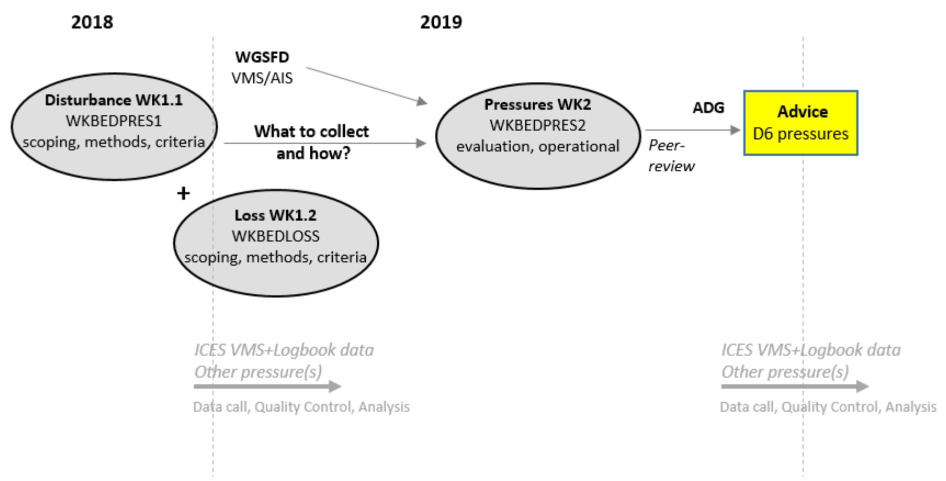


**Figure 1. Stepwise process to assess the spatial extent and distribution of physical loss and disturbance within ICES.**

Within ICES, a stepwise process (Figure 1 above), occurring over a 10-month period in 2018-2019, is followed to assess the spatial extent and distribution of physical loss and disturbance pressures on the seabed (including intertidal areas) in MSFD marine waters. During this process, ICES, in collaboration with its strategic partners, will:

1. Identify benthic physical disturbance pressure layers covering the EU regions in a workshop (WKBEDPRES1, ICES HQ 24–26 October 2018), including mapping of data flows and establish criteria to ensure the practical use of the data in assessing benthic impact.
2. Identify physical pressure layers causing loss of benthic habitats across the EU regions in a workshop (this report, ICES HQ 11–13 March 2019), including mapping of data flows and establish guidance to ensure the practical use of the data in assessing benthic impact.
3. Collate benthic physical loss and disturbance pressure layer data (October 2018 – August 2019), using identified sources and targeted data calls.

4. Evaluate and test operational application of benthic physical loss and disturbance pressure layers in WKBEDPRES2 (ICES HQ, 30 September–2 October 2019).

The workshop reports will be peer-reviewed. As part of this review, collated pressure layers will be tested in a benthic impact assessment context by two ICES working groups (WGFBIT and WGECO). This will build on the assessment framework as described in ICES advice to DG ENV (ICES, 2017), and for which a technical guideline document has been produced by WGFBIT in their 2019 report (Annex 4, page 47).

**Physical disturbance**

The workshop WKBEDPRES1 (24–26 October 2018) identified benthic physical disturbance (D6C2) pressure layers available within ICES and in the European and wider marine community across the four EU (MSFD) regions – including the mapping of pertinent data flows and the establishment of criteria needed to ensure the practical use of the data in assessing benthic impact. Preliminary analysis indicated that the key human activities that resulted in physical disturbance to the seabed are very similar for the four EU regions examined (Baltic Sea, North East Atlantic, Mediterranean Sea and Black Sea). Fishing is found to be the most extensive cause of physical abrasion. Aggregate extraction and dredging are also of relevance in most regions, but generally cause less spatially extensive disturbance.

The workshop concluded that the data flows and quantitative methodologies for the processing of physical disturbance from bottom fishing currently exist within ICES (i.e. within WGFBIT and WGSFD) and were deemed appropriate for EU requirements e.g. MSFD purposes for assessing the seafloor. These methodologies are in line with previous ICES advice on indicators (ICES 2016, 2017). However, similar data flows of bottom fishing activity are yet to be established for the Mediterranean Sea and Black Sea. To allow for better coverage, it was recommended that future calls should also account for other sources of data reflecting fishing activity causing seabed abrasion (e.g. AIS). Data flows for other activities causing physical pressures (e.g. aggregate extraction and dredging) need to be improved to ensure consistent collation at the regional scale from national level and using well documented data management practices (of which ICES's transparent assessment framework (TAF) is an integral part of).

**Physical loss**

The WKBEDLOSS workshop aimed to clearly define, and provide a wider insight into the spatial extent and distribution of human activities causing loss of benthic habitats (D6C1). A natural starting point in WKBEDLOSS was the cataloguing of human activities that cause loss of benthic habitats. This process has already been undertaken by various Regional Sea Conventions (RSCs), ICES working groups and workshops (WKBEDPRES1), EU projects, regional bodies, and member states, and their input into WKBEDLOSS, for each ecoregion and subdivision, is of primary importance. The initial list of activities considered the widest possible list that lead to seabed loss. However, not all physical loss pressures may be available for operationalisation. The workshop considered how to determine the range of activities that have contributed to loss and the extent to which the historical events can be included.

**Combining physical loss and disturbance**

A workshop in Q3 of 2019 will evaluate and test the operational application of benthic physical loss and disturbance pressure layers in WKBEDPRES2 The workshop on scoping of physical pressure layers causing loss of benthic habitats D6C1– methods to operational data products (WKBEDLOSS) Prior to the WKBEDPRES2 workshop, findings from WKBEDPRES1 and WKBEDLOSS will be used to guide the collation of pressure layers and to showcase the usability of data products and their operationalisation in a benthic impact assessment. Here, the assessment should be appropriate for D6C3 and D6C5, in that it allows determining adverse effects of single and cumulative pressures. The assessment should be in line with the operational requirements of impact indicators that are presently in development (ICES, 2017) and for which a technical guideline document has been produced by WGFBIT (ICES 2019, Annex 4, page 47).

**Running of WKBEDLOSS workshop**

WKBEDLOSS was able to draw from the wide range of expertise represented by 20 attendees from across 9 countries, including DG ENV, HELCOM, various EU-funded projects, ICES WGFBIT and WKBEDPRES1 (Figure 2). The workshop was able to make use of worked examples from countries representing the Black Sea, Mediterranean Sea, Bay of Biscay, Celtic Sea, North Sea and Baltic Sea on how reporting of habitat loss was under developed or carried out.

**Figure. 2. Photo of WKBEDLOSS participants**

The main findings from WKBEDLOSS are presented in the executive summary. These findings will also be used as inputs into WKBEDPRES2 and the advice drafting group phase of the ICES advisory committee (ACOM) process to provide an ICES response to the EU request. The WKBEDLOSS report defines physical loss in chapter 2, building on from WKBEDPRES1 definitions. Chapter 3 shows the main human activities that cause physical loss and chapter 4 presents a description of data flows.

## 1.1 References

ICES. 2016. EU request for guidance on how pressure maps of fishing intensity contribute to an assessment of the state of seabed habitats. In Report of the ICES Advisory Committee, 2016. ICES Advice 2016, Book 1, Section 1.6.2.4. 5 pp

ICES. 2017. EU request on indicators of the pressure and impact of bottom-contacting fishing gear on the seabed, and of trade-offs in the catch and the value of landings. ICES Special Request Advice 2017.13, ICES, Copenhagen, 27pp.

ICES. 2018. Workshop on scoping for benthic pressure layers D6C2 - from methods to operational data product (WKBEDPRES1), 24–26 October 2018, ICES HQ, Copenhagen, Denmark. ICES CM 2018/ACOM:59. 62 pp.

ICES. 2019. Interim Report of the Working Group on Fisheries Benthic Impact and Trade-offs (WGFBIT), 12–16 November 2018, ICES Headquarters, Copenhagen, Denmark. ICES CM 2018/HAPISG:21. 74 pp.

# 2 Concepts

## 2.1 Defining physical loss

WKBEDLOSS has defined physical loss as any human-induced permanent alteration of the physical habitat from which recovery is impossible without further intervention.

### 2.1.1 Defining "physical habitat"

Within this definition the EUNIS level 2 habitat (Evans *et al*. 2016, Table 1) classifications were chosen as the basis for the assessment of physical loss. Here, physical loss from a human activity would be denoted by a shift in habitat type from one category to another (e.g. MA6 to MA3). The Commission Decision (EU) 2017/848 notes that physical loss may also arise from permanent changes in seabed morphology. As this can be open to interpretation relating to scale, WKBEDLOSS has constrained the definition to EUNIS level 2 habitat change only. This approach will facilitate a European sea-wide assessment that is comparable.

**Table 1 EUNIS level 2 habitat types (Evans *et al*. 2016).**

| | | | Hard/firm | | Soft | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Rock* | Biogenic habitat** | Coarse | Mixed | Sand | Mud |
| Depth Zones | Phytal gradient/ hydrodynamic gradient | Littoral | MA1 | MA2 | MA3 | MA4 | MA5 | MA6 |
| | | Infralittoral | MB1 | MB2 | MB3 | MB4 | MB5 | MB6 |
| | | Circalittoral | MC1 | MC2 | MC3 | MC4 | MC5 | MC6 |
| | Aphytal/ hydodynamic gradient | Offshore circalittoral | MD1 | MD2 | MD3 | MD4 | MD5 | MD6 |
| | | Upper bathyal | ME1 | ME2 | ME3 | ME4 | ME5 | ME6 |
| | | Lower bathyal | MF1 | MF2 | MF3 | MF4 | MF5 | MF6 |
| | | Abyssal | MG1 | MG2 | MG3 | MG4 | MG5 | MG6 |

*** Includes soft rock, maerl, clays, artificial hard substrata**

**** These are habitats where animals or, more rarely, plants form a substrate for other organisms to attach to.**

Note that the MSFD broad habitat types (Decision (EU) 2017/848, Table 2) are based on the EUNIS level 2 habitat types, but some EUNIS level 2 habitats are merged into one MSFD broad habitat type. For example, EUNIS level 2 habitats MA1 and MA2 are merged into a single MSFD broad habitat type. The same principle applies to MG1, MG2, MG3, MG4, MG5 and MG6. Given the higher resolution in habitat type, WKBEDLOSS opted to use the EUNIS level 2 habitat types, rather than the (lower resolution) MSFD broad habitat types, particularly as this facilitates a consistent assessment of physical loss through a change in substrate type at EUNIS level 2, which cannot be done for some of the merged MSFD broad habitat types, such as littoral sediment.

