

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

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International Council for the Exploration of the Sea Conseil International pour l'Exploration de la Mer

H.C. Andersens Boulevard 44-46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk

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

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Editor

Steven Degraer

Authors

Steven Degraer • Sebastian Valanko • Daniel Van Denderen • Philip Boulcott • Valeria Abaza • Guillaume Bernard • Silvia Bianchelli • Olivier Brivois • Paul Coleman • David Connor • Florent Grasso • Laura Kaikkonen • Leena Laamanen • Nadia Papadopoulou • Ole Ritzau Eigaard • Owen Rowe • Petra Schmitt • Chris Smith • Alina Spinu • Vera Van Lancker •



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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. Un-sealed 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 licensed 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.

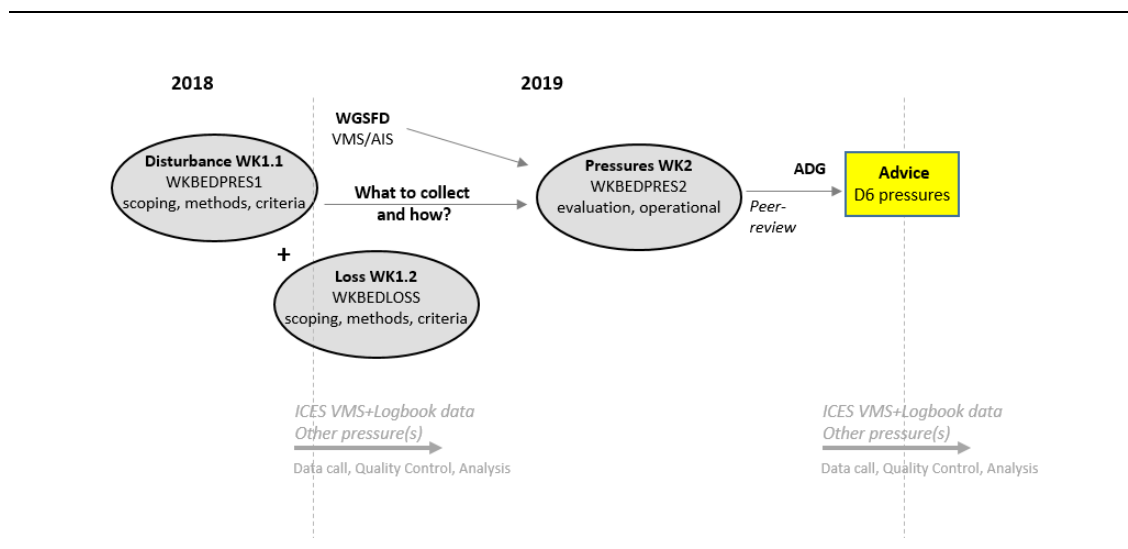


Figure 1. Stepwise process to assess the spatial extent and distribution of physical loss and disturbance within ICES.

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 WGECON). 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
	Aphyta/ hydrodynamic 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.

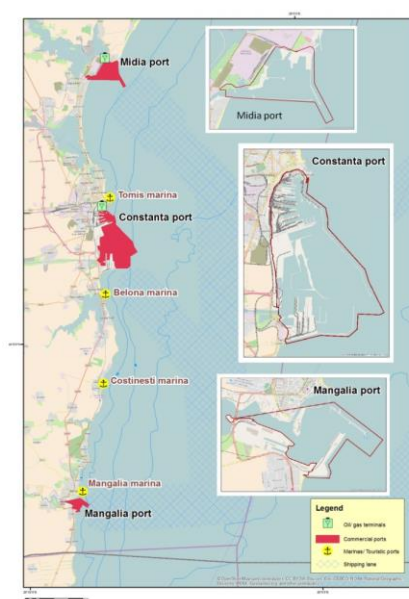


Figure 3. Transport infrastructures (ports and marinas) in Romania (source: MARSPLAN-BS project)

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.

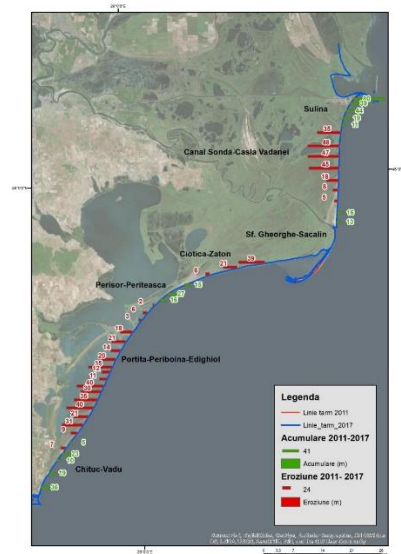


Figure. 4. Coastal processes (erosion/accretion) (source: NIMRD monitoring programme)

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.

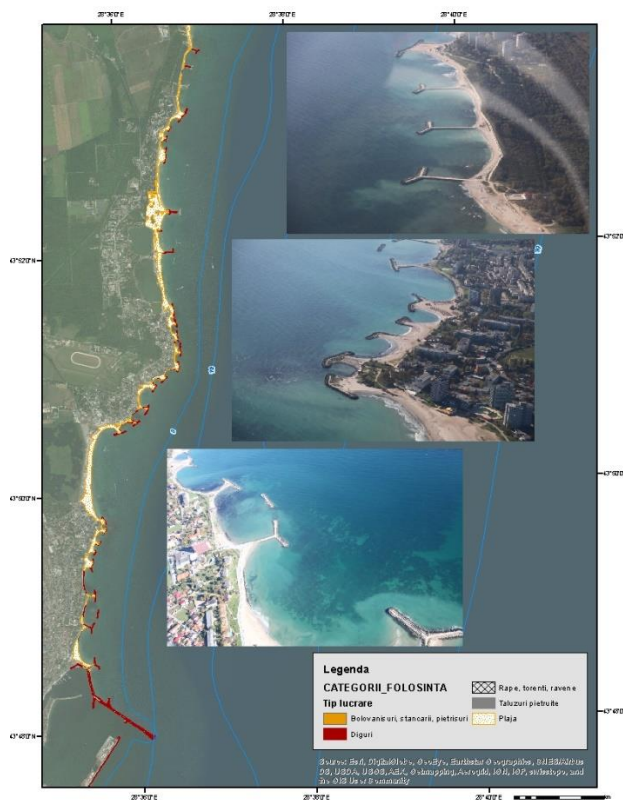


Figure 6. Coastal defence infrastructures (source: NIMRD database)

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.

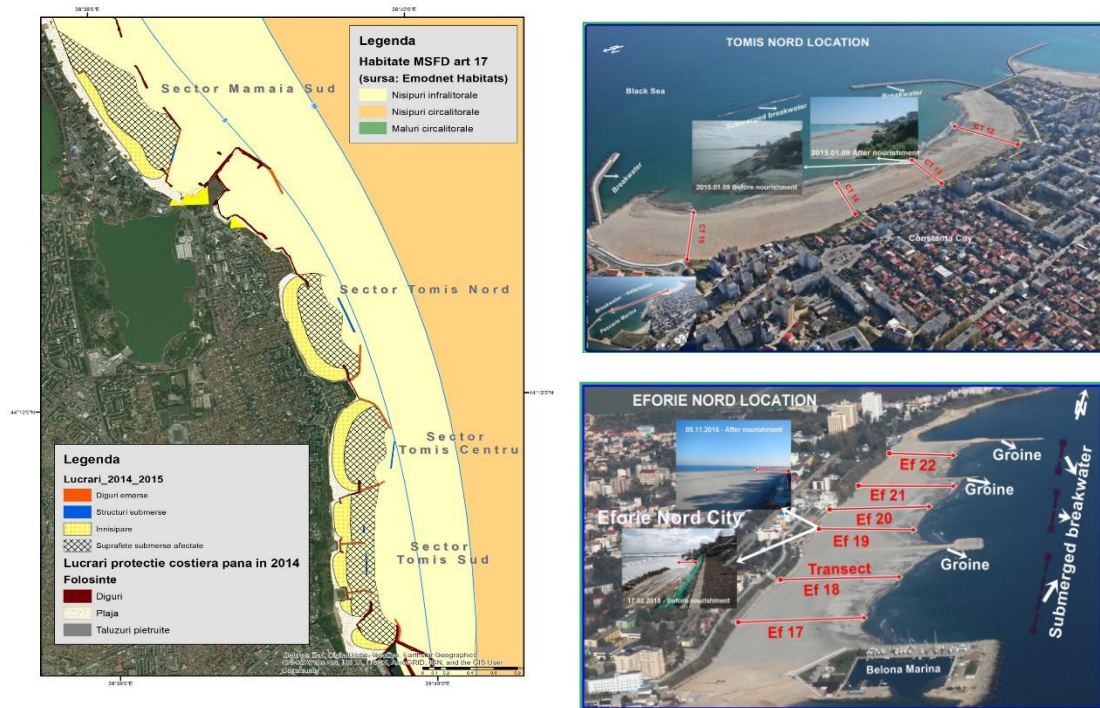


Figure.7. Beach nourishment and coastal defence (source: NIMRD monitoring programme) (yellow - emerged beach, black grids - submerged disturbed/lost areas)

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.

