HELCOM BalticBOOST Workshop on the development of joint principles to define environmental targets for pressures affecting the seabed habitats

Helsinki, Finland, 28-29 November 2016

Document title	Synthesis of the literature review on human impacts to benthic habitats
Submission date	14.11.2016
Submitted by	BalticBOOST project

Background

This document presents interim synthesis of a literature review which was made by the WP 3.1 of the BalticBOOST project. The synthesis is primarily giving support to the development of guidelines to define environmental targets for pressures affecting the seabed habitats and, secondarily, support also other data products needed in the preparation of the Second HELCOM Holistic Assessment. The literature review targeted to non-fishery impacts of human activities on benthic habitats.

The Meeting is invited to provide feed-back to the document and its results.

Synthesis of the literature review on human impacts to benthic habitats

Introduction

The general objective of the BalticBOOST project is to enhance regional coherence in the accomplishment of the 2018 reporting under the MSFD by developing joint tools, defining data needs and to set up data arrangements to support indicator-based assessments of the state of and pressures on the Baltic Sea. The WP 3.1 of the BalticBOOST project has the objective of developing joint principles to define environmental targets for pressures affecting seabed habitats. During the project, it was decided to call these joint principles as 'guidelines', as this term better indicates what the project is developing. The work began in December 2015 and will end in mid-December 2016. The WP 3.1 partners are SYKE (WP leader), IOW, ICES, SLU and DTU Aqua. To present interim findings and get guidance from HELCOM Contracting Parties two workshops have been arranged in connection to the WP3.1 work. The first workshop was held in Copenhagen, 2-3 June 2016 (BalticBOOST Theme 3 WS 1-2016).

Development of guidelines for setting environmental targets requires information on the relationships of pressure impacts and the environmental state. The information used in this project was based on a literature study of reported impacts of human activities on benthic species and habitats as well as a series of case studies where more data-driven approaches were used to analyse the relationship between impacts and the state of environment. SYKE and IOW focused on non-fishery pressures, SLU and DTU Aqua focused on fishery pressures and ICES encompassed all pressures. This workshop document includes only the non-fishery results based on the literature review whereas separate documents present the case studies of fishery and non-fishery impacts. In the project we considered physical pressures, i.e. physical loss and physical disturbance of seabed habitats.

In addition to providing information as a base to define guidelines for environmental target setting, the literature study also supported the development of sensitivity estimates, which are needed in the Baltic Sea Impact Index, and spatial extents of pressures which are needed in the development of the spatial pressure layers. The sensitivity estimates for habitats seabed habitats are presented in Annex 1.

The approaches to the meet the objectives

2.1. Linkage framework – links from activities to pressures and impacts

The WP 3.1 started by building a linkage framework which allows impacts to be back-tracked to pressures, human activities and activity sectors. The linkages help to identify which activities cause the pressures on benthic habitats. The linkage frameworks were compiled in co-operation with the HELCOM TAPAS projects on the basis of the works made in the FP7 ODEMM project, OSPAR, JNCC and INPN. The linkages are referred to as impact chains. In the HOLAS II assessment of activities, pressures and impacts, these chains allow a flexibility to perform assessments for different purposes (e.g. an assessment of pressures stemming from a selected activity or vice versa). Figure 1 visualizes the generalized activity types and the pressures they generate on seabed habitats.

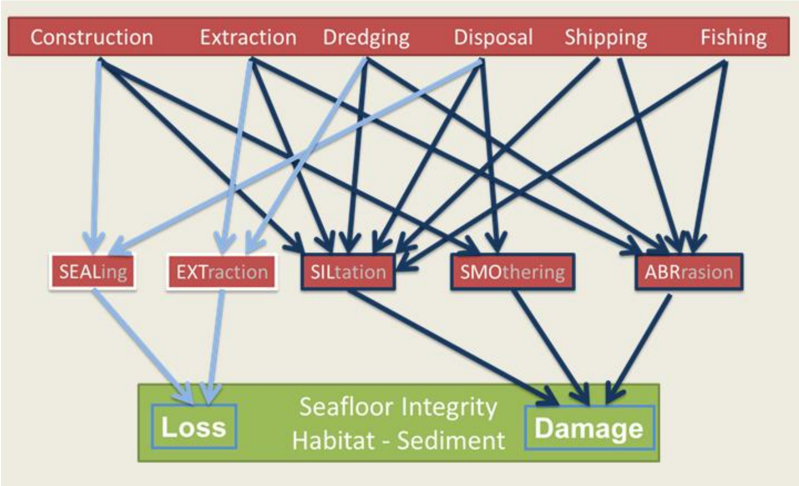

Figure 1. Links between generalized activity types and the physical pressures they exert on the seabed. Light blue arrows indicate the links leading to physical loss of seabed habitats, whereas dark blue arrows indicate links to physical disturbance.