### 2.1.2 Physical loss typology

WKBEDLOSS distinguished between three types of physical loss: sealed physical loss, unsealed physical loss and the loss of biogenic habitat. This distinction is necessary as data flows recording physical loss differ according to these types. Sealed loss is largely informed by the distribution of structures placed in the marine environment (e.g. wind turbines, port infrastructure) and substrates introduced to the marine environment (e.g. dredge disposal sites). Unsealed loss is largely informed by the distribution of seabed habitat change (e.g. at aggregate extraction sites). The loss of biogenic habitat necessitates an assessment of the historical distribution of the habitat.

Loss of non-biogenic habitats can be defined by the way that loss arises: sealed or unsealed. Sealed loss, in general, arises where structures or substrates have been introduced which in and of themselves change the physical habitat. Unsealed loss results from changes in physical habitat due to alterations in physical habitat resulting from an activity or activities and from the indirect effects of placement of man-made structures (e.g. a structure causes changes in water flows that lead to removal of fine sediment and ultimately change the EUNIS level 2 sediment class). Examples of sealed and unsealed loss are provided in Table 3.

Biogenic habitats are habitats where animals or, more rarely plants, form a hard substrate for other organisms to attach to (Evans *et al*., 2016). Such physical habitats are distinct as they are characterised by living, habitat-forming species that are more easily impacted or disturbed by human activities than other physical substrates and often exhibit very slow recovery responses. These habitats often have limited spatial extents, compared with habitats formed of rock or sediment, and may be challenging to assess within broad-scale regional assessments.

### 2.1.3 Defining "recovery" and "further intervention"

Recovery in the context of physical loss indicates the re-establishment of the original natural EUNIS level 2 habitat (i.e. human intervention). Similarly, where human interventions have been put in place to initiate recovery, recovery would be regarded to have taken place in instances where the physical habitat is returned to its initial classification (e.g. removal of man-made structures from the seabed, restoring the original substrate by deposition, or re-introducing species in the case of loss of biogenic habitat).

The removal of offshore platforms during their decommissioning is an example of an intervention leading to recovery of the physical habitat. However, if rigs are partially removed where, for example, there has been an adoption of a "rigs to reefs" strategy, this will still count as loss to the extent that the footprint of the structure remains. Similarly, it is envisioned that shallow water structures such as wind farms will have to be removed at the end of their life cycle and the seabed will need to be physically restored to the original substrate.

Currently there is no mention of 'loss reversal' or 'physical gain' in Commission documentation for MSFD. However, with the exception of land claim, there is little actual net loss of physical seabed, as loss is always offset by some kind of transformation to a different physical substrate type, even though it may be artificial. In the case of introduction of hard structures, these can form artificial reefs. However, they represent a clear physical loss of the natural seabed. Artificial reefs are also a similar case, as they are purposefully installed to provide hard substrate to increase biodiversity, block areas and provide recreational services, but at the same time change the local EUNIS level 2 habitat type. It should be noted that the definition of loss within WKBEDLOSS does not allow the quantification of loss reversal or physical gain as defined by these examples. Loss reversal will be possible for some habitats with different interventions ranging from minimal intervention (i.e. stopping activities causing harm, applying spatial management measures), to removing problems (e.g. grazers), rebuilding structure (e.g. by adding 3-d supports), abiotic interventions at the seabed (e.g. aerating sediments), as well as active restoration (by transplanting red corals, kelp forests, oysters etc.). The level of interventions applied will be shaped by the restoration motivations including for example 'bringing nature back' (e.g. aiming to loss reversal) or 'building with nature' (e.g. opting for soft engineering solutions causing less harm but not reversing loss) (Ounanian *et al.* 2018). Loss reversal is required under the EU Biodiversity Strategy 2020 under Target 2 that aims to restore 15% of damaged/degraded ecosystems in the EU (EU 2011) in line with the Convention on Biological Diversity Aichi targets. New discoveries of pockets of lost or perceived lost habitats could also count as loss reversal/ habitat gain depending on scale (see recent discoveries in Boavida *et al*. 2016, Garrabou *et al*. 2017, Corriero *et al*. 2019). Of course an accounting system for loss (and change between habitat types) requires among others an agreed baseline and threshold (see below).

### 2.1.4 Physical loss and physical disturbance

The definition of physical loss adopted by WKBEDLOSS is a clarification of the definition provided by WKBEDPRES1.

The WKBEDPRES1 defined physical disturbance as activities that physically disturb benthic biota and the seabed, but do not change the physical habitat permanently even when full recovery would take longer than 12 years, as long as recovery to the original state can be expected given enough time. Disturbance activities would hence still leave the same EUNIS level 2 habitat in place after the activity has ceased.

To clarify recovery, and the distinction between loss and disturbance, WKBEDLOSS uses the definition "*impossible without further intervention*" rather than "given enough time". Within this definition of loss, disturbance-causing pressures might lead to loss if the intensity, extent, or frequency of the pressure, combined with local environmental conditions, causes a change in EUNIS level 2 habitat from which recovery is impossible without further intervention. Some examples of differences are given in Table 2.

**Table 2. Similar activities that might cause either loss or disturbance**

| Activity | Impact | Loss/Disturbance |
|---|---|---|
| Aggregate extraction – deep penetrating (example 1) | Where removal changes the EUNIS level 2 habitat type | Loss |
| Aggregate extraction – deep penetrating (example 2) | Where removal does not change the EUNIS level 2 habitat type | Disturbance |
| Aggregate extraction intense activity (e.g. high intensity and/or high regularity) | Where the activity eventually effects changes to sediment that results in a change in EUNIS level 2 habitat type | Loss |
| Bottom-contacting fishing – intense activity | Where the activity eventually effects changes to sediment that results in a change in EUNIS level 2 habitat type | Loss |
| Aggregate extraction where changes in morphology change sedimentation patterns through time | Long-term change in EUNIS level 2 habitat | Loss |
| Placement of renewable structures - dredging activities during development period | No change EUNIS level 2 habitat | Disturbance |
| Placement of renewable structures – construction of pilings | Change to EUNIS level 2 habitat | Loss |
| Placement of renewable structures – change to hydrography | Resulting in changes to EUNIS level 2 habitat | Loss |

Where historical activity records are not available, but the current physical habitat is clearly different from what can be considered as "natural seabed" under D6C1, this should be described as physical loss.

## 2.2 Setting the baseline

**Article 4 of the Commission Decision (EU) 2017/848** states that the threshold values relating to GES shall be based on time series that are appropriate for the assessment. As loss brings about permanent changes to the seabed, and given the definition above, all historical loss-causing activities are therefore relevant to the assessment. Conceptually, physical loss includes physical loss at the current date of an assessment which is caused by all recent and historic human activities within the marine environment. Physical loss hence includes loss from activities which may or may not have been monitored or documented.

For D6C2, reference sites (undisturbed areas of seabed) can be used as a baseline to compare against sites that have been disturbed by an activity (e.g. bottom trawling). This relationship or difference can be used to assess the overall condition of benthic habitats affected by disturbance and can be used to guide discussions for setting a level that is acceptable in terms of ecosystem health (i.e. GES). WKBEDLOSS notes that in order to assess/report an overall percentage of habitat loss, reference sites are of no use: the natural EUNIS level 2 habitat is either still there (i.e. no physical loss) or it is no longer there (i.e. physical loss). Therefore, the assessment of D6C1 requires an acceptance of the natural spatial distribution of each habitat type as the baseline and to report physical loss as the fraction of that habitat. It was further noted that for some biogenic habitats, a historic distribution may need to be derived to be able to report on particular habitats that may have been widespread and are now lost. This may however require managerial/policy choices on how far back data relating to historic distributions are sought and may need to be done on a case by case basis, specific for each biogenic habitat type.

## 2.3 Common currency (bed loss and disturbance)

A common currency should be used in the assessment of physical loss, as provided in Commission Decision (EU) 2017/848. Loss can be given as extent in square kilometres, or percentage loss per EUNIS level 2 habitat. Similar common metrics are used under D6C2.

## 2.4 References


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# 3 Human activities causing physical loss

## 3.1 Identifying human activities causing physical loss

WKBEDLOSS considered the physical loss caused by a wide range of human activities (Table 3) across seven EU ecoregions (Baltic Sea, Celtic Seas, Belgian EEZ, French Bay of Biscay (BoB), Romanian EEZ in the Black Sea, and Mediterranean Sea). WKBEDLOSS based this scoping exercise on the WKBEDPRES1 work (table 2.1.1 in their report) which examined activities drawn from the revised MSFD Annex III Table 2b (Commission Directive (EU) 2017/845). Here activities were classified as causing "physical disturbance" or "physical loss" or were regarded as "not directly relevant". During this exercise some activities classified as causing only physical disturbance by WKBEDPRES1 were revised as they were viewed by WKBEDLOSS as potential causes of physical loss. These were demersal fishing, dredging and deposition of material, and cables. All of the activities causing loss were present in each of the 7 regions, with a few exceptions (e.g. Romania and Belgium do not have marine aquaculture, there is no oil-gas extraction in French BoB, and the Mediterranean Sea does not have marine wind farms yet, although these are planned for the future, along with more oil-gas extraction (Piante & Ody 2015). Two worked examples are presented below based on MSFD reporting and GIS spatial outputs.