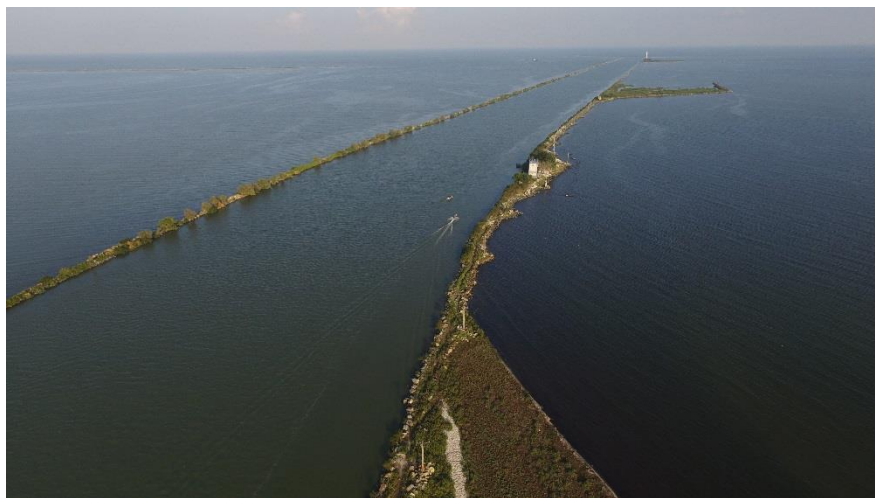


Figure. 8. Protection dikes of Sulina channel (Danube branch) (source: NIMRD database)

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.

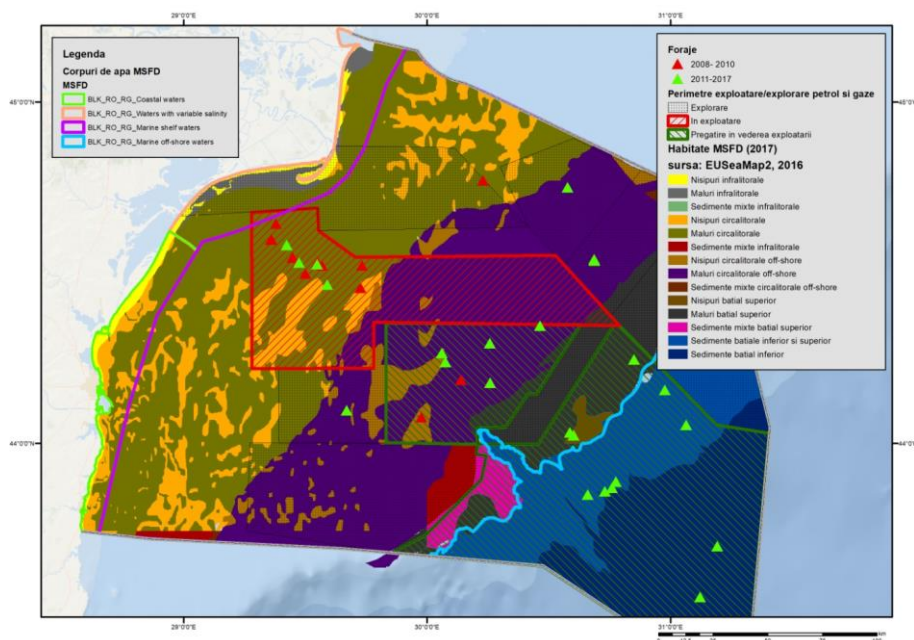


Figure.9. Oil and gas exploration and exploitation platforms (red polygon – exploitation perimeter, green polygons - in preparation for exploitation in the next 10 years, black polygons in exploration; red triangles – drillings carried out between 2008 and 2010; green triangles – drillings in 2011–2017)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

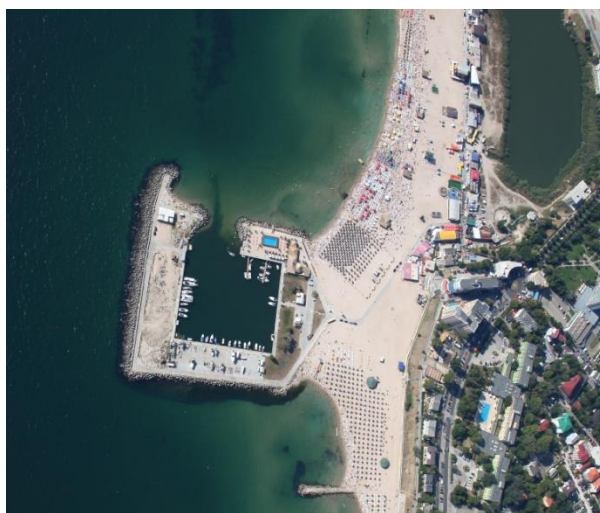


Figure 10. Touristic port (source: NIMRD database)

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 (km ²) 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 km² 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 km² 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.

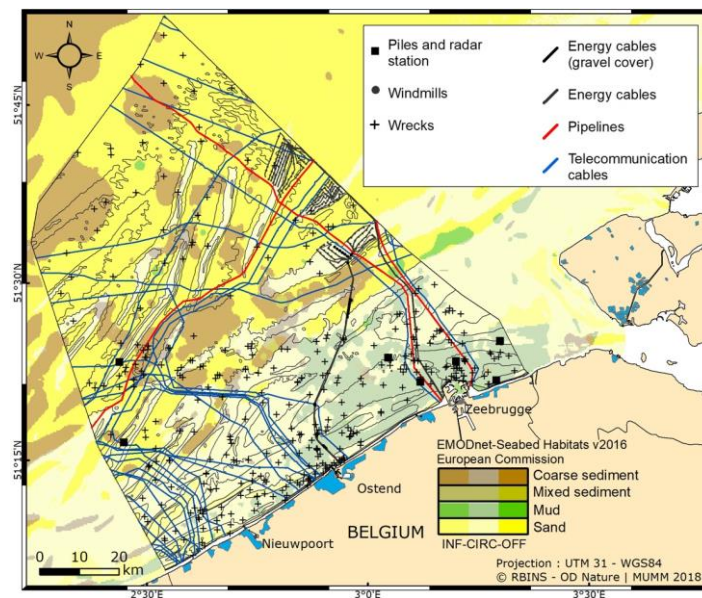


Figure 11. Activities contributing to physical loss in the Belgian part of the North Sea (3454 km²), overlain on the distribution of EUNIS level 2 habitat types (INF: Infralittoral; CIRC: circalittoral; OFF: offshore circalittoral) (Van Lancker *et al.*, 2018).