2.2. Catalogue of activities, pressures and impacts

A literature review was carried out to assess the impacts of human activities on the seabed habitats. The focus of the review was non-fishery related activities causing physical pressures on the seafloor, as the fishery impacts were evaluated separately in WP 3.2. Reviews of fishery impacts have also been made in the BALTFIMPA and BENTHIS projects. The aim was of the review done in WP3.1 was to get quantitative estimates on the impact caused by the human activities identified to harm the seabed habitats in the linkage framework presented above. In addition, we aimed at retrieving information on spatial and temporal extent of the impacts as well as how the habitats recover once the activities have ceased.

To facilitate this work a catalogue was created. The catalogue includes information of the type of activity, pressure it is causing, intensity of the pressure, lasting of the pressure, target of the impact, type of impact, magnitude of the impact, spatial extent of the impact, recovery from the impact, region of the study, type of study and reference to the study cited. In total, circa 120 studies with >380 hits for different impacts on benthic habitats were added into the catalogue. The catalogue was then synthesized, together with input from WP3.2, into a table summarizing the level of activity and magnitude of pressure and impact on different benthic habitats and species. The synthesis also summarizes recoverability from the pressure and the spatial extents.

2.3. Developing the conceptual model for environmental targets

The WP has started to approach the environmental targets from the human activity perspective; how much pressure can an activity produce without causing significant impacts on the marine ecosystem? In Figure 2 this is expressed as Maximum allowable pressure that is (more or less) consistent with GES. In this scheme, the environmental target (blue line) is placed near GES and the GES is presented as a 'fuzzy area' on the pressure scale. This is considered to reflect the reality where it is extremely difficult to define the exact dependency between a pressure and state. The WP 3.1 has worked to find this answer with the use of explorative visualization of the dependency, multivariate analyses and simple correlations of pressures and state parameters (incl. GES indicators). However, in practice, many simplifications and assumptions based on expert knowledge were needed and there have been difficulties to distinguish the impacts of physical pressures from other pressures, such as eutrophication, hypoxia, chemical pollution, changes in food web structure as well as natural pressures.

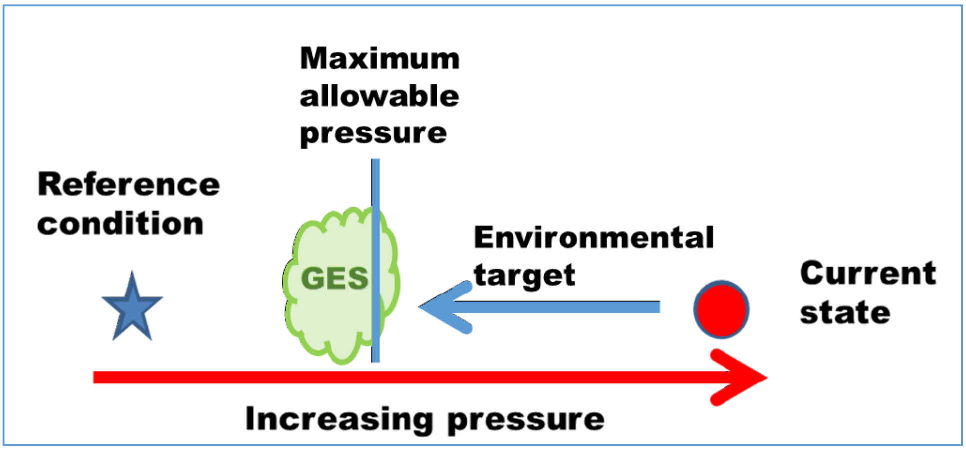

Figure 2. Schematic figure of the relations of GES (green fuzzy area), maximum allowable pressure which is at GES (vertical line) and the environmental target (blue arrow of reduced pressure) on the horizontal pressure gradient (red arrow).

One of the WP 3.1 objectives was to analyse the amount of human activities (and associated pressures) in marine areas and estimate how the benthic habitats respond to these activities. This task has proven to be very complex and clear dependencies have been difficult to find. The main reasons for this are:

(1) the spatially limited impact from the non-fishery activities: benthic monitoring sites do not capture local impacts;

(2) temporally limited impacts do not overlap with the benthic monitoring frequency;

(3) physical impacts are difficult to distinguish from eutrophication, contamination or natural processes (e.g. upwelling, wind-forced resuspension, etc.);

(4) indicators with GES thresholds are typically spatially and temporally aggregated and hence not adequate for this analysis;

(5) pressure gradients and impact gradients are too narrow for statistical analyses;

(6) often several impacts take place at the same time which makes it difficult to allocate the correct magnitude to specific impacts.