**Table 3. Activities causing physical loss within EU ecoregions. The activities were assessed to cause either physical loss (Lo) or both physical loss and disturbance (Lo/Di) (activities marked green), were classified as causing sealed or unsealed habitat loss, and characterised by the time lag for the physical loss to occur (instant/intermediate/long). N.D.R., not directly relevant to physical loss, nor disturbance.**

| Activity | Loss, Disturbance, or both | Sealed / unsealed | Time lag for loss to occur |
|---|---|---|---|
| Fish and shellfish harvesting (professional, recreational) | Lo/Di | unsealed | very long |
| Restructuring of seabed morphology, including dredging | Lo/Di | unsealed | instant/intermediate |
| Extraction of minerals (rock, metal ores, gravel, sand, shell) | Lo/Di | unsealed | instant /intermediate / long |
| Restructuring of seabed morphology, including depositing of materials | Lo/Di | sealed | instant/intermediate |
| Transport infrastructure | Lo | sealed | Instant |
| Aquaculture — marine, including infrastructure | Lo/Di | sealed | Instant |
| Renewable energy generation, including infrastructure | Lo/Di | sealed | Instant |
| Tourism and leisure infrastructure | Lo | sealed | Instant |
| Coastal defence and flood protection | Lo/Di | sealed | Instant |
| Land claim | Lo | sealed | Instant |

| Activity | Loss, Disturbance, or both | Sealed / unsealed | Time lag for loss to occur |
|---|---|---|---|
| Canalisation and other watercourse modifications | Lo | sealed | Instant |
| Military operations (subject to Article 2(2)) | Lo/Di | sealed | Instant |
| Transmission of electricity and communications (cables) | Lo/Di | sealed | Instant |
| Extraction of oil and gas, including infrastructure | Lo/Di | sealed | Instant |
| Offshore structures (other than for oil/gas/renewables) | Lo | sealed | Instant |
| Marine plant harvesting | Di | | |
| Hunting and collecting for other purposes | Di | | |
| Transport — shipping (including anchoring) | Di | | |
| Research, survey and educational activities | Di | | |
| Tourism and leisure activities (including anchoring) | Di | | |
| Extraction of salt | Di | | |
| Extraction of water | Di | | |
| Non-renewable energy generation | N.D.R | | |
| Fish and shellfish processing | N.D.R | | |
| Aquaculture — freshwater | N.D.R | | |
| Agriculture | N.D.R | | |
| Forestry | N.D.R | | |
| Transport — air | N.D.R | | |
| Transport — land | N.D.R | | |
| Urban uses | N.D.R | | |
| Industrial uses | N.D.R | | |
| Waste treatment and disposal | N.D.R | | |

## 3.2 Examples

### 3.2.1 Black Sea, Romanian waters example

For the assessment of the seabed habitat loss, carried out within the MSFD scope for the second reporting cycle, in 2018, the activities that have been taken into consideration in the entire Romanian Economic Exclusive Zone (22500 km²) were the following:

1. **Transport infrastructures (**Figure 3) (marine ports) produce loss of infralittoral sediments by regular dredging and dredged material deposits for maintenance. As dredged materials are deposited within the port area, maintenance works were included here. Under Water Framework Directive these kinds of water bodies were considered as heavily modified, as the communities inhabiting them consist from opportunistic species, resistant to pollution. The construction themselves are older than 40 years, but some ports have been extended and modernized in the last 30 years (e.g. Constanta). The extent of the area affected by the transport infrastructures represents 0.16% of the EEZ.

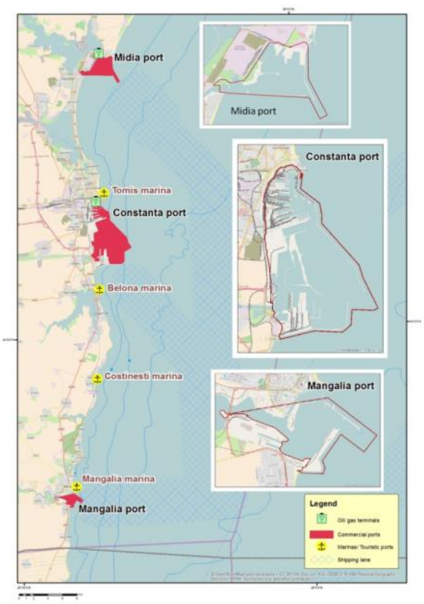


**Figure. 3. Transport infrastructures (ports and marinas) in Romania (source: MARSPLAN-BS project)**

2. **Restructuring of seabed morphology, including dredging and depositing of materials** (Figure 4) – include natural hydro-morphological processes in coastal areas such as erosion/accretion and dumped sediments from dredging of navigation channels. The extent of natural hydro-morphological coastal processes was assessed as 0.03% of EEZ. Natural processes have been amplified by human activities (such as the channel dikes that modified the hydrodynamic processes and the configuration of the emerged and submerged beaches), but the extent of human intervention is unknown. The amount of dumped sediments resulted from dredging of navigational channels, is unknown due to lack of data.

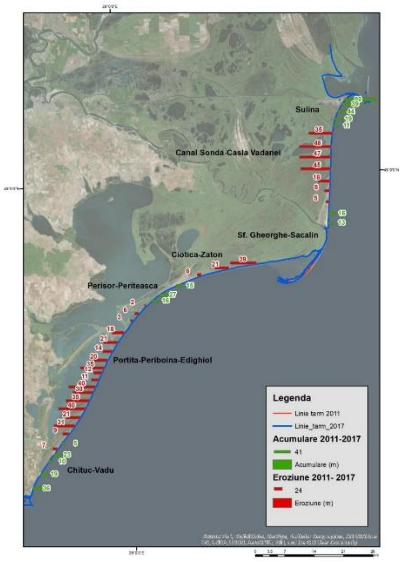


**Figure. 4. Coastal processes (erosion/accretion) (source: NIMRD monitoring programme)**

3. **Extraction of minerals (rock, metal ores, gravel, sand, shell) (**Figure 5) – sediments extracted from the circalittoral zone used for beach nourishment, ongoing activity, representing 0.01% of the EEZ. In order to reduce the risk of coastal erosion and extend the tourist beaches, in 2011, the strategic coastal Master Plan for Coastal Protection was updated, promoting investments to protect the environment from erosion risks in the most affected areas. In 2014/15, in the first phase, 5 priority projects were implemented, including the following activities:
    - Rehabilitation of breaking wave type structures and building the new dikes as a conservation measure, for retaining beach sand and increasing the shore stability.
    - Beach nourishment of 6 km along the littoral zone (the sand was extracted from circalittoral areas).

The second phase of the project will start later in 2019, and is expected to increase the amount of sediment extracted.

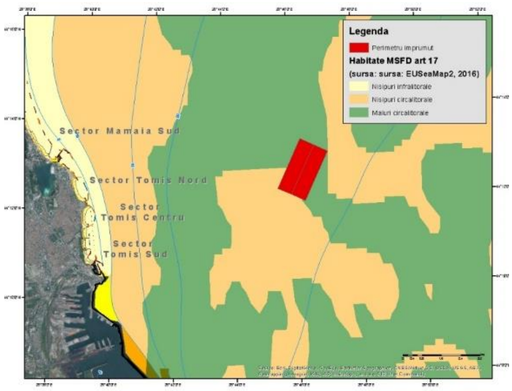


**Figure 5. Location of sand extraction site (source: NIMRD monitoring programme)**

4. **Coastal defence and flood protection** (Figure 6) – dikes, groins, shore reinforcements, activities implemented regularly in the last century for coastal protection against erosion of tourist beaches. This kind of activities will continue in the future. Data used for the assessment originate from annual national monitoring programme, including GPS measurements, aerial images, and satellite data. The extent of coastal defence infrastructure was assessed as 0.005% of the EEZ.

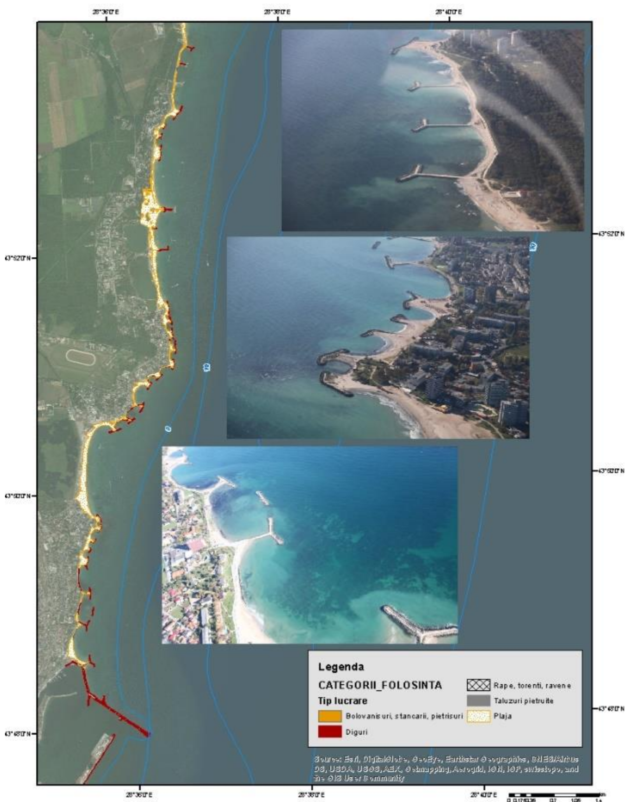


**Figure. 6. Coastal defence infrastructures (source: NIMRD database)**

5. **Land claim** (Figure 7) refers to beach nourishment for tourist purpose and relates to the activities explained above (extension of coastal defence system and sand extraction). The extent of new rehabilitated beaches was assessed as 0.002% of EEZ.