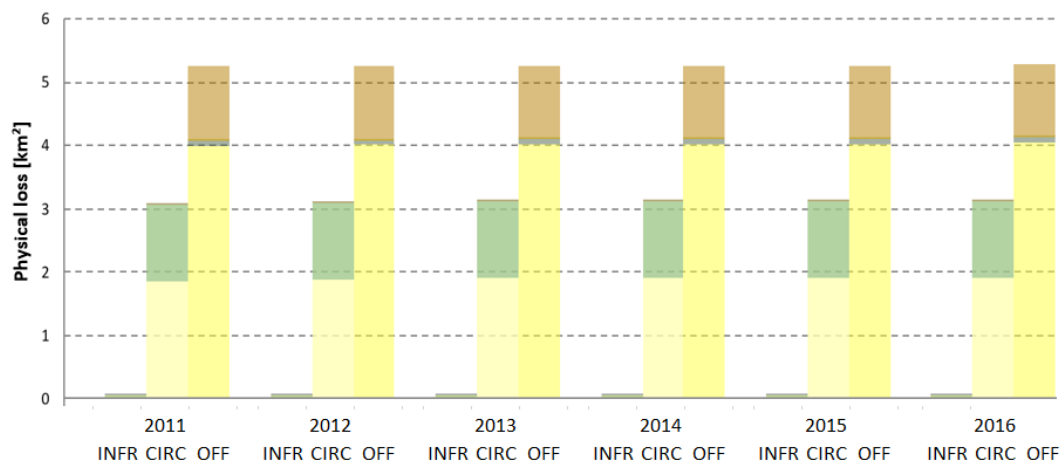


Figure.12. Cumulative physical loss per EUNIS level 2 habitat type, Belgian part of the North Sea (3454 km²) (legend and colour scale, see Van Lancker *et al.*, 2018).

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.

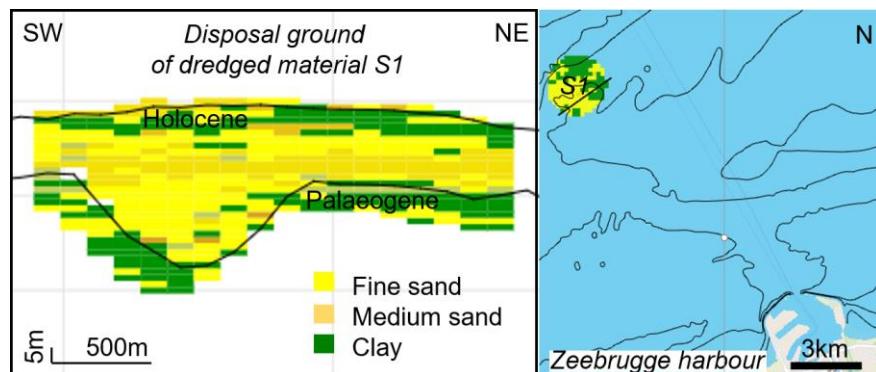


Figure. 13. Sealed physical loss as a result of disposal of dredged material, here illustrated for the S1 disposal ground of dredged material, Belgian part of the North Sea (subsurface view via TILES consortium, 2018; transect shown in the right panel).

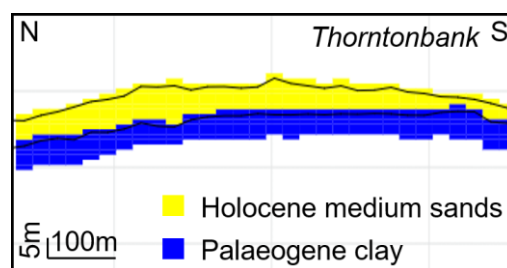


Figure.14. Unsealed physical loss as a result of long-term aggregate extraction, here illustrated for the Thorntonbank, Belgian part of the North Sea. Continuing extraction along the southern flank of the sandbank will deplete the Holocene cover changing the habitat from sand to clay (subsurface view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

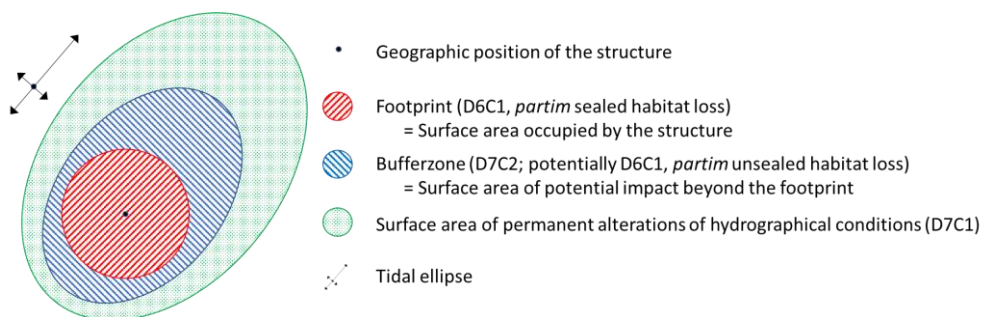


Figure.15. Area of influence around a structure with reference to physical loss (D6C1) and hydrographical alterations (D7C1 and D7C2).

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	<ul style="list-style-type: none"> - Information by type on area should be provided from licensing. - information on deposition method and hydrodynamic condition (local or dispersive) - 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	<ul style="list-style-type: none"> - Footprint depends on the aquaculture method and species - 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	<ul style="list-style-type: none"> - Information on area should be provided from licensing or by administration <p>Note: For land claim the initial coastline should be identified, if possible</p>
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	<ul style="list-style-type: none"> - 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. - 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	<ul style="list-style-type: none"> - oil and gas platforms/ drilling pits: information on footprint should be provided from licensing - 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 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 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.

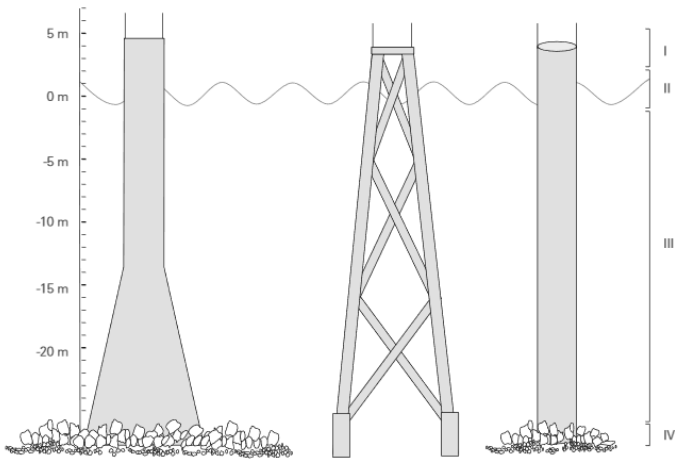


Figure.16. Different foundation type for the installation of wind turbines. From left to right: gravity-based foundation; jacket foundation and monopile (Degraer *et al.*, 2013).

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.

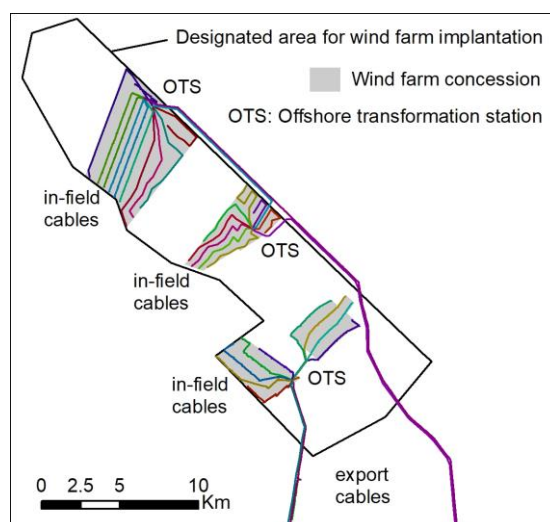


Figure.17. Spatial extent of a designated wind farm area, compared to licensed area and the effective footprint of the installations. Example from Belgian part of the North Sea (status 2016).

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.