However, based on the literature review and the case studies, our ambition is to propose ranges of harmful effects for a couple of activity-pressure-impact chains.

Results

3.1. Linkage framework

The linkage chains visualized in Figure 1 were expanded to cover more detailed information about human activities affecting benthic habitats. Table 1 presents the activities causing physical disturbance and physical loss to seabed. The activities in the table act on very different magnitudes and scales (spatial and temporal). There are also other pressures affecting benthic habitats and these are listed in Table 2. In these ‘other pressures’ the impacts are either indirect (e.g. changes in water flows), chemical (e.g. causing eutrophication, hypoxia, contamination) or spatially very limited (e.g. input of heat, seismic waves, impulsive sounds). We have not considered eutrophication or hypoxia/anoxia in the WP 3.1 work as other reports give more comprehensive estimates of their impacts (e.g. HELCOM 2009, 2013). The interim

HELCOM linkage framework is presented in the HELCOM web site (http://www.helcom.fi/action-areas/maritime-spatial-planning/human-activities-and-pressures).

Table 1. Lists of human activities causing the main pressures affecting benthic habitats (physical loss and physical disturbance or damage). The lists of human activities are from the linkage framework.

Change of seabed substrate or morphology (~ physical loss)	**Physical disturbance or damage to the seabed**
Finfish mariculture	Finfish mariculture
Shellfish mariculture	Shellfish mariculture
Wind energy production: wind farms under construction	Wind energy production: wind farms under construction
Wave energy production	Wave energy production
Cables, incl. placement	Cables, incl. placement
Fishery: Benthic trawling	Fishery: Potting/Creeling
Fishery: Mussels and scallop dredging	Fishery: Netting
Marine plant harvesting: Maerl and Furcellaria harvesting	Fishery: Demersal long lining
Marine plant harvesting: Reed harvesting	Fishery: Benthic trawling
Extraction of sand and gravel	Fishery: Benthic seining
Pipelines, incl. placement	Fishery: Mussels and scallop dredging
Permanent land claim (urban, industrial, leisure, agriculture purposes)	Marine plant harvesting: Machine collection (fucoids, kelp)
Large-scale water deviation	Marine plant harvesting: Maerl and Furcellaria harvesting
Canalisation	Marine plant harvesting: Reed harvesting
Culverting/trenching	Extraction of metal ores
Coastal dams, weirs	Extraction of sand and gravel
Sea walls	Oil and gas industry infrastructure (Oil platforms)
Breakwaters	Pipelines, incl. placement
Groynes	Coastal dams, weirs
Flood protection	Sea walls
Tidal barrages	Breakwaters
Artificial reefs and islands	Groynes
Dredging (Capital/maintenance)	Flood protection
Beach replenishment/ nourishment	Tidal barrages
Tourism and leisure infrastructure: Piers	Dredging (Capital/maintenance)
Tourism and leisure infrastructure: Marinas and leisure harbours	Beach replenishment/ nourishment
Tourism and leisure infrastructure: Slipways	Tourism and leisure infrastructure: Marinas and leisure harbours
Transport infrastructure: Fishing harbours	Tourism and leisure activities: Recreational boating, yachting
Transport infrastructure: Industrial and ferry ports (harbours, bunkering points at sea; oil terminals)	Tourism and leisure activities: Beach use (bathing sites, beaches)
Transport infrastructure: Bridges and causeways	Tourism and leisure activities: Wildlife watching
Transport infrastructure: Tunnels	Tourism and leisure activities: Underwater cultural heritage
Solid waste disposal, incl. deposit of dredged material	Transport infrastructure: Industrial and ferry ports (harbours, bunkering points at sea; oil terminals)
Carbon capture and storage (Carbon sequestration)	Transport infrastructure: Ship/boat-building facilities
Military infrastructure (e.g. military firing ranges)	Transport: Passage of ships/boats
Waste disposal (munitions)	Transport: Mooring, anchoring, beaching, launching
	Solid waste disposal, incl. deposit of dredged material
	Military infrastructure (e.g. military firing ranges)
	Waste disposal (munitions)

	Research and survey: Fish surveys
	Research and survey: Environmental monitoring stations

Table 2. Other pressures affecting benthic habitats and human activities causing these pressures. Selected activities affecting only benthic habitats have been included from the linkage framework.