**Figure.7. Beach nourishment and coastal defence (source: NIMRD monitoring programme) (yellow - emerged beach, black grids - submerged disturbed/lost areas)**

6. **Canalisation and other watercourse modifications** (Figure 8**)** include the navigation channels connecting Danube river with the Black Sea and represent less than 0.001% of the EEZ.

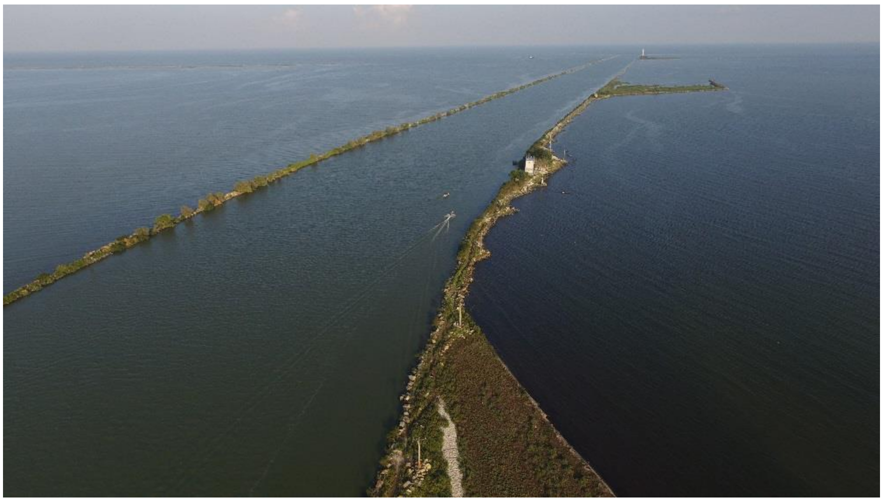

**Figure. 8. Protection dikes of Sulina channel (Danube branch) (source: NIMRD database**

7. **Extraction of oil and gas, including infrastructure** (Figure 9) – offshore platforms for exploitation of oil and gas and drilling pits. The activity developed in the last 50 years, but most of them are recently established (10 years). The extent of the area was assessed as 0.03% of EEZ, representing the footprint of the drilling pits (calculated as average value of 250m buffer) in the licenced areas.

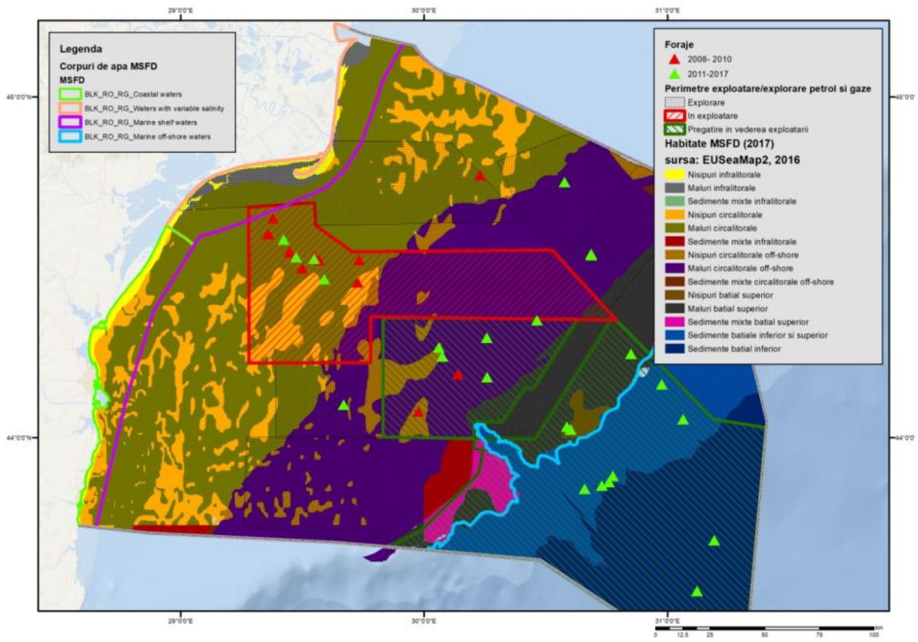


**Figure.9. Oil and gas exploration and exploitation platforms (red polygon – exploitation perimeter, green polygons - in preparation for exploitation in the next 10 years, black polygons in exploration; red triangles – drillings carried out between 2008 and 2010; green triangles – drillings in 2011–2017) (source: NIMRD database)**

8. **Tourism and leisure infrastructure** (Figure 10**)** include marinas (touristic ports – 4 in Romania) which occupy a very small surface, less than 0.14 km², representing less than 0.0001% of EEZ.

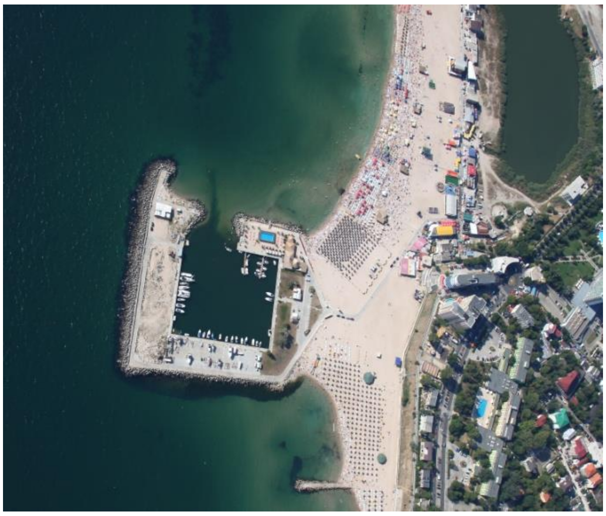

**Figure. 10. Touristic port (source: NIMRD database)**

9. **Transmission of electricity and communications (cables) –** there is one communication cable in the Romanian marine area, no data on its surface or period when it was installed.
10. **Aquaculture — marine, including infrastructure – this activity does not exist in Romania**, but it is well developed in other parts of the Black Sea (e.g. Bulgaria).

For the activities implemented in the coastal area, due to the lack of data it was not possible to assess the loss for each broad habitat type. Using the available EUSeaMap data (EMODnet 2016), we have assessed the loss for each broad habitat type only for the activities connected with oil and gas extraction, on circalittoral and offshore circalittoral habitats, expressed in km², as shown in Table 4.

**Table 4. Habitat loss for each broad habitat type in Romania**

| Habitat (source: EUSeaMap2, 2016) | Assessment area | Lost and affected area (km²) 250 m buffer for each drilling |
|---|---|---|
| Circalittoral mud | BLK_RO_RG_MT01 | 2.6 |
| Circalittoral sand | BLK_RO_RG_MT01 | 0.2 |
| Off-shore circalittoral mud | BLK_RO_RG_MT01 | 1.8 |
| Off-shore circalittoral sand | BLK_RO_RG_MT01 | 0.4 |
| Upper bathyal mud | BLK_RO_RG_MT01 | 0.8 |
| Upper and lower bathyal | BLK_RO_RG_MT01 | 1.6 |

### 3.2.2 North Sea Belgian waters example

In complement to the Black Sea activities contributing to seabed habitat loss, some typical examples are given here for the Belgian part of the North Sea (BPNS).

For the BPNS, the following activities were reported as physical loss in the 2018 MSFD assessment report (Van Lancker *et al*., 2018): (1) piles and radar station; (2) wind farms; (3) wrecks; (4) energy cables (gravel cover); (5) pipelines (gravel cover) and (6) telecommunication cables (Figure 11). In total, this amounts to 8.49 $km^2$ or 0.25% of physical loss with respect to the surface area of the BPNS (Figure 12). The largest contribution comes from three major pipelines transporting gas from Norway. Due to their protective gravel cover they account for 8.08 $km^2$ or 95% of the total loss. Presently, coastal infrastructure and coastal defence works are not accounted for in the Belgian reporting, since the intertidal zone does not come under the Federal Authorities' responsibility.

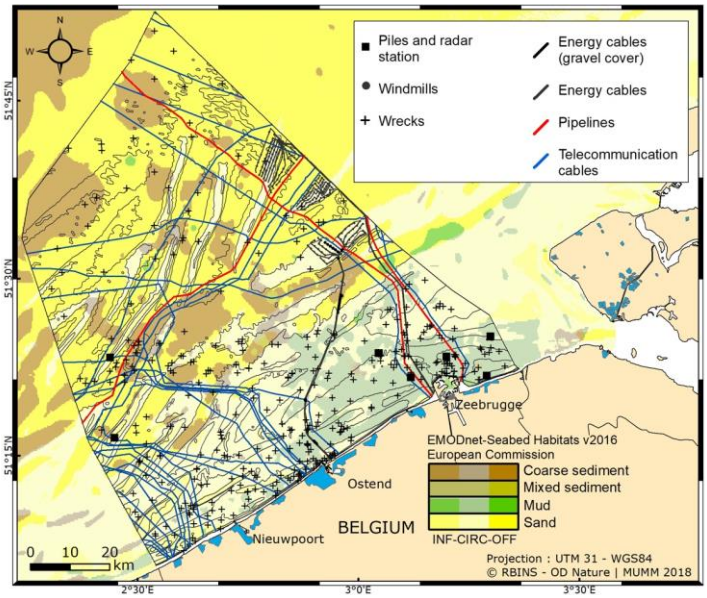


**Figure 11. Activities contributing to physical loss in the Belgian part of the North Sea (3454 km²), overlain on the distribution of EUNIS level 2 habitat types (INF: Infralittoral; CIRC: circalittoral; OFF: offshore circalittoral) (Van Lancker *et al*., 2018).**