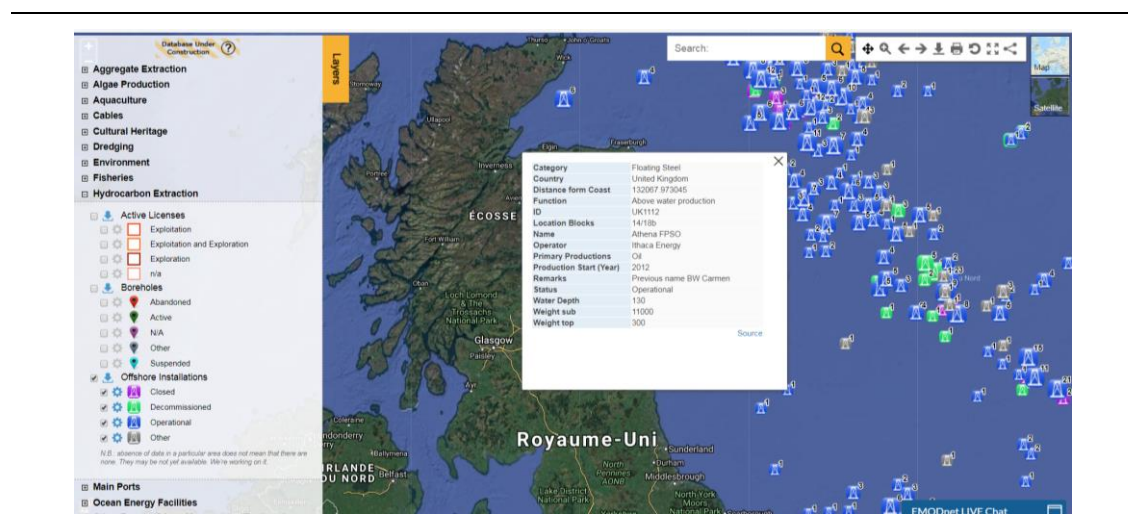


Figure 18. Point wise data on oil and gas extraction sites are available through EMODnet Human activities data portal.

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	<ul style="list-style-type: none"> - actual footprint (if known). - licensed areas (if footprint not known). Shapefiles may be used. - penetration depth of activity - volume (m³)/ licensed volume - mass (if available) - position, time - vessel type and size - extraction method - 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	<p>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 (km²).</p> <ul style="list-style-type: none"> - 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.

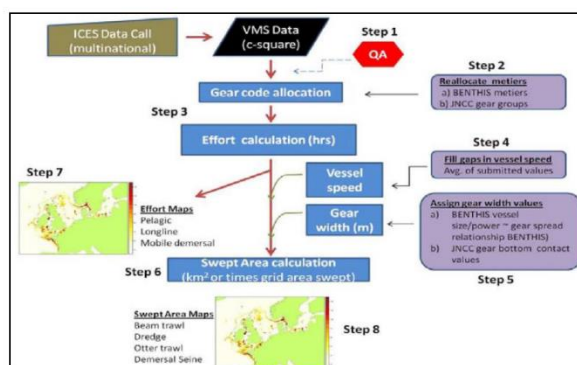


Figure 4.2.1. Workflow for production of swept area ratio (SAR) maps from aggregated VMS and logbook data in c-squares of 0.05x0.05 degrees (ICES 2015)

Data flow for:
Aggregate extraction (<http://magg.ices.dk>)

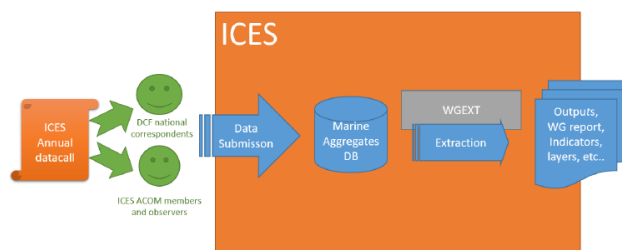


Figure 4.3.1. Data flow for aggregate extraction

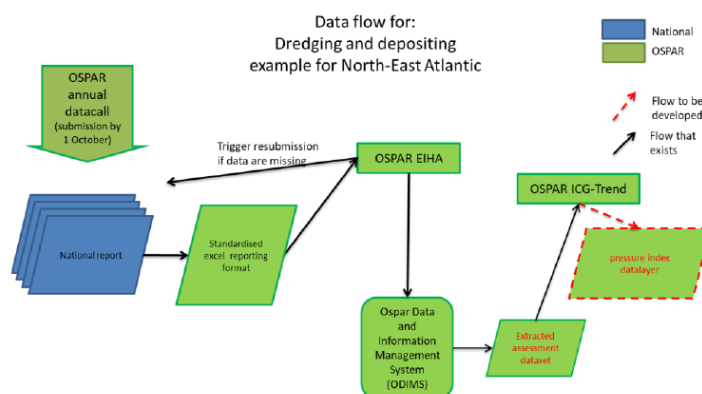


Figure 4.4.1. Data flow example for dredging and depositing.

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 20th 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 only gridded data	Wind farm spatial extent, munition dump site
4	Roughly estimated or modelled extension of physical habitat loss	Loss of biogenic reefs 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 N° 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: Zeebodintegriteit. 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	<p>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 subdivision¹ 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).</p> <p>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.</p> <p>The following supporting material is provided to guide the interpretation of ToRs a-c:</p> <p>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).</p> <p>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).</p> <p>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:</p> <ul style="list-style-type: none"> - data sources, data flow and data management best practices - operational guidance of how pressure data should be (re)processed, interpolated/extrapolated when data is missing - 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	<p>Workshop with researchers and RSCs investigators</p> <p>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.</p>

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

Name	Institute	Email	Country (of institute)
Alina Spinu	National Institute for Marine Research and Development Grigore Antipa	aspinu@alpha.rmri.ro	Romania
Chris Smith	Hellenic Centre for Marine Research (HCMR)	csmith@hcmr.gr	Greece
Daniel van Denderen	International Council for the Exploration of the Sea (ICES)	pdvd@aqu.dtu.dk	Denmark
David Connor	European Commission DG Environment	david.CONNOR@ec.europa.eu	
Florent Grasso	Ifremer	florent.grasso@ifremer.fr	France
Guillaume Bernard	Centre National de Recherche Scientifique (CNRS)	guillaume.bernard@u-bordeaux.fr	France
Laura Kaikkonen	Faculty of Biological and Environmental Sciences, Helsinki university	laura.m.kaikkonen@helsinki.fi	Finland
Leena Laamanen	Finnish Environment Institute (SYKE)	Leena.Laamanen@ymparisto.fi	Finland
Nadia Papadopoulou	Hellenic Centre for Marine Research (HCMR)	nadiapap@hcmr.gr	Greece
Ole Ritzau Eigaard	DTU	ore@aqu.dtu.dk	Denmark
Olivier Brivois	Bureau de Recherches Géologiques et Minières – Service géologique national	o.brivois@brgm.fr	France
Owen Rowe	HELCOM	Owen.Rowe@helcom.fi	Finland
Paul Coleman	Marine Institute	paul.coleman@marine.ie	Ireland
Petra Schmitt	Bioconsult Schuchardt & Scholle GbR	schmitt@bioconsult.de	Germany
Philip Boulcott	Marine Science Scotland	p.boulcott@marlab.ac.uk	UK
Sebastian Valanko	International Council for the Exploration of the Sea (ICES)	sebastian.valanko@ices.dk	Denmark
Silvia Bianchelli	Università Politecnica delle Marche , Department of Life and Environmental Sciences - DiSVA	silvia.bianchelli@univpm.it	Italy
Steven Degraer (Chair)	Royal Belgian Institute of Natural Sciences/OD Nature	steven.degraer@naturalsciences.be	Belgium

Name	Institute	Email	Country (of institute)
Valeria Abaza	National Institute for Marine Research and Development Grigore Antipa	vabaza@alpha.rmri.ro	Romania
Vera Van Lancker	Royal Belgian Institute of Natural Sciences. Operational Directorate Natural Environment (OD Nature)	vvanlancker@naturalsciences.be	Belgium

Annex 3: Technical Minutes from the Review Group on methods to assess the spatial extent and distribution of physical disturbance (D6C2) and physical loss (D6C1/C4)

- RGD6Pres
- By correspondence November 2019
- Participants: Gerjan Piet (chair), Samuli Korpinen, Miquel Canals Artigas
- ICES Expert Groups and Workshops: WKBEDPRES1, WKBEDLOSS, and WKBEDPRES2

Aim

The Review Group on methods to assess the spatial extent and distribution of physical disturbance (D6C2) and physical loss (D6C1/C4) pressures on the seabed (RGD6PRES) task was to evaluate the response from the open workshop (WKBEDPRES1, WKBEDLOSS, and WKBEDPRES2) in collaboration with the Working Group on Spatial Fisheries Data (WGSFD). The aim is to focus on whether the working groups missed important points relevant to the original request and if the conclusions are sound.