Changes to hydrological conditions	**Input of nutrients**	**Input of litter, incl. micro litter**	**Input of heat**	**Deposit of contaminated dredged material at sea**	**Impulsive noise**	**Input of organic matter**	**Input of seismic waves**
Wind energy production: operational wind farms	Finfish mariculture	Netting	Fossil fuel energy production	Dredging (capital/ maintenance)	Wind farms under construction	Finfish mari-culture	Seismic surveys
Wave energy production	Shellfish mariculture	Benthic trawling	Nuclear energy production	Solid waste disposal, incl. deposit of dredged material	Military infrastructure (e.g. military firing ranges)	Shellfish mari-culture	
Oil and gas industry infrastructure (Oil platforms)	Urban waste water treatment	Benthic seining					
Breakwaters	Industrial waste water treatment						
Groynes	Industrial animal farming						
Artificial reefs and islands							
Piers							
Marinas and leisure harbours							
Coastal dams, weirs							

3.2. Spatial extent of pressures

As our environmental monitoring programmes rarely have spatial components that cover local, regional and national scales, it is necessary to develop estimates of the spatial extent of different pressures. These estimates will form an important component in the process to judge whether an activity and its pressures cause significant harm to the benthic habitats (and hence whether environmental targets are needed to be established). The WP 3.1 included the spatial extents of pressures to the literature review and the case studies. Also in WP 3.2 spatial extents were added to the analyses of the impacts of fishing gears on seabed. In addition, for pressures that diminish at increasing distances from their source, the spatial representation of the pressures needs to incorporate the correct form of this decline. This gradient was also studied in the project (see Figure 3). The synthesis report will include detailed results of the spatial extents, but typical non-fishery extents were 1-3 km from the pressure source (Table 3).

Another aspect of spatial extent is the distribution of the human activities. While non-fishery activities are typically spatially limited, fishery with demersal gears is widespread.

Table 3. Spatial extents of pressures from their source (km). The extents are estimated to the distance where impacts are considered negligible. Note that hydrographic conditions affect the distances.

Activity	**Pressure extent (km)**
Capital dredging	4 km (fish), 3 km (benthos), 3 km (vegetation), 3 km (water turbidity)
Maintenance dredging	4 km (fish), 3 km (benthos), 3 km (vegetation), 3 km (water turbidity)
Sand extraction	5 km (water turbidity), 4 km (fish), 3 km (vegetation), 2 km (benthos)
Disposal of dredged matter	4 km (fish), 3 km (benthos), 3 km (vegetation), 2 km (water turbidity)
Shipping and ferry traffic	1 km (fish), 1 km (water turbidity, 30 m in depth), 0.5 km (vegetation), 0.3 km abrasion (substrate change)
Boating	0.5 km (water turbidity, 4 m in depth),
Marinas	0.5 km (fish), 0.5 km (vegetation)
Wind turbines (operational)	0.1 km (abrasion effect)

3.3. Correlations between amount of human activities, associated pressures and their impacts

An important part of the WP 3.1 was the dependency of pressures and impacts on the magnitude of a human activity. For this work, the catalogue separated different human activities causing pressures and impacts on benthic habitats. As this dependency is affected by the distance from the pressure source, it was important to record also this distance in the catalogue. For many human activities and pressures such detailed information was not available, but Figure 3 presents an example of such a result. On the basis of the figure, one can make at least three observations: (1) the pressure increase is not linear but logarithmic (i.e. high pressures are caused already at low activities and the increased activity increase the pressure only marginally), (2) the turbidity pressure decreases away from the 'core zone', and (3) the turbidity pressure is mostly limited to 2 km distance. Although as detailed figures were not available for many activities and pressures, these conclusions were made for several activities.

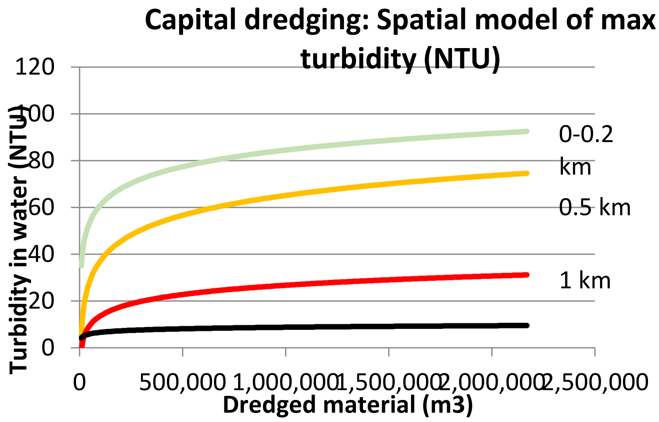

Figure 3. Dependence of water turbidity on dredging activity at different distances from the dredging site. Data is from the Vuosaari harbor construction case study in Finland