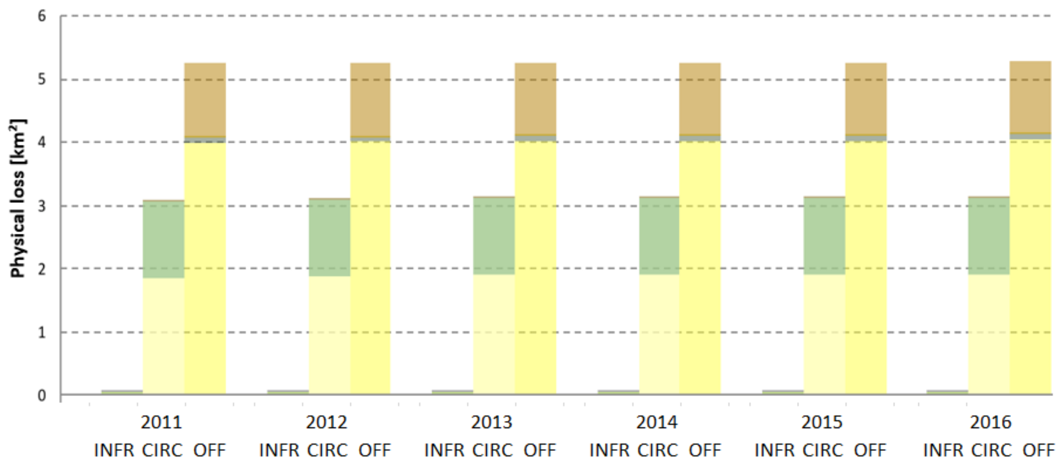


**Figure.12. Cumulative physical loss per EUNIS level 2 habitat type, Belgian part of the North Sea (3454 km²) (legend and colour scale, see Van Lancker *et al.,* 2018).**

Cumulatively, up to 2016, the effective footprint of structures associated with wind farm implantation (turbines, energy cables and their protective cover) account for less than 0.01% of the BPNS. This is derived from data from three windfarms, comprising 160 wind turbines, and three offshore transformation stations (OTS), all with associated cabling and protective gravel or rock covers. By the end of 2018, an installed capacity of 1.152 GigaWatt, consisting of 274 wind turbines and five OTS were operational. Still, the activity is growing rapidly, and 400 to 430 wind turbines are envisaged by 2020. A renewed marine spatial plan, becoming effective in 2020, foresees a new zone to install an extra capacity of around 2 GigaWatt. In terms of designated area for renewable energy, the present zone occupies 7 % of the BPNS; which would be extended to about 12.4 % after 2020.

In the 2018 MSFD reporting, only sealed loss from artificial hard structures and cables and pipelines is reported. However, locations exist where anthropogenic activity led to a loss of the naturally occurring habitat type. This might be the case when long-term disposal of dredged material led to accumulation of muddy to clayey deposits on top of naturally occurring sands (Figure 13). Also, cases of unsealed loss are studied, e.g. where aggregate extraction altered the EUNIS level 2 habitat through depletion of the upper Holocene sediment cover exposing the underlying Pleistocene or Palaeogene sediment layers (Figure 14) In both cases, repetitive *in situ* surveying will need to confirm the irreversibility of the change to distinguish between loss (cf. no recovery without intervention) or disturbance.

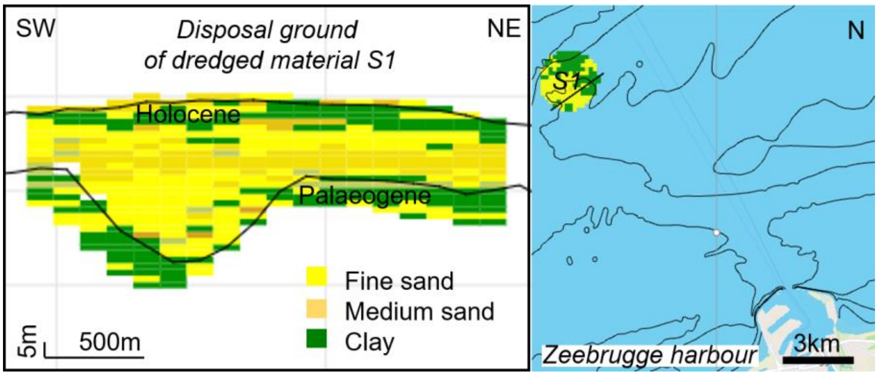


**Figure. 13. Sealed physical loss as a result of disposal of dredged material, here illustrated for the S1 disposal ground of dredged material, Belgian part of the North Sea (subsurface view via TILES consortium, 2018; transect shown in the right panel).**

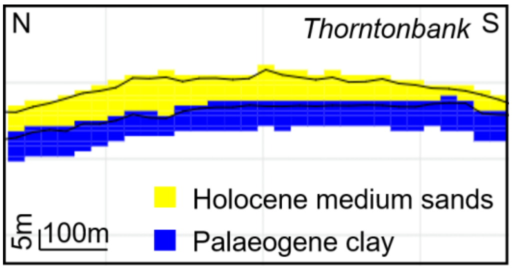


**Figure.14. Unsealed physical loss as a result of long-term aggregate extraction, here illustrated for the Thornton-bank, Belgian part of the North Sea. Continuing extraction along the southern flank of the sandbank will deplete the Holocene cover changing the habitat from sand to clay (subsurface view via TILES consortium, 2018).**

The MSFD reporting on physical loss and disturbance is available on-line: https://odnature.naturalsciences.be/msfd/nl/assessments/2018/page-d6 (Van Lancker *et al*, 2018), as well as the full report on the quantification of changes ('Bijlage D6', Kint *et al*., 2018). INSPIRE-compliant data layers (WMS/WFS) are available at http://geoserver.bmdc.be/MSFD/ows?version=2.0.0. The general WFS link is http://geoserver.bmdc.be/ows?version=2.0.0.

## 3.3 References

Commission Decision (EU) 2017/848 of 17 May 2017 laying down criteria and methodological standards on good environmental status of marine waters and specifications and standardised methods for monitoring and assessment, and repealing Decision 2010/477/EU.

EMODnet broad-scale seabed habitat map for Europe (2016), licensed under CC-BY 4.0 from the European Marine Observation and Data Network (EMODnet) Seabed Habitats initiative (www.emodnet-seabedhabitats.eu), funded by the European Commission.

Kint, L., Montereale Gavazzi, G. & Van Lancker, V., 2018. Kaderrichtlijn Mariene Strategie. Beschrijvend element 6: Zeebodemintegriteit. Ruimtelijke analyse fysisch verlies en fysische verstoring. Brussel, Koninklijk Belgisch Instituut voor Natuurwetenschappen, 41 p.

Piante C., Ody D. (2015). Blue Growth in the Mediterranean Sea: the Challenge of Good Environmental Status. MedTrends Project. WWF-France. 192 pages.TILES Consortium 2018. Aggregate Resource Decision-support Tool: http://www.bmdc.be/tiles-dss. Belspo Brain-be project TILES (Transnational and Integrated Long-term Marine Exploitation Strategies, BR/121/A2/TILES).

Van Lancker, V., Kint, L. & Montereale Gavazzi, G. (2018). Fysische verstoring en verlies van de zeebodem (D6). In: Belgische Staat. Evaluatie van de goede milieutoestand van de Belgische mariene wateren. Kaderrichtlijn Mariene Strategie. BMM, Federale Overheidsdienst Volksgezondheid, Veiligheid van de Voedselketen en Leefmilieu, Brussel, België, 24 pp.

# 4 Description of data flows

## 4.1 Sealed and unsealed physical loss data flows

### 4.1.1 Footprints and buffer zones

If data is provided as point locations or lines, footprints need to be applied (Figure 15).

- Point locations (e.g. indicated position of a wind turbine): should be submitted as polygon not poly-points. The polygon would be the footprint of the individual structure. If the structure is raised, then the footings only count, or if it is a floating structure then only the moorings/anchors count as the footprint.
- Lines (e.g. cables or pipelines): should be submitted as polygons not poly-lines. The polygon would be the width of the cable/pipeline, plus the width of any overfill used (if substrate differs to the surrounding seabed). If a cable/pipeline is buried deeper than the biotic layer (e.g. 30-50 cm), then it would not count towards physical loss assumed it is covered by the natural seabed substrate. If the pipeline is raised, then only the footings count to its footprint. Industry should report on the status of the cable installation.

Buffer zones (area of potential impact that extends beyond the footprint) can apply to both disturbance and loss. Here, the zone of loss may be extended due to long-term hydrographical changes from the water flow around a structure (scouring leading to change of EUNIS level 2 habitat type).

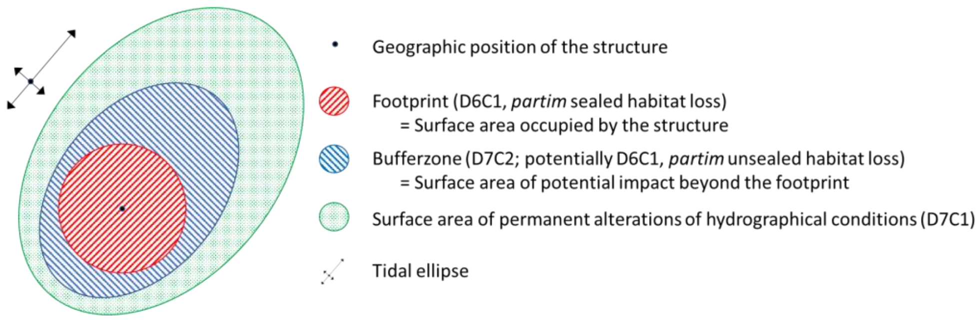


**Figure.15. Area of influence around a structure with reference to physical loss (D6C1) and hydrographical alterations (D7C1 and D7C2).**

For some activities, the actual footprint of sealing and therefore physical loss, is only a part of the licensing zone. The use of the licensed zone gives an overestimate of the area lost and efforts should be made to map the actual footprint and buffer zone (e.g. offshore wind farms). Similarly, at some point during the unsealed loss-causing activity there may be loss, but not across the entire licensable extent of the activity (e.g. aggregate extraction). See Foden *et al*. (2011) for a comprehensive overview on how to estimate the spatial extent of human activities.