Background

Commission Decision 2017/848/EU sets out criteria and methodological standards for Good Environmental Status (GES) in relation to the eleven MSFD Descriptors. The Decision sets out the following criteria to be used for benthic habitats:

- D6C1 Physical loss (pressure)
- D6C2 Physical disturbance (pressure)
- D6C3 Adverse effects of physical disturbance on habitats (impact)
- D6C4 Extent of habitat loss (state)
- D6C5 Extent of adverse effects on the condition of a habitat (state)

The two requests together cover D6C1, D6C2 and D6C4.

Request: D6C1 physical loss pressure and D6C4 habitat loss

Advise on appropriate methods to assess the spatial extent and distribution of physical loss pressures on the seabed (including intertidal areas, where relevant) in MSFD marine waters. Demonstrate the application of the advice by providing estimates of the spatial extent of physical loss per subdivision and per MSFD broad habitat type (where possible), together with associated distribution maps. The advice will provide information on gaps in data for physical loss activities/pressures and/or habitat types and recommend key methodological improvements which may be needed.

This request should:

1. Identify which are the main activities responsible for physical loss pressures, based on the uses and activities listed in MSFD Annex III (Directive (EU) 2017/845) or subtypes thereof, and distinguishing these from activities that cause physical disturbance or which may lead to both loss and disturbance, accounting for potential (sub)regional differences;
2. Based on the definitions provided in the GES Decision, provide operational definitions of physical loss and physical disturbance which are relevant to the different activities causing each type of pressure, and to the different habitat types, and drawing from ICES advice on D6C2 (a separate ICES request);
3. Build upon the methods developed under the Regional Sea Conventions (e.g. HELCOM's SPICE) and Water Framework Directive, where appropriate, and take account of available data (e.g. habitats data in EMODnet);
4. Recommend appropriate methods to assess the distribution and extent of physical loss to the seabed, which should:
 - a. Encompass the main activities contributing to this pressure (including permanent physical restructuring of the coast and seabed such as by land claim, 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);
 - b. Be applicable to all EU waters (noting subregional variations where necessary due, for example, to data availability);
 - c. Be suitable for assessment of the pressure for the 6-year MSFD reporting cycle;
 - d. Be operational to derive demonstration products (point 7) with available data.
5. Recommend any key improvements needed in the proposed methods and/or associated data needed.
6. Where possible, express the typical extent of hydrological changes that could be associated with physical losses to the seabed (e.g. as an estimate of the area of influence around infrastructures), especially from modelling and mapping of relevant activities and their pressures for use in criterion D7C1); Demonstrate the application of the methods to give the distribution and extent of physical loss pressure in each MSFD (sub)region
7. Provide estimates of the total extent of physical loss pressure, in km² and as a proportion (%), per subdivision/subregion and per MSFD broad habitat type. Distinguish the proportion of the total extent of the pressure which is attributable to each activity. Provide an indication of the data precision, accuracy and likely data gaps for the areas used in the demonstration.

Overview of relevant information available in the WKBEDLOSS, WKBEDPRES2 reports

Request	Information available
1	<p>Human activities causing physical loss are identified and listed in Table 3 and Table 5 (left column on activities). Whether they cause loss, disturbance or both is indicated. Activities are classified as causing sealed or unsealed habitat loss, and characterised by the time lag for the physical loss to occur (instant/intermediate/ long). Seven EU ecoregions (Baltic Sea, Celtic Seas, Belgian EEZ, French Bay of Biscay (BoB), Romanian EEZ in the Black Sea, and Mediterranean Sea) have been considered. All of the activities causing loss were present in each of the 7 regions, with a few exceptions at present. Examples are provided from the Black Sea and the North Sea.</p> <p><u>Specific comments:</u></p>

Request	Information available
	<p>It is to be noted that sewer pipes on the seafloor or in shallow trenches also cause loss and disturbance leading to the sealing of habitats with time lags ranging from instant for losses to long for disturbance. Sewer pipes of various types are common occurrence in many shallow areas adjacent to the coast (e.g. in the Mediterranean Sea).</p> <p>Waste treatment and disposal is identified as NDR, whereas there are examples showing that this activity can lead to seabed loss and disturbance, as illustrated by the dumping of mine tailings on several coastal sites in Europe including some Norwegian fjords (Koski, 2012), the discharge of red mud from aluminium processing in the Gulf of Lion in France (Dauvin, 2010; Fontanier et al., 2014; Boury-Esnault et al., 2017; Fabri et al., 2017) or Antykira Bay in Greece (Poulos et al., 1996), or the disposal of coal fly ash and polluted industrial waste in the Eastern Mediterranean Sea (Kress et al., 1996, 1998; Herut et al., 2010).</p> <p>Extraction of salt, which requires infrastructure in coastal water and causes sealing of habitat, is not mentioned in relation to Physical loss. The fish and shellfish harvesting can cause loss (as correctly mentioned in the report) but it is unclear how to differentiate this, in practice, from disturbance.</p> <p>Bottom trawling, especially in soft bottom bathyal habitats, may lead to permanent loss involving major modifications of the original seafloor morphology (e.g. by meters to tens of meters in the vertical direction extending along 10's to 100's of square kilometres or even more according to the size of fishing grounds). This leads to complete restructuring of the original seascape, involving the formation of artificial contour-parallel terraces and the modification of natural seafloor drainage patterns. Morphology change causes change of sedimentation patterns. Recovery from those changes is impossible in practical terms (ref. Puig et al., 2012, Nature). This view is aligned with Commission Decision (EU) 2017/848, where it is noted that physical loss may also arise from permanent changes in seabed morphology, but may conflict with the WKBEDLOSS view that has constrained the definition of physical loss to EUNIS level 2 habitat change only. That's a matter that could be worth reconsidering.</p> <p>According to WKBEDPRES2, there may be other pressure-activity combinations assessed nationally that lie beyond regional assessment, but are regarded as important when viewed at the smaller national (e.g. boating anchoring abrasion) or local scale; e.g. munition on-site demolition, firing ranges and pressures related to explosions (dumping grounds or military activities), or pressures related to research activities (abrasion and loss due to ballast weights, sampling, etc.).</p>
2	<p>In WKBEDLOSS, physical loss was defined by one sentence where the key term is 'permanent alteration'. In WKBEDPRES2, the definition was sharpened to distinguish between 'sealed physical loss', 'unsealed physical loss' and 'loss of biogenic habitat'.</p> <p>The definition mentions that 'permanent alteration' means that human intervention is required to allow habitat recovery. In case of 'sealed loss' this is obvious, but in case of 'unsealed loss' and 'loss of biogenic habitat' more questions arise of the time scale: very few things are permanent in this world, especially in nature. The COMDEC defines it as follows: <i>"Physical loss shall be understood as a permanent change to the seabed which has lasted or is expected to last for a period of two reporting cycles (12 years) or more"</i>. This gives an entirely different time horizon as 'permanent'. As the COMDEC allows for longer time scales, it is probably not a legal problem, but in relation to activity impacts, one should operate with more practical time scales such as 12-100 years.</p> <p>The request asks for definitions <i>"which are relevant to the different activities [...], and to the different habitat types"</i>. This is actually lacking from both reports as only a general definition is given. Clearly the EC request aims towards a practical approach where 'loss' could mean different things for different habitats (which have different recovery times if any) or even different activities (for reasons that are not always self-evident). The habitat-</p>