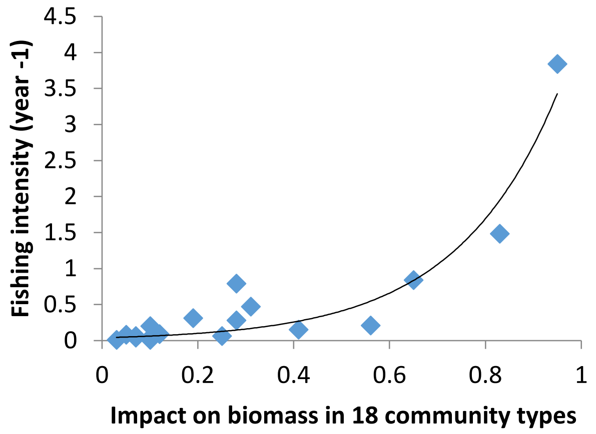

Figure 4. Impact of bottom-trawling fishing on benthic biomass in 18 benthic communities. The fishing intensity is an average value over all occurrences of that community type in the Baltic Sea and the impact on biomass is modelled for each community type in the Baltic Sea scale.

Based on the literature review, a couple of interim thresholds were proposed and given in Table 4 and 5. The thresholds are predominantly estimates based on several impact studies but still they should be used in caution as local environmental conditions strongly affect the pressure magnitudes and their impacts.

Table 4. Estimates of maximal allowable pressures on some state parameters. The results are preliminary and will be corrected in the project. The pressure amounts are measured at 0.2-0.9 km distance but the amounts still depend on local environmental factors. The numbers are from semi-exposed coast.

	Physical disturbance
Fucus coverage	20-30 g/m^2/d sediment
Fucus depth limit	
Fucus colonization	0.2 cm burial
Fucus growth	7 g/m^2 sediment

Red algae growth	
Seagrasses in bays	1 marina, 10 ferries/day
Herring fry mortality (detachment)	40-60 g/m^2/d
Pike juvenile mortality	1 marina
Benthic fauna mortality	10-40 cm burial in mud, 1-2 cm burial in hard bottom
Mortality of juvenile Macoma balthica	40-60 g/m^2/d
Benthic fauna community (Benthic Quality Index)	

Table 5. Amounts of human activities causing the maximal allowable physical disturbance pressures. The pressure amounts are measured at 0.2-0.9 km distance but the amounts still depend on local environmental factors. The numbers are from semi-exposed coast.

	Physical disturbance		
	Sedimentation	Turbidity	Abrasion, changes in water flow
Capital dredging	~8000 m^3	~8000 m^3	
Maintenance dredging		8000-12000 m^3	
Disposal of dredged matter	500-3000 m^3		
Sand extraction			
Wind turbine construction	1 turbine	1 turbine	1 turbine
Pipeline construction			
Cable placement			
Shipping and ferry traffic		1 ship	
Boating		1 ferry	
Marinas			

3.4. Recovery of benthic habitats from a pressure

The catalogue recorded also observed recoveries of the benthic features (species and habitat parameters). Typical recovery times were between 1-10 years depending on the feature and energy of the habitat (sheltered/ exposed). Also the activity intensity affects the recovery; high dredging intensities have resulted in 15 years of recovery, twice longer than normally (reviewed in ICES 2016). Table 4 gives a synthesis of the recoverability of benthic habitats. In the table, the habitat recoverability is a combined value of different features. Also the features with longest recovery times are mentioned.

Table 6. Recoverability of benthic broad habitat types from the physical disturbance pressure. The values comprise a synthesis of several studies. Note also that hydrographic conditions affect the recovery time.

Broad benthic habitat type	Typical recovery time in years	Features of longest recovery times
Infralittoral hard bottom	Disposal, dredging, sand extraction: >5 years	Herring spawning, Vegetation
Infralittoral mud bottom	Disposal and dredging: 5-10 y (in exposed areas faster)	Vegetation
Infralittoral sand bottom	Sand extraction: >6 y at the site, 2 y at 0.5-1km.	Benthic fauna
Circalittoral hard bottom		
Circalittoral mud bottom	Disposal of dredged matter: 4 y at the site; Capital dredging: 4-6 y at the site (1 y on exposed sites).	Benthic fauna
Circalittoral sand bottom	Sand extraction: >6 y at the site, 2 y at 0.5-1km.	Benthic fauna
Pelagic habitats	1 day – 1 week	turbidity

3.5. Magnitude of pressures and impacts from human activities

The synthesis aimed to find out which human activities have been observed to cause impacts on benthic habitats or species. While linkage frameworks may have accurately pointed out links between activities and pressures, it is still a different issue whether an activity actually causes an impact as this depends on a number of factors such as frequency, duration and magnitude.