### 4.1.2 Data flow for activities causing "sealed" physical loss

1. Identify the MSFD-competent authorities

It is recognised that most sealed loss data will be held by the relevant licensing authorities within member states. The spatial data for physical infrastructures occurring at sea might be derived from the licensing and permitting processes for several activities. However, for some activities, regional or European-wide datasets from member states exist which can be used.

2. Request spatial data (preferably in shapefile or CAD format) and attribute information (see Table 5) for each activity:
    a) Type of activity (e.g. activity, structure type, licence information,…)
    b) Geographic location, preferably in polygon format
    c) Dates/timing/period of the operational phases (as an attribute for the activity, included in the attribute table)
3. Assess footprint either directly from the data at hand or, if original data is points or polylines (and not a polygon), a footprint should be estimated
4. Assess and document the level of confidence for each feature in the attribute table.
5. Archive INSPIRE-compliant metadata and document on data processing (e.g. assessing footprint from points or polylines)

**Table 5. Human activities, advised data sources and specificities with regard to the data call for physical loss reporting.**

| Activity | Data sources (including some known regional sources) | Specific definitions for details in the data call/ data flow, e.g. buffers to derive the foot print |
|---|---|---|
| Restructuring of seabed morphology, including depositing of materials | National data call, or if not possible: national reporting through OSPAR and HELCOM | - Information by type on area should be provided from licensing.<br>- information on deposition method and hydrodynamic condition (local or dispersive)<br>- Type of deposited sediment and natural substrate in the deposition area |
| Transport infrastructure | National data call | Information by type on area should be provided from licensing or by national port administration |
| Aquaculture — marine, including infrastructure | National data call | - Footprint depends on the aquaculture method and species<br>- Information on area should be estimated based on the installation type and moorings |
| Renewable energy generation, including infrastructure | National data call (for wind farms, only licensed areas as large polygons are available through EMODnet Human activities) | Information on area should be estimated based on the installation type and moorings from licensing or EIAs |
| Tourism and leisure infrastructure | National data call | Information on area should be provided from licensing or by administration |
| Coastal defence and flood protection | National data call | Information on area should be provided from licensing or by administration |
| Land claim | National data call | - Information on area should be provided from licensing or by administration<br>Note: For land claim the initial coastline should be identified, if possible |
| Canalisation and other watercourse modifications | National data call | Information on area should be provided from licensing, EIAs or by administration |
| Military operations (e.g. munition dump sites) | National data call, existing data sources on munition dump sites (OSPAR, HELCOM, EMODnet) | Information on area of historical munition deposition sites should be provided |
| Transmission of electricity and communications (cables) | National data call | - cables: information on whether cables (or part of cables) are buried inside the sea bed (depth) or protected/covered with gravel or laid straight on the surface of the seabed.<br>- Diameter of the cable (including shielding structure) to be used to estimate needed buffer, if possible |
| Extraction of oil and gas, including infrastructure (oil rigs, pipelines) | National data call, or if not possible: EMODnet / Human activities /Hydrocarbon extraction / Offshore installations, include status of operational and decommissioned | - oil and gas platforms/ drilling pits: information on footprint should be provided from licensing<br>- pipelines: information on whether they are buried inside the sea bed or protected/covered with gravel or laid straight on the surface of the seabed. |
| Offshore structures (other than for oil/gas/renewables) | National data call | - information on footprint should be provided depending on the structure (artificial reefs/wrecks) and mooring, if available |

#### 4.1.2.1 Example 1: data collection on renewable energy infrastructure

Wind farms are currently the most prominent infrastructures introduced to the marine environment. To quantify their actual footprint several information sources are needed (Table 6).

**Table 6** *Data collection need to estimate the actual footprint of a wind farm.*

| Positional data needed | Spatial extent* |
|---|---|
| Wind turbines<br>Protective cover reducing scouring | Depending on foundation, 10 – 15 m radius. |
| In-field cables** and their protective cover | E.g., a radius of 0.075 m for the cable; 1 m for the cover. |
| Export cables and their protective cover<br>Reserve cables** | E.g., a radius of 0.150 m; 1 m for the cover. |
| Offshore transformation station or module (OTS/OTM) | 15 m radius |
| Modular grid platforms | 15 m radius |

***A typical spatial extent is here provided as applied for the windfarms on the Belgian part of the North Sea (Kint *et al*, 2018).**

****For the cables, an extra radius of 5 m may be applied representing the mean width of trench disturbance (Foden *et al.*, 2011)**

The installation of wind farms typically takes place over several phases that may be spread over months to years. The history of each phase is logged and can be traced from the official reporting of the industry to the responsible government authority. Care is needed to obtain actual positions, as laid, contrary to the planned coordinates of the wind turbines as this can differ considerably. Different types of pylon structure exist, each having a different footprint: (1) monopiles, (2) jacket foundations and (3) gravity-based foundations (Figure 16). To account for the spatial extent, radii of respectively 10 m, 15 m and 12.5 m can be used.

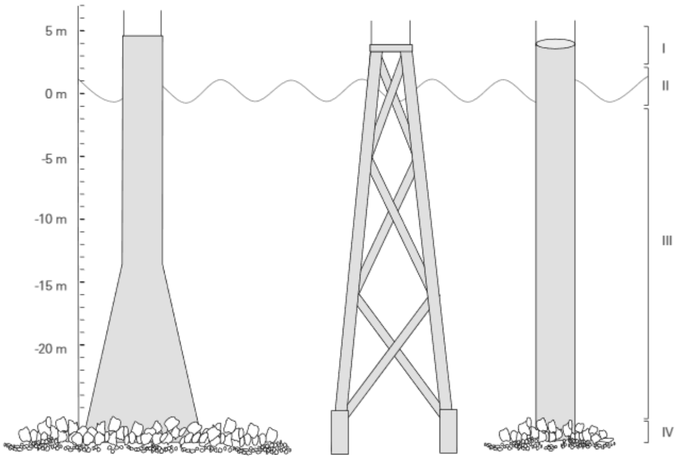


**Figure.16. Different foundation type for the installation of wind turbines. From left to right: gravity-based foundation; jacket foundation and monopile (Degraer *et al.*, 2013).**

Data on positions and timing of the operations can be obtained via national authorities that are responsible for the management of wind farms implantation (Figure 17). Pre-installation works may result in unsealed physical loss and therefore information is needed on pré- and post-EUNIS Level 2 habitats.

There are three main cable types associated with renewable energy: (1) in-field cables, interconnecting the wind turbines, (2) reserve cables, and (3) export cables transporting the energy to land via offshore transformation stations. These are electrical substations where all the energy produced by the wind turbines is brought together and converted by transformers to a high voltage transmission. With the expansions of wind farms, modular grid platforms are installed. These group and connect the offshore produced energy of several windfarms to be injected in the onshore grid system via fewer cables.

In countries where details on the installation phases are not available, spatial data on the licensed areas can be used as a proxy. These data can be obtained via national MSP Portals, or via pan-European data portals such as EMODnet-Human Activities, HELCOM or OSPAR portals. Information is needed on all the activity phases: operational, planned, production, under construction. Attribute tables ideally identify each of the steps in the wind farm implantation, with the successive dates on the operations.

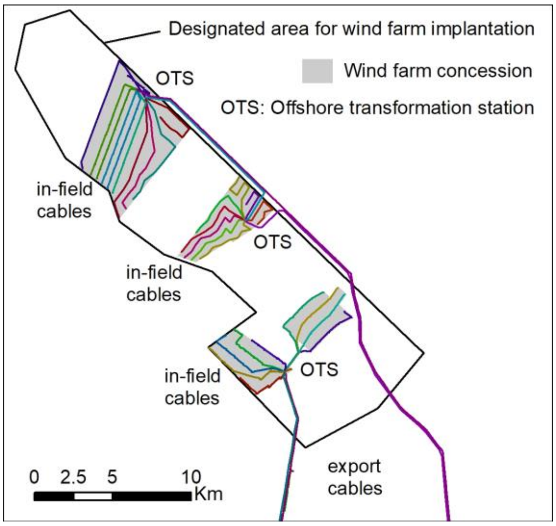


**Figure.17. Spatial extent of a designated wind farm area, compared to licensed area and the effective footprint of the installations. Example from Belgian part of the North Sea (status 2016).**

#### 4.1.2.2 Example 2: extraction of oil and gas, including infrastructures data as an example of existing regional data source

Data on infrastructures relative to oil and gas extraction are available in EMODnet Human activities data portal (Figure 18). The database on offshore installations for hydrocarbon extraction was created in 2015 by Cogea for the European Marine Observation and Data Network (EMODnet). The dataset includes the name and ID number, location, operator, water depth, production start, current status, category and function of the installation. The OSPAR commission source covers data for Germany, Ireland, the Netherlands, Spain and the United Kingdom. In addition, data on Italian offshore installations have been collected and harmonized from the Italian Ministry of Economic Development, from the Norwegian Petroleum Directorate data on Norwegian installations, from the Danish Energy Agency data on Danish installations, from Marine Traffic and HELCOM data on Polish and Russian installations in the Baltic Sea, from Marine Traffic data on Bulgarian, Russian and Ukrainian installations in the Black Sea, Libyan and Spanish installations in the Mediterranean Sea, and from the Croatian Hydrocarbon Agency data on Croatian installations in the Adriatic Sea. The distance to coast (EEA coastline shapefile) has been calculated using the original data map projections, where available. In the other cases it was used the UTM WGS84 Zone projected coordinate system where data fall in.