Request	Information available
	<p>specific definitions become clearer by some examples: a loss of hard bottom reef does not return by its own means, but a more mobile substrate slowly redistributes over the seabed. In practice, one could define ‘permanent alteration’ with habitat-specific time scales varying from 12 years to more (e.g. 100). The habitat-specific loss definition clearly has scientific value and is lacking from the report. We would recommend that EUNIS2-specific time scales are explored based on their features (abiotic or biotic).</p>
3	<p>The title of the report itself refers to “methods to operational data products”. It is understood that methodologies need to be quantitative. Five generic steps are identified to assess sealed and unsealed physical loss, whereas three steps are identified to assess the loss of biogenic habitat (cf. data flows). How to distinguish unsealed physical loss from disturbance is also addressed.</p> <p>Advised (Table 5) and potential (Table 7) data sources are considered within section 4 on “Description of data flows”, where the need of applying footprints and buffer zones to point location and lines is addressed together with a proposal for data formats and attribute information (section 4.1.2). For activities causing “sealed” physical loss it is recognised that the relevant licensing authorities within Member States will hold most sealed loss data. For some activities, existing regional or European-wide datasets from Member States can be used too. It is 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.</p> <p>Both for sealed and unsealed loss national data calls could be an option or, if not possible, data can be extracted from national reporting through RSCs, and also from EMODNET. Examples are provided for specific cases. Data flows and associated methods are provided for biogenic habitats as well (section 4.3).</p>
4	<p>The report gives practical examples of assessment methods for sealed and unsealed seabed in different marine regions.</p> <p>Referring to points a), b), c) and d) in this request (see above), items in a) are considered to variable extents in the report. For b) it is assumed that the methods are applicable to all EU waters even though data availability could be an issue in some subregions. Concerning c), the methods are suitable for assessment of the pressure for the 6-year MSFD reporting cycle. Finally, for d) the methods are operational and demonstration products could be derived (see examples in the report itself).</p>
5	<p>The report provides step-wise methods for sealed seabed, unsealed seabed and biogenic habitats to carry out physical loss assessments. In that respect, the report recommends an improvement to previous methods (e.g. SPICE).</p> <p><u>Specific comments:</u></p> <p>The data needed for the assessments could be obtained from national data calls or, if not possible, they can be extracted from national reporting through RSCs, and also from EMODNET and eventually other databases and portals.</p> <p>Crossing high-resolution multibeam bathymetry data with VMS and AIS data is needed to assess large-scale morphological change (and subsequent loss) in soft bathyal habitats due to recurrent bottom trawling. It is unclear if the needed high-resolution multibeam bathymetry data could be obtained from existing databases and portals to the required extent.</p>
6	<p>The extent of hydrological changes is not addressed in the report. Local and subregional examples of the application of the methods are included (Black Sea, North Sea, for renewable energy infrastructure, and for extraction of oil and gas) but not at the scale of each</p>

Request	Information available
	MSFD (sub)region. Examples of hydrographical change pressure causing physical loss were given for seabed around offshore structures.
7	Two case studies are presented for Romanian waters and Belgian waters. In both cases, the loss was also attributed to different activities. The report did not cover the marine regions/subregions and did not provide indication of data precision, accuracy and likely data gaps.
Addi- tional ob- servation	<p>Likely related to the request #2 (definition of loss): the WKBEDLOS report builds on the assumption that the physical loss is assessed only on EUNIS level 2, but WKBEDPRES2 correctly adds that ‘...activities/pressures [can] have a disproportionate effect on specific biological habitats (EUNIS higher level 4+)’ and states that these can be assessed on Member State level.</p> <p>It should be stressed that the biotic components should not be left out of the definitions of physical loss. On the other hand, one can argue that the biogenic habitats on EUNIS 2 level can contain relatively many substrate-forming species, but there is no clear definition which habitats could be counted into these. In this report, it is understandable that the focus is in the broader picture, but I would still recommend adding text explaining how loss of biologically defined habitats could be assessed. This could be added to the definitions section where habitat-specific definitions are presented.</p>

Request: D6C2 physical disturbance pressure

Advise on appropriate methods to assess the spatial extent and distribution of physical disturbance pressures on the seabed (including intertidal areas) in MSFD marine waters. Demonstrate the application of the advice by providing estimates of the spatial extent of physical disturbance per subdivision and per MSFD broad habitat type (where possible), together with associated distribution maps. The advice will provide information on gaps in data for physical disturbance activities/pressures and/or habitat types and recommend key methodological improvements which may be needed.

1. Identify which are the main activities responsible for physical disturbance pressures, based on the uses and activities listed in MSFD Annex III (Directive (EU) 2017/845) or subtypes thereof, and distinguishing these from activities that cause physical loss;
2. Compare the use of VMS and AIS data, and associated data required to determine fishing effort and type, such as fishers' logbooks, in the context of use for MSFD D6 assessments. This should include a side-by-side comparison against a number of parameters, including source of the data (who holds the raw data), availability (e.g. legal requirements, including vessels to be covered), accessibility (including any costs, restrictions such as due to data sensitivity, ease of access), use (e.g. restrictions on its release), spatial coverage in European waters, temporal coverage (historic, and within year), resolution (spatial granularity), accuracy, technical requirements for processing (to define when vessels are physically disturbing the seabed), resources needed (e.g. technical expertise, time per unit area). The comparison should include maps showing the distribution of bottom-fishing activity from the two data sources for the same time period, indicating where the distribution overlaps and where not, with an associated quantification of this (e.g. number/proportion of grid cells per subdivision for AIS only, VMS only and both) and explanations for any differences. Note: this work will be carried out in close collaboration with EMODnet and JRC Bluehub

3. Advise on the relevance of distinguishing surface and subsurface abrasion for different human activities (including dredging, depositing of materials, extraction of minerals, fish and shellfish harvesting), given that the demonstration advice for fishing impact (ICES advice sr.2017.13) only used surface abrasion to assess benthic impact.
4. Advise on the benefits of knowing the variation and trends in the data during a six-year assessment periods (e.g. for environmental status or management purposes), and on the most appropriate spatial resolution for the data (e.g. in relation to spatial variation in the broad habitat types);
5. Take account of methods in Regional Sea Conventions (e.g. HELCOM's SPICE), RMFOs and available data (e.g. habitats data in EMODnet);
6. Recommend appropriate methods to assess the distribution and extent of physical disturbance to the seabed, which should:
 - a. Encompass the main activities contributing to this pressure (including dredging and depositing of materials, extraction of minerals, and use of bottom-contacting fishing gear per metier;
 - b. Be applicable to all EU waters (noting subregional variations where necessary due, for example, to data availability);
 - c. Be suitable for assessment of the pressure over a 6-year MSFD reporting;
 - d. Express the intensity of the pressure, where appropriate (e.g. as needed to assess adverse effects under D6C3 and D6C5);
 - e. Be operational to derive demonstration products (point 8) with available data.
7. Recommend any key improvements needed in the proposed methods and/or associated data needed, such as the data coverage for smaller coastal fishing vessels and the spatial scope of fishers' logbook data
8. Demonstrate the application of the methods to give the distribution and extent of physical disturbance pressure for each MSFD (sub)region. Provide estimates of the total extent of physical disturbance pressure, in km² and as a proportion (%), per subdivision/subregion and per MSFD broad habitat type. Distinguish the proportion of the total extent of the pressure which is attributable to each activity, including the different fishing metiers separately. Provide an indication of the data precision, accuracy and likely data gaps for the areas used in the demonstration.

Overview of relevant information available in the WKBEDPRES1, WKBEDPRES2 reports

Re-quest	Information available
1	<p>For each pressure, key activities (green highlight) in the assessment process were identified for each of the regional seas along with lesser activities still thought to be important (yellow highlight), either due to their severity or areal extent (Tables 2.1 to 2.4).</p> <p>For each physical pressure related to physical disturbance and loss (abrasion, removal, deposition and sealing), the same activities across the regional areas were judged to cause the most widespread/significant effect, although their magnitude is likely to be variable between the regional areas.</p> <p>No formal assessment was conducted for the prioritisation. This is now entirely based on expert judgement.</p> <p><u>Specific comments:</u></p> <p>In some cases, understanding disturbance and loss as a continuum is a wise approach as disturbance can lead to loss in certain circumstances, especially for highly sensitive habitats (cf. section 2.1 in WGBEDPRES report). Examples of this are aggregate extraction or bottom</p>