Human activities can be ranked in their importance as exerting pressures or causing impacts. Rankings depend strongly on their purpose and therefore they are seldom comparable. In some rankings, the impacts are assessed in relation to a wider area or time period, whereas in the BalticBOOST ranking, the purpose is to compare *at the site* the magnitude of pressures and impacts. The reason for this focus is the HELCOM HOLAS methodological approach where spatial data layers of human activities, pressures and impacts are produced. Such products are spatially detailed enough to allow further assessment of significance of activities in wider areas.

The synthesis of the human activities allowed ranking them according to the amounts of pressures they cause and impacts on the benthic habitats. As only a few of the pressures could be compared on a same scale (i.e. same parameter, same units) and impacts on different species or environmental parameters cannot be directly compared, the WP 3.1 synthesis relied on a qualitative analysis of the activities, where the *magnitudes* were compared. For example, if capital dredging caused predominantly >75% mortality in benthic fauna (in near vicinity around the core zone) and wind turbine construction caused only 30%

mortality at the same distance, one can rank them. Similarly, one can compare other impacts. The catalogue and the synthesis are meant to be kept together in order to ensure transparency in the interpretation. Table 5 lists a general ranking for physical disturbance pressure (excluding fisheries at the moment), but the project aims at more specific rankings per broad habitat type. At this stage, all the rankings are temporary and need to be finalized with the BalticBOOST WP 3.1 work by the end of November 2016.

Table 7. Ranking of human activities on the basis of their pressures and impacts. The activities are categorized into six categories on the basis of the magnitude of pressures and severity of impacts they cause. The ranking may differ between benthic habitat types and therefore the final WP 3.1 product will separate the benthic habitats. [The fishery activities need to be yet confirmed]

Rank	**Activity causing physical disturbance**
High pressures and impacts	Maintenance and capital dredging (incl. harbours), Sand extraction and Sediment disposal
Moderate to high	Construction of water course modification and Coastal defence and flood protection, Finfish mariculture, Shellfish mariculture
Moderate	Wind turbine construction, Contaminated sediments, Shipping, Marinas
Low to moderate	Boating, Pipeline placement, Maerl and furcellaria harvesting
Low	Cable placement
No	

1. Conclusions of the literature synthesis

In this synthesis we have summarized information of >120 peer-reviewed papers and EIA reports and catalogued >420 estimates of impacts. Our focus area has been the Baltic Sea, but peer-reviewed papers were also accepted from the North Sea in case of aggregate extraction which is widely studied in that region but only few studies were available in the Baltic Sea.

Based on the literature synthesis, spatial extents of the pressures ad impacts from (non-fishery) human activities are relatively limited. Most of the impacts were restricted to 2-4 km, depending on water flows and type of impacts. This indicates that the non-fishery pressures may have restricted spatial impact on the marine environment. Such a conclusion may however be hasty, as many of the activities take place in specific substrates (e.g. sand extraction focuses on specific types of sand or gravel) or localities (e.g. maintenance dredging takes place usually in shallow coastal waters and bays). Thus, assessing the impacts in relation to habitats' area and distribution is ecologically more relevant point of view. Such an assessment was made, for example, in the German case study (Document 1-4 of the Meeting).

One of the main ideas of the literature study was to find levels for the so-called maximum allowable pressures. This level of human activity or pressure is needed in order to quantitatively set an environmental target for a benthic habitat type and specific pressure or human activity. The task was found to be very difficult as papers or EIA reports have not been made with this specific question in mind and the reported material does not allow re-calculation of that estimate. Despite the difficulties, some rough estimates were provided from the larger construction projects, such as the Vuosaari harbour project in the Gulf of Finland (see also the case study, document 1-5 of the Meeting).

The catalogue developed in the project was also used to produce sensitivity estimates for the benthic habitats against the pressures. Such estimates were derived from the synthesis of impacts and recovery times. The sensitivity estimates are an integral part of the assessment of cumulative impacts on benthic habitats which is under preparation for the Second HELCOM Holistic Assessment.

The results of this synthesis should not be detached from their original purpose and they are not an assessment but only components which can be used for an assessment. For instance, the ranking of the human activities can be misleading if used as an assessment result. This report's ranking does not include the actual frequency of human activities (which data is available in the HELCOM Data and Map Service), but ranks the activities based on their reported impacts and the magnitude of pressures they have produced. The OSPAR Quality Status Report 2010 or the HELCOM Initial Holistic Assessment also rank human activities but these rankings include also real occurrences of activities.