However, even though regional datasets on extraction of oil and gas infrastructures are available, the data does not provide the footprint of the structure on the seabed. An estimate of the surface area of the footprint needs to be applied to derive the area of physical loss in km².

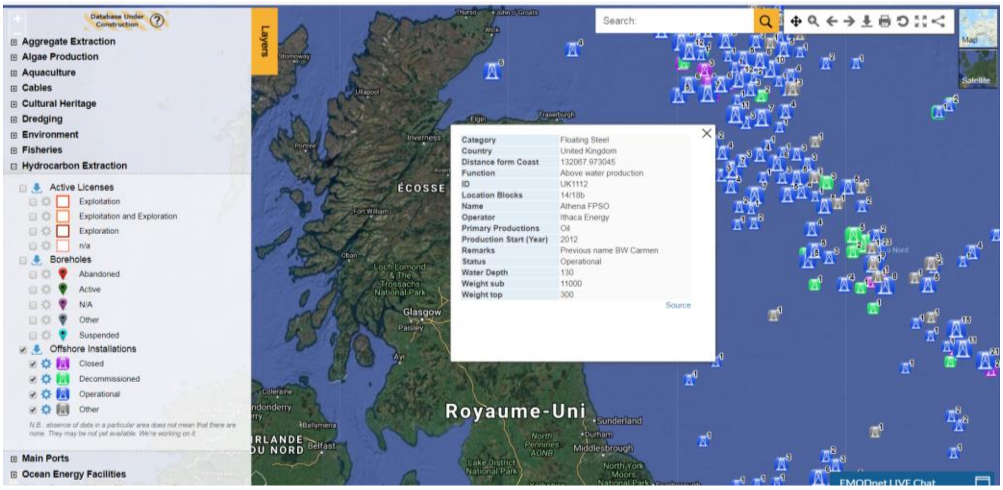


**Figure 18. Point wise data on oil and gas extraction sites are available through EMODnet Human activities data portal.**

## 4.2 Data flow process for activities causing "unsealed" physical loss

Activities that can cause unsealed loss may in some instances result in disturbance (e.g. when the activity is not sufficiently intense or long lasting to lead to a change in EUNIS level 2 habitat type). Hence, mapping unsealed loss requires further qualification following the compilation of activity/pressure data to ascertain if loss rather than disturbance has occurred (including for example from the indirect effects of placement of manmade structures).

Determining if loss has occurred, for example, in the assessment of whether aggregate extraction causes disturbance or loss, is reliant on monitoring of the physical habitat or on modelled severity of the activity (the latter acting as a proxy of loss in the absence of monitoring data and being scientifically validated). Where activities such as aggregate extraction, dredging or fishing (or their combination) are conducted at such a high intensity as to cause changes in the EUNIS level 2 habitat, this falls under the definition of physical habitat loss. In situations where limited monitoring occurs to ascertain changes in EUNIS level 2 habitat, modelled severity of the activity may be used to determine loss, if scientifically validated.

1. **Identify the MSFD-competent authorities**

Here, unsealed loss-causing activity data are needed to define the footprint. The data requirements noted below are specific to their respective activities and this is reflected in the fact that their data flows differ. Since the activities associated with unsealed loss are similar to disturbance activities, the relevant MSFD-competent authorities will be similar to those outlined in WKBEDPRES1.

**Table 7 Human activities, potential data sources and information for a data call**

| Activity | Data sources (including some known regional sources) | Specific definitions for details in the data call/ data flow, e.g. buffers to derive the foot print |
|---|---|---|
| Extraction (e.g. for sand) | National data call, or if not possible: national reporting through OSPAR and HELCOM | - actual footprint (if known).<br>- licensed areas (if footprint not known). Shapefiles may be used.<br>- penetration depth of activity<br>- volume ($m^3$)/ licensed volume<br>- mass (if available)<br>- position, time<br>- vessel type and size<br>- extraction method<br>- EUNIS level 2 habitat type (before and after activity) |
| Dredging (e.g. navigational dredging) | National data call, or if not possible: national reporting through OSPAR and HELCOM | As above. |
| Fishing (e.g. by a specific gear) | National data call, or if not possible: national reporting through OSPAR and HELCOM | If fishing activities are regarded to have caused loss, the footprint can be calculated using the swept area method outlined in WKBEDPRES1, e.g. vessel by métier and application of standardised swept area metrics relating to gear. When applied to derived tow length this calculates swept area ($km^2$).<br>- broad-scale habitat type (before and after activity) |

2. **Request spatial data (preferably in shapefile, raster or CAD format) and attribute information (see Table 7) for each activity:**

    a) Type of activity (e.g. activity, license information if applicable)
    b) Geographic location, preferably in polygon or raster format
    c) Dates/timing/period of the activity

Data requirements for unsealed loss are similar to those noted in WKBEDPRES1. Schematics of these flows are shown below.

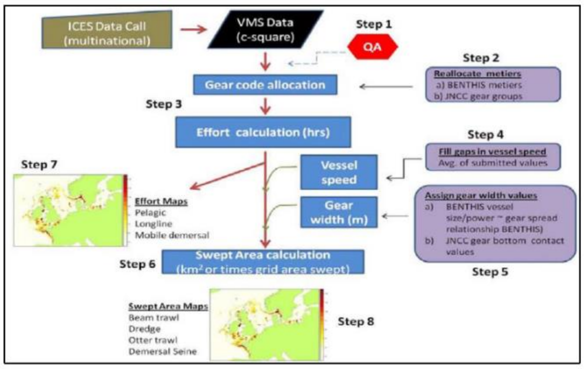


Figure 4.2.1. Workflow for production of swept area ratio (SAR) maps from aggregated VMS and logbook data in c-squares of 0.05x0.05 degrees (ICES 2015)

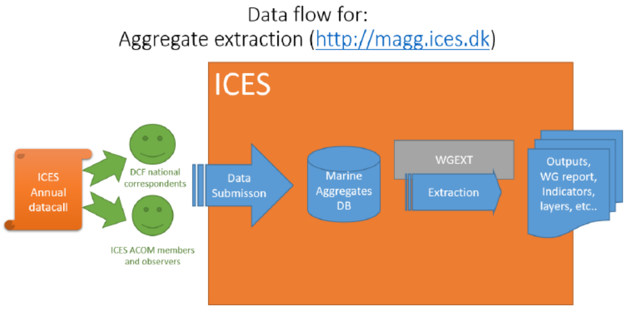


Figure 4.3.1. Data flow for aggregate extraction

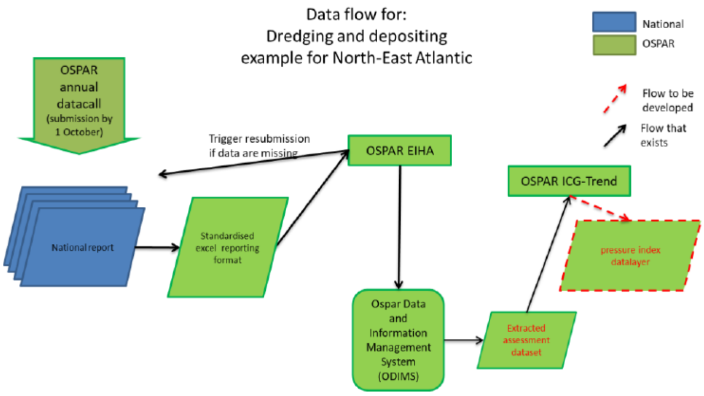


Figure 4.4.1. Data flow example for dredging and depositing.

Although the data flows described by WKBEDPRES1 and above are suitable in most part for recording loss, in all three cases above, data relating to EUNIS level 2 habitat type is required (derived from monitoring data and/or from models). A guide to how this might be done is given below.

**Further monitoring required to determine loss from existing data flows:**

Due to high monitoring costs associated with determining loss, a targeted monitoring approach may be adopted in assessments by member states. However, in devising a monitoring strategy, it should also be noted that loss on the wider scale can happen and should therefore form part of monitoring efforts.

It should be noted that sealed loss, acting through permanent changes in hydrographical conditions, may also result in unsealed loss. Determining the extent of unsealed loss will require further monitoring effort. Since loss patterns may be predictable, such monitoring may be guided or even partially replaced by hydrographical models. Such modelling is likely to be data hungry, reliant on data relating to the sealed loss involved, hydrographical conditions, and sediment type. It should be noted that methods for assessing unsealed loss resulting from sealed loss have been developed (O'Hara Murray and Gallego 2014), but how such model results relate to loss as defined in WKBEDLOSS is, as yet, unclear.

Where multiple activities occur, impacts may be cumulative. If monitoring indicates that changes in the broad-scale habitat type occur where activities overlap, then this should be classified as loss. Modelling of cumulative activities and effects may be used to support this assessment, if validated.

1. Assess footprint directly from the data
2. Assess and document the level of confidence for each feature (with respect to polygons derived from licenced aggregate extraction or dredging in the attribute table).
3. Archive INSPIRE-compliant metadata and document on data processing (e.g. assessing footprint)

## 4.3 Data flow for the collection of biogenic habitat loss

WKBEDLOSS proposes to use estimates of the historic distribution and extent of biogenic habitat to assess the degree of habitat loss within biogenic habitats. The use of historic distribution is seen to be necessary because current extents do not allow us to fully quantify loss: for example, some biogenic habitats may have been widespread but are now almost completely lost.

However, it should be noted that, although for MSFD purposes the assessment of biogenic habitat loss should be conducted at the regional sub-division level and loss of biogenic habitat may represent only a very small proportion of an EEZ, within a EUNIS level 2 habitat type (e.g. infralittoral biogenic habitat MB2) the proportion of recorded loss in a subdivision could be much higher.