Re- quest	Information available
	<p>trawling, where, if severe or recurrent enough or of sufficient duration, may remove a surface sediment type (marine soil) exposing a different subsurface sediment type or lead to smothering and ultimately sealing of areas by sediment deposition.</p>
2	<p>This is the core of chapter 3 of WKBEDPRESS2 report, where all key points are adequately addressed. This chapter is specifically focussed on fishing activity, which is a major cause of physical disturbance (via abrasion) on the sea floor in EU waters. For the North East Atlantic and Baltic Sea there is an annual ICES data call for VMS/logbook data to all ICES/EU countries. This allows standardizing, harmonizing and aggregating the different national datasets. The ICES datacentre has a workflow to calculate swept area ratios (SAR) based on hours fished, average fishing speed and gear width. The VMS/logbook data call requests that data are aggregated on the 0.05 degrees c-squares level (corresponding to 15 km² at 61 °N); this resolution was chosen to reflect the ping rate and the normal speed of a vessel during fishing activities, and reduces the possibility that a vessel can traverse grid cells without being recorded.</p> <p>Data confidentiality can cause problems in the use of VMS data if individual vessels can be identified from the data or maps. This problem is exacerbated at the edge of fishing areas or where finer resolutions in aggregated data are required. WGSFD suggested that SAR is not considered sensitive information that can relate back to an individual vessel. However, if steps towards higher data resolutions are taken in the future, issues around data confidentiality should be considered.</p> <p>AIS data sources are identified (e.g. in WGSFD 2019 report) and the difficulties and limitations to access to those data are highlighted. It is to be noted that the primary purpose of AIS is improving maritime safety. Since May 2014, AIS has been compulsory for all fishing vessels larger than 15 m overall length (class A); smaller vessels can have AIS class B installed voluntarily. Data challenges when working with the AIS data include lack of gear information, irregular coverage, lack of unique vessel identifier for merging with logbook data (i.e. AIS device is identified, but not necessarily the vessel) and time zone. It is noted that AIS could be used to supplement the VMS and logbook data, but AIS is not yet a standardised product in most ICES countries (cf. Table 3.1).</p> <p>An AIS North Sea case study is presented for 2017 with maps showing differences between the spatial distributions based on AIS/fleet register data and based on ICES VMS/logbook data (cf. Fig. 3.1). It is concluded that in general, AIS data underestimate fishing activity, showing lower maximum fishing hours. For example, comparison shows that in the central North Sea, away from the coastlines, registrations based on AIS data are missing. In some cases the maps show a misclassification of gears in the AIS/fleet register data. It is also concluded for fisheries assessment on a regional scale that AIS data should be merged with logbook at a national level to minimise errors. However, issues relating to vessel ID to ensure correct coupling with logbooks remain a major restriction in their applicability. Clearly, in regions where VMS/logbook data are available, the VMS data gives a more reliable data product, even though the frequency position data is lower than AIS.</p> <p>Also, several case studies around Europe where AIS data have been used successfully at a local scale are mentioned. It is noticed that raising methods applied locally to a regional scale is still problematic.</p> <p>A cost benefit summary of methods to improve the assessment of the extent of fishing activities is presented (cf. Table 3.2) together with some recommendations (see point 7 below).</p>
3	<p>This is the focus of section 4.4 of the WGBEDPRES2 report. Surface abrasion is defined as the damage to seabed surface features (top 2cm), and subsurface abrasion is the penetration and/or disturbance of the substrate below the surface of the seabed (below 2cm).</p>

Re-quest	Information available
	<p>The seabed abrasion pressure and physical disturbance caused by mobile fishing gears needs to take into account the penetration depth of the gears. For visualisation on maps, separating abrasion into two classes (surface and subsurface) may be useful, but the assessment of the pressure will be more accurate if the actual penetration of each gear (or gear component) is used to quantify pressure, and when penetration depth dependent depletion is used in impact assessment (as in the PD assessment method). An alternative way of presenting abrasion pressure that takes account of both the footprint (SAR) of the fisheries using different gear types and the depletion (d) of the gear used, would be to sum the product of SAR and d for all different gear types used. This product would directly correlate with the abrasion pressure by mobile fishing.</p> <p>For the HELCOM and OSPAR areas, ICES already provides SARs both as surface and subsurface components. It is noticed that the combination of these two categories may benefit future assessments.</p> <p><u>Specific comments:</u></p> <p>The proposal to use the actual penetration of each gear sounds promising and is considered an improvement to the current use of surface and subsurface.</p> <p>In a similar way that the soil layer on land plays a pivotal role as growing substrate and for ecosystem functioning, including biogeochemical exchanges, there is a soil layer on the sea-floor that plays an equivalent role. The depth of subsurface abrasion directly relates to the potential destruction of marine soils and, therefore, measuring it will allow for better-informed assessments. Likely, this is relevant to the recovery potential (or reversal of loss) of benthic ecosystems too. Whenever possible, crossing subsurface abrasion depth and intensity with ecosystem recovery could provide new valuable clues to address this issue.</p>
4	<p>Temporal resolution is adequately addressed in WKBEDPRES2 Chapter 4.6, whereas spatial resolution is adequately addressed in WKBEDPRES2 Chapter 4.5.</p> <p>Having trends during 6-year cycles allows assessment to:</p> <ul style="list-style-type: none"> Identify increases or decreases of the pressure. Identify the existence of episodic pressures. Evaluate the effectiveness of management measures. <p>If there is potential for recovery and the pressure is variable in space and time, taking account of variations in pressure between years will help to get to most accurate estimate of impact. If no recovery occurs, or the pressure is constant in space and time, taking account of temporal variation in pressure over time will not make a difference in assessing the impact. Therefore, impact assessments for all pressures, except sealing resulting in loss, would benefit from taking account of variations in the pressure.</p> <p>The distribution of fishing and aggregate extraction effort becomes less patchy and more homogeneous over longer time scales, within cells and between cells. Evaluating pressures over longer time-scales will therefore result in a higher, and probably more realistic, estimate of the impact of these activities.</p> <p>Pertaining to the most appropriate spatial resolution, the VMS/logbook data call requests that data are aggregated on the 0.05 degrees c-squares level (corresponding to 15 km² at 61 °N) in ICES outputs; this resolution was chosen to reflect the ping rate and the normal speed of a vessel during fishing activities, and is intended to reduce the possibility that a vessel can traverse grid cells without being recorded. It is advised to step towards higher data resolution in the future (i.e. to 0,01 degrees c-squares as a general rule). Using interpolation methods or increasing the ping rate of tracking systems, primarily VMS, could help to increase resolution. This would allow relating pressures to habitat distribution and sensitivity, as there are</p>

Re-quest	Information available
	<p>often several habitats within a single 0.05 degrees c-square. This will ultimately lead to better assessment of pressures.</p> <p><u>Specific comments:</u></p> <p>Current practice is that pressure data are usually collected on a yearly basis through ICES data calls. Aggregated data over the whole year prevent analysis of any seasonality in spatial patterns including pressures that might have a pronounced seasonal character in some ecoregions and habitats with seasonal patterns in the benthic community. Wherever seasonality can be considered relevant, then seasonal spatial distributions are required. Seasonally resolved data may be required to assess impact on ecosystem components with seasonal spatial distributions. Note that this is recognised in WGBEDPRESS1 report, page 32.</p>
5	<p>Regional activities are explicitly addressed in section 2.3 of the WGBEDPRES2 report for the four major pressures identified (abrasion, removal, deposition and sealing). Methods for abrasion assessment are summarized for the relevant regions in tables 2.1, 2.2, 2.3 and 2.4 of the same report. Abrasion resulting largely from fishing is assessed from the same methods in all five regions considered. Specific weaknesses refer to the lack of knowledge on parameterising/modelling abrasion from turbulence or anchoring. Similarly, there is no methodology available to assess the extent of abrasion due to static gears, which may be important in countries with large, small scale fisheries (SSF). This also applies to aggregate extraction, the construction phase of structures, and dredging, all of which have relatively small footprints when assessed at the (sub)regional scale. Removal is assessed similarly in all regions but not exactly the same. It is mostly caused by aggregate extraction, which is much less extensive in the Mediterranean and Black Seas, where information is not available. Deposition is dominated by dredge disposal in all regions. Pressure data on deposition to depict positioning/extent beyond the position of the vessel is available from only a few Member States. It is noted that the deposition of sediments after resuspension (e.g. from bottom-contacting fisheries) has not, as yet, been modelled as there is no agreed method, and its incorporation into regional assessments is unlikely despite it extending beyond the activity footprint. Sealing is mostly caused by the placement of permanent structures as part of a variety of activities. The methodological approach to data collection for sealing and its assessment is similar in all regions.</p> <p>A point relevant to all the pressures above is the need for better mapping products that relate to pressure layers. EMODNet maps with MSFD Benthic Broad Habitat Types, with respect to accuracy and resolution, particularly from areas that have been widely modelled rather than sampled, should not just be seen as a finished product, with future efforts needed to improve accuracy, particularly through groundtruthing.</p>
6	<p>The most significant interactions (green highlights in the overall tables within the report) were further considered in a more detailed regional analysis that looked at the availability of data, relevant metrics, methods to assess the pressure, and data flows, as well as the identification of gaps and potential limitations (cf. section 2.4 of WGBEDPRES2 report, and tables 2.5, 2.6, 2.7 and 2.8 therein). These are:</p> <p>Abrasion caused by mobile bottom contacting fishing gears (cf. Table 2.5).</p> <p>Removal caused by aggregate extraction (Table 2.6).</p> <p>Deposition caused by disposal of (dredged) material (Table 2.7).</p> <p>Sealing caused by physical structures (Table 2.8).</p> <p>Impact can be calculated for abrasion (cf. section 5.3.1 of WGBEDPRES2 report).</p> <p>For removal (cf. section 5.3.1 of WGBEDPRES2 report) the intensity of the pressure is duration expressed in minutes, which may not be the most appropriate metric to calculate impact.</p>