Annex 1: Sensitivity of benthic habitats to pressures

The target in the reviewed studies varied from species to community to habitat impacts. The collected information was synthesized according to activity, pressure and habitat, taking into account the reported intensities and type of impact. In addition, impacts on vascular plants and fish recruitment areas were treated separately. In the synthesis, the magnitude of the impact of different activities was estimated and the activities were ranked in five categories (high impact, moderate to high impact, moderate impact, moderate to low impact, and low impact). Similarly recoverability of habitats/communities from the pressure was categorized based on the literature survey (slow recoverability, moderate recoverability, high recoverability, and immediate recovery). Habitat sensitivity to the activities was based on the impact and recoverability, according to table 1.

Table 1. Cross-table to assess sensitivity based on impact and recoverability.

	immediate recoverability	high recoverability	moderate recoverability	slow recoverability
no impact	very low sensitivity	low sensitivity	low sensitivity	low sensitivity
low impact	low sensitivity	low sensitivity	moderate sensitivity	moderate sensitivity
moderate impact	low sensitivity	moderate sensitivity	moderate sensitivity	high sensitivity
high impact	moderate sensitivity	moderate sensitivity	high sensitivity	high sensitivity

To assess the confidence of the impacts and habitat sensitivities derived from the literature survey a categorical approach will be used. The exact definitions of confidence categories are not yet settled, but a proposal is to use categories as following:

High = Several studies showing similar magnitude of impacts

Intermediate = Single studies verified by expert judgment

Low = Studies not consistent or expert judgment

Impacts

Based on the literature survey, dredging (both capital and maintenance), extraction and disposal have the highest impacts on all types of seabed habitats. Wind turbine construction and contamination of sediments have moderate impacts, whereas cable placement have low impact on all habitat types. Shipping and boating were considered to have a moderate impact on hard bottoms, but a low impact on sandy and muddy bottoms. The water column was considered to be most impacted by disposal and dredging, followed by sand extraction and shipping in the Moderate to high-category. In sheltered areas, marinas and boating were considered to have moderate impact on the water column, whereas elsewhere boating was considered to have low to moderate impacts. Dredging and disposal have high impact on vascular plants and fish recruitment. Additionally small-scale dredging in sheltered areas have a high impact on vascular plants.

HARD BOTTOM SEABED

Rank	Activity causing physical disturbance	Category	Weight
High pressures and impacts	Maintenance and capital dredging (incl. harbours), sand extraction and sediment disposal	80-100%	1
Moderate to high		60-<80%	0,8

Moderate	wind turbine construction and contaminated sediments, boating	40-<60%	0,6
Low to moderate		20-<40%	0,4
Low	Cable placement	0- <20%	0,2
No		0	0

SANDY SEABED

Rank	Activity causing physical disturbance	Category	Weight
High pressures and impacts	Maintenance and capital dredging (incl. harbours), sand extraction and sediment disposal	80-100%	1
Moderate to high		60-<80%	0,8
Moderate	wind turbine construction and contaminated sediments	40-<60%	0,6
Low to moderate		20-<40%	0,4
Low	Cable placement, boating	0- <20%	0,2
No		0	0

MUDDY SEABED

Rank	Activity causing physical disturbance	Category	Weight
High pressures and impacts	Maintenance and capital dredging (incl. harbours), sand extraction and sediment disposal	80-100%	1

Moderate to high		60-<80%	0,8
Moderate	wind turbine construction and contaminated sediments	40-<60%	0,6
Low to moderate		20-<40%	0,4
Low	Cable placement, boating	0- <20%	0,2
No		0	0

WATER COLUMN

Rank	Activity causing physical disturbance	Category	Weight
High pressures and impacts	Disposal, capital dredging, maintenance dredging	80-100%	1
Moderate to high	Sand extraction, shipping	60-<80%	0,8
Moderate	Marinas and boating in sheltered sites	40-<60%	0,6
Low to moderate	boating	20-<40%	0,4
Low		0- <20%	0,2
No		0	0

FISH RECRUITMENT

Rank	Activity causing physical disturbance	Category	Weight
High pressures and impacts	maintenance and capital dredging (incl. harbours), sand extraction, sediment disposal	80-100%	1

Moderate to high	marinas and boating (in sheltered sites) and shipping	60-<80%	0,8
Moderate		40-<60%	0,6
Low to moderate		20-<40%	0,4
Low	wind turbine construction	0- <20%	0,2
No		0	0

VASCULAR PLANTS

Rank	Activity causing physical disturbance	Category	Weight
High pressures and impacts	maintenance and capital dredging, sediment disposal, small-scale dredging in sheltered areas	80-100%	1
Moderate to high	sand extraction, marinas (in sheltered areas), ship traffic, boating (in sheltered areas)	60-<80%	0,8
Moderate		40-<60%	0,6
Low to moderate		20-<40%	0,4
Low		0- <20%	0,2
No		0	0

Habitat sensitivity

Based on the intensity of the impacts and the recoverability of habitats, the sensitivity of habitats to different human activities was estimated. Impacts and recoverability were assessed in the literature survey and complemented by expert judgment where this information was lacking. Generally, hard bottoms are most sensitive to human activities, followed by sandy bottoms. Mud bottom habitats seem to be least sensitive to pressures from human activities. The results will be complemented with sensitivity estimates for habitat forming species if time allows.