In the case of biogenic habitats, the data flow should:

1. Identify the potential biogenic habitat-forming species in the area (subregion or subdivision) (historical and recent)
    a) Which habitats may or may not have been present - biogenic habitat reference list from EUNIS level 2 (Evans *et al*., 2016).
    b) Check if the named habitat-forming species was ever dense enough or is currently dense enough to have been classified as biogenic habitat.
2. Assess the natural spatial distribution and extent of the biogenic habitat
    c) If an estimate of historical loss is required for the assessment:
        i. Identify the available historical records of the species (presence/distribution and where possible density or extent) (see also section 4.4)
        ii. Set the historic extent baseline or reference point/conditions. This setting should be a policy/societal decision. Habitat suitability modelling may play a role in estimating the historic distribution and extent. For certain habitats, there are regional reviews that could inform on past distribution (e.g. OSPAR data on the occurrence of habitats in the Threatened and/or declining species and habitats list, regional/European research reports/databases on specific species)

iii. If no suitable data (distribution/density) are available to assess the extent of the historical baseline, it could be assessed from habitat suitability models using suitable threshold levels.

d) If recent loss data are required for the assessment:

i. Monitoring data of extent of the feature over defined reporting time frames (MSFD reporting cycle).

ii. Monitoring should take a targeted approach and should be informed by the proximity of relevant pressures.

3. Assess the loss of biogenic habitat

a) Collate the present-day spatial distribution and extent of the biogenic habitat

b) Compare the present-day distribution with the natural (historic) spatial distribution of the biogenic habitat

## 4.4 Level of detail of information in relation to distance from threshold

The level of detail and confidence in the information needed to assess the extent of physical loss depends on the distance between the actual current extent of physical loss and the threshold value that will be defined in accordance with Commission Decision (EU) 2017/848 for criterion D6C4. Closer to the threshold, a higher level of detail would be needed. For example, the biogenic habitat of European flat oyster beds prevailed over extensive areas of the southern North Sea until early 20$^{th}$ century and is known to have virtually disappeared, in part because of fisheries. This represents near 100% physical loss of the habitat and would undoubtedly be way beyond any threshold (although yet to be defined for D6C4). A detailed habitat mapping for this biogenic habitat hence is not needed to conclude its physical loss would not meet the threshold.

## 4.5 Data management best practice

It is recommended to follow the ICES manual for data management best practices (ICES, 2019). This centres on the FAIR principles, ensuring that all data are:

- Findable (through documentation and metadata)
- Accessible (through clarity on licensing, formats and the ICES data policy)
- Interoperable (through extended use of shared reference systems and services)
- Reusable (by having known data quality and good documentation)

### 4.5.1 Quality Assurance of Data sources

During data collection phase, it is important to identify a level of confidence in the positional accuracy of the data (Table 8).

**Table 8. Recommendation for assigning confidence to data contributing to assessing physical habitat loss, 1 = high, 4 = low.**

| Confidence level | Description | Examples |
|---|---|---|
| 1 | Data on actual positions of a human activity, originating from official documents or portals. | Wind turbines and their cable routings |
| 2 | Data on planned, instead of coordinates on actual positions, as originating from official documents or portals | Pipelines |
| 3 | Data on the licensed areas of the human activities, typically available from marine spatial plans or<br>only gridded data | Wind farm spatial extent, munition dump site |
| 4 | Roughly estimated or modelled extension of physical habitat loss | Loss of biogenic reefs<br>Unsealed loss |

In addition to the FAIR principles (see section 4.5), the workshop emphasized three additional points that may be important for collation of data related to habitat loss:

- Recording of the timestamp or date of the activities, preferably including the subsequent phases in the operations.
- Buffer zones, where applied, should be added to the data structure.
- Data contributing to physical loss is not likely to have data confidentiality issues, except for military mines, or wrecks classified as war graves.

## 4.6 References


Degraer, S., Brabant, R., & Rumes, B. (2013). Environmental impacts of offshore wind farms in the Belgian part of the North Sea: Learning from the past to optimise future monitoring programmes. Royal Belgian Institute of Natural Sciences (RBINS), Operational Directorate Natural Environment. Marine Ecology and Management Section: Brussels.

Evans, D. *et al*. (2016, revised 2017). Revising the marine section of the EUNIS Habitat classification - Report of a workshop held at the European Topic Centre on Biological Diversity, 12 & 13 May 2016. ETC/BD Working Paper Nº A/2016, revised 2017.

ICES. 2019. ICES User Handbook: Best practice for Data Management. 12pp.http://doi.org/10.17895/ices.pub.4889

Foden, J., Rogers, S. I., & Jones, A. P. (2011). Human pressures on UK seabed habitats: a cumulative impact assessment. Marine Ecology Progress Series, 428, 33-47.

Kint, L., Montereale Gavazzi, G. & Van Lancker, V., 2018. Kaderrichtlijn Mariene Strategie. Beschrijvend element 6: Zeebodemintegriteit. Ruimtelijke analyse fysisch verlies en fysische verstoring. Brussel, Koninklijk Belgisch Instituut voor Natuurwetenschappen, 41 p.

O'Hara Murray, R. B. and A. Gallego (2014) Modelling offshore wind farms off the east coast of Scotland using the Finite-Volume Coastal Ocean Model (FVCOM), EIMR, Stornoway, Lewis, UK

# Annex 1: Terms of reference

**WKBEDLOSS** - Scoping workshop on physical loss pressures on the seabed D6C1/C4 - from methods to operational data products

The *Workshop on scoping of physical loss pressures on the seabed D6C1/C4 - from methods to operational data product (WKBEDLOSS)*, chaired by Steven Degraer, Belgium will meet in Copenhagen, Denmark, 11–13 March 2019 to:

a. Identify the main physical pressure(s) causing loss of benthic habitats per EU ecoregion, taking account of the results of ICES WKBEDPRES1 (2018). Evaluate the relative significance of each pressure per ecoregion, the characteristics of these pressure(s), and identify which human activities the pressures are linked to.

b. Taking account of the results of other initiatives on the effects of pressures on the seabed, establish guidance for the collection of pressure data. Identify and report on methods to collect pressure data that will ensure the data can be used to assess the benthic habitat impacts of these pressures.

c. Define and report on practical steps to collate data on physical pressure(s) expected to impact benthic habitats, including data management best practices (pressure data to be sourced and data flows to be mapped). Steps should state actions to be taken, when, and by whom, to ensure the identified pressure data can be collated by June 2019 (through data calls, working groups, projects, organizations).

Prior to the workshop, the Chair, together with two ACOM approved invited attendees (tbc) will prepare material to address the TORs. This group will also ensure the completion of the workshop report.

WKBEDLOSS will report to the attention of ACOM by 15 April 2019.

## Supporting information

| | |
|---|---|
| Priority | High, in response to a special request from DGENV on the Common Implementation (CIS) of the MSFD. The advice will feed into ongoing efforts to provide guidance on the operational implementation of the MSFD. |
| Scientific justification | This workshop focuses on the requirement of D6C1 to assess the spatial extent and distribution of physical loss pressures on the seabed (including the intertidal area) for each subdivision[1] and per MSFD broad habitat type in each subdivision for criterion D6C4. Physical loss by all relevant human activities should be considered (e.g. permanent physical restructuring of the coast and seabed such as by land claim, canalisation, certain coastal defence and flood protection measures, construction of coastal and offshore structures, restructuring of the seabed, extraction of minerals including gravel and sand, and placement of cables and pipelines, dredging and immersion).<br><br>The workshop will prepare a guidance document to illustrate for each physical loss pressure the data flow from "owner" to product. General guidelines will be required that define how 1) pressure data should be (re)processed and how 2) the pressure data should be interpolated and/or extrapolated when data is missing.<br><br>The following supporting material is provided to guide the interpretation of ToRs a-c:<br><br>What are the main physical pressure(s) causing benthic habitat loss per EU ecoregion? This TOR will ensure the scoping of pressures most relevant to seabed loss. For each EU ecoregion the top pressures causing physical loss to the seabed should be identified. When evaluating physical loss pressures, consideration will also be given to which habitat-pressure impacts are most important (and how this should be accounted for when aggregating results). For each pressure a description of the link to the main drivers and/or sectors-activities will be included (i.e. manageable human activity).<br><br>What features should be used when collecting these pressure data? The workshop should agree upon pressure features for drafting a guidance document for the collection of pressure data (see TOR C). The features should be in line with the criteria proposed by WKBEDPRESS1 (2018).<br><br>What practical steps are needed to collect data? Using agreed criteria (see TOR B), a draft guidance document for the collation of pressure data will be produced to ensure best practice and correct standardization when assessing spatial extent and distribution of pressure and habitat data. The document will consider work done in Regional Sea Conventions (e.g. HELCOM's SPICE), RMFOs and available data (e.g. habitat data in EMODnet). The document, for each physical loss pressure and each ecoregion, will include:<br><br>- data sources, data flow and data management best practices<br>- operational guidance of how pressure data should be (re)processed, interpolated/extrapolated when data is missing<br>- practical steps/tasks to collect and map data by June 2019 (data calls, working groups, projects, organizations) |
| Resource requirements | ICES data centre, secretariat and advice process. |
| Participants | Workshop with researchers and RSCs investigators<br><br>If requests to attend exceed the meeting space available ICES reserves the right to refuse participants. Choices will be based on the experts' relevant qualifications for the Workshop. Participants join the workshop at national expense. |

| | |
|---|---|
| Secretariat facilities | Data Centre, Secretariat support and meeting room |
| Financial | Covered by DGENV special request. |
| Linkages to advisory committees | Direct link to ACOM. |
| Linkages to other committees or groups | Links to WGSFD, WGFBIT, WGEXT, WGMPCZM, WGMHM, WGECON, BEWG, WGMRE, CSGMSFD and SCICOM. |
| Linkages to other organizations | Links to OSPAR, HELCOM, Barcelona Convention, Bucharest Convention |

# Annex 2: List of participants

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