Re- quest	Information available
	<p>Volume would be better but is presently limited by a lack of detailed, harmonised reporting of aggregate extraction activities by Member States. Standard operational workflow is still required.</p> <p>There is no method available for deposition (cf. section 5.3.3 of WGBEDPRES2 report).</p> <p>Intensity of the pressure is not relevant for sealing. However, at one level where the substrate is essentially the same as the placement material (concrete vs bed rock) it may be argued (under certain conditions) that this would not represent a physical loss, since the colonising community would essentially represent the pre-impacted state. The impact therefore should be determined by assessing how different the resulting benthic community state is compared to its pre-impacted condition.</p> <p>Overall, the methods to assess the distribution and extent of physical disturbance to the seabed encompass the main activities, are potentially applicable to all EU waters with explicit references to data gaps and availability where deemed relevant, are suitable for assessment of the pressure over a 6-year MSFD reporting, express the intensity of the pressure, and are operational to derive demonstration products with available data.</p> <p>The demonstration assessment in chapter 5 of WGBEDPRES2 report shows the preferred methodologies for one region, namely the North Sea.</p>
7	<p>Several key improvements were mentioned in the reference documents: spatio-/temporal scale, VMS or AIS, and coverage of the fleet including small vessels. These are considered in more detail below:</p> <p>ICES, which is collecting VMS data for the Baltic Sea and the Northeast Atlantic, indicates that one data gap apparent in VMS data is that it is only mandatory for vessels larger than 12 m (overall length) since 2012 and the interval between positions is recorded at a maximum of 2 hours (varying between 15 minutes and 2 hours on EU level). Improved spatial resolution of aggregated VMS data from current 0,05 degrees c-squares to 0,01 degrees c-squares is suggested. Data aggregation on a 0.01 degrees resolution without using interpolation would require the ping rate to be increased accordingly with a five times higher frequency.</p> <p>In the proposal for amending the fisheries control regulation (COM/2018/368 final) it is stated that, "All vessels including those below 12 metres' length must have a tracking system". If this proposal is approved, it would greatly improve the ability to document fishing pressure from SSF from vessels below 12 meters (overall length). The ICES VMS/logbook data call does not cover the Mediterranean Sea and Black Sea regions. Additionally, in these regions, a large proportion of the fleet is below 12 meters, and does therefore not currently have VMS on-board.</p> <p><u>Specific comments:</u></p> <p>Need to homogenise spatial resolution for VMS data in all EU ecoregions.</p> <p>There is a need to implement the use of VMS to fishing vessels < 12 m length in all EU regional seas.</p> <p>It is necessary to solve the problems in accessing VMS data in some countries, and confidentially issues that are directly related to spatio-temporal resolution of the data. Mediterranean EU MS are not submitting any VMS data.</p> <p>Seasonal spatial distributions accounting for seasonal benthos dynamics might improve future impact assessments.</p> <p>Specifics of different fishing gear to be integrated in swept area ratios (SAR) as estimated by WGSFD. Technological creeping to be considered too.</p>

Re- quest	Information available
	<p>Benthic habitat maps to be produced at EU scale following common methodology and with equal resolution (i.e. there is a lack of benthic community maps from the Mediterranean Sea, for instance). Existing maps (e.g. EMODNET) to be refined both in terms of resolution and habitat discrimination.</p> <p>There is a need to develop an indicator equivalent to SAR for static fishing gear for which disturbance levels are currently unknown. It is, however, unlikely that this will be a major contributor to physical disturbance.</p> <p>Waste treatment and disposal are identified as NDR, even though sewer pipe discharges are relevant for seafloor disturbance. This is also the case for the disposal of industrial waste.</p>
8	<p>A comprehensive demonstration assessment is provided for the North Sea in section 5 of the WGBEDPRESS2 report, where the above-mentioned four main pressures (abrasion, removal, deposition and sealing) have been addressed. This includes quantification per physical disturbance pressure in km² and as a proportion (%), also in relation to the total areas of the region and per broad habitat type (Tables 5.1, 5.2 and 5.3 of the referred report). The cumulative physical disturbance is also accounted for in Table 5.4 and a critical discussion on the applicability of the assessment process outlined in the demonstration is included (section 5.5 of WGBEDPRESS2 report). It is also recognised that for most ecoregions, due to lack of data - including, among others, data for the assessment and validation of community sensitivity parameters and groundtruthing of modelling -, assessment is not feasible for all the pressures examined at the spatial coverage required. The operational products reflect the direct (primary) pressures of each activity. Indirect (secondary) pressures, such as the deposition of particulates resulting from fishing and aggregate extraction, require the construction of further models and model parameters before they can be included into the assessment.</p> <p><u>Specific comments:</u></p> <p>Further refinements and improvements pending, the methods depicted are considered appropriate to inform on the distribution and extent of physical disturbance pressure for each MSFD subregion and for most habitats. Notwithstanding the importance of scale in habitat disturbance (and loss) as aptly pointed out in WGBEDPRES2 report section 2.6. This may be particularly relevant when the national/regional extent of the affected habitat is small and the pressure footprint proportionally large. At small scales, disturbance can lead to habitat degradation or loss, but may not be reported or assessed. The situation could eventually become critical for specific sensitive or priority habitats that should be assessed and resolved separately in the first instance. WGBEDPRES1 report recognises that some specific habitats, in particular in coastal areas, may be strongly affected at a local scale by pressures that were not ranked as being important on a regional scale, e.g. seagrass beds that may be affected by anchoring (cf. section 2.4 of WGBEDPRES1 report).</p>

Synthesis and conclusion

The review will need to evaluate if the work has been done so that ICES can base its advice on it with regard to two EU (DGENV) special requests, one on physical disturbance pressures and the other on physical loss pressures. More specifically ICES has been requested to:

- A) Advise on appropriate methods to assess the spatial extent and distribution of physical disturbance pressures and physical loss pressures on the seabed (including intertidal areas) in MSFD marine waters.
- B) Demonstrate the application of the advice by providing estimates of the spatial extent of physical disturbance and physical loss per subdivision and per MSFD broad habitat type (where possible), together with associated distribution maps.
- C) The advice will provide information on gaps in data for physical loss and physical disturbance activities/pressures and/or habitat types and recommend key methodological improvements which may be needed.

Based on the review our overall response to the ToRs is given below:

ToR A

The three workshops have provided the methods to do an assessment, at least in some of the MSFD regions, of (some of) the main pressures contributing to Physical Loss or Physical Disturbance. Even though the reviewers found pressures that were not considered in the workshops these are not expected to be major contributors to Physical Loss or Physical Disturbance and hence do not prevent a first assessment of the spatial extent of physical disturbance and physical loss.

ToR B

The methodology laid out in WKBEDPRES2 for the North Sea is adequate to demonstrate the application of the advice. It was found to be generally applicable to each ecoregion and pressure type thought to have a main impact upon seabed integrity making future assessments and advice for the other ecoregions possible.

ToR C

All the major gaps in relation to the methodology applied are mentioned and adequately discussed. Key methodological improvements were proposed.