Infralittoral hard bottoms

	impact	**recoverability**	**sensitivity**	**remarks**
Construction	moderate	slow	high	Loss, damage from abrasion and smothering during work on site plus siltation in adjacent areas
Extraction	high	moderate	high	Loss, otherwise damage from siltation in nearby areas
Dumping	high	slow	high	Loss from periodical (maintenance) dumping
Dredging	low	n/a	low	No dredging on rocks, but damage from siltation from nearby areas
Shipping	low to moderate	slow	moderate	Possible damage from constant resuspension of fine sediments
Sum of "adversely affected"	moderate to high	slow	**high**	Sensitivity even higher with perennial algae or biogenic reefs

Circalittoral hard bottoms

	Impact	**recoverability**	**sensitivity**	**remarks**
Construction	moderate	slow	high	Loss, damage from abrasion and smothering during work on site plus siltation in adjacent areas
Extraction	High	moderate	high	Loss, otherwise damage from siltation in nearby areas
Dumping	High	slow	high	Loss from periodical (maintenance) dumping
Dredging	Low	n/a	low	No dredging on rocks, but damage from siltation from nearby areas
Shipping	Low	slow	moderate	Possible damage from constant resuspension of fine sediments
Sum of "adversely affected"	moderate to high	slow	**high**	Lower hydrological impacts in deeper water lead to more sensitive communities

Infralittoral sand bottoms

activity	Impact	recoverability	sensitivity	Remarks
Construction	Moderate	moderate	moderate	Loss, damage from abrasion and smothering during work on site plus siltation in adjacent areas
Extraction	moderate to high	moderate	moderate to high	Loss, damage from abrasion and smothering during work on site plus siltation in adjacent areas
Dumping	moderate to high	moderate	high	Loss from periodical (maintenance) dumping, depending on material and contamination
Dredging	moderate to high	moderate	moderate	Loss from periodical (maintenance) dredging
Shipping	Low	moderate	low	Possible damage from constant resuspension of fine sediments
Sum of “adversely affected”	Moderate	moderate (high in exposed areas with sediment transport)	**moderate to high**	Sensitivity even higher with perennial algae or biogenic reefs

Circalittoral sand bottoms

activity	Impact	recoverability	sensitivity	Remarks
Construction	Moderate	moderate	moderate	Loss, damage from abrasion and smothering during work on site plus siltation in adjacent areas
Extraction	moderate to high	moderate	moderate to high	Loss, damage from abrasion and smothering during work on site plus siltation in adjacent areas
Dumping	moderate to high	moderate	high	Loss from periodical (maintenance) dumping, depending on material and contamination
Dredging	moderate to high	moderate	moderate	Loss from periodical (maintenance) dredging

Shipping	Low	moderate	low	Possible damage from constant resuspension of fine sediments
Sum of "adversely affected"	Moderate	moderate (high in exposed areas with sediment transport)	**moderate to high**	Lower hydrological impacts in deeper water lead to more sensitive communities

Infralittoral mud bottoms

	Impact	**recoverability**	**sensitivity**	**Remarks**
Construction	moderate	high	low	Loss, damage from abrasion and smothering during work on site plus siltation in adjacent areas
Extraction	moderate	high	low	Loss, damage from abrasion and smothering during work on site plus siltation in adjacent areas
Dumping	moderate	high	moderate	Loss from periodical (maintenance) dumping, depending on material and contamination
Dredging	moderate	high	moderate	Loss from periodical (maintenance) dredging
Shipping	low	moderate	low	Possible damage from constant resuspension of fine sediments
"adversely affected"	moderate	high	**low to moderate**	Areas with high natural sedimentation are less, but areas with perennial macrophytes or biogenic reefs are more sensitive

Circalittoral mud bottoms

	impact	**recoverability**	**sensitivity**	**Remarks**
Construction	moderate	high	low	Loss, damage from abrasion and smothering during work on site plus siltation in adjacent areas

Extraction	moderate	high	low	Loss, damage from abrasion and smothering during work on site plus siltation in adjacent areas
Dumping	moderate	high	moderate	Loss from periodical (maintenance) dumping, depending on material and contamination
Dredging	moderate	high	moderate	Loss from periodical (maintenance) dredging
Shipping	low	moderate	low	Possible damage from constant resuspension of fine sediments
"adversely affected"	moderate	high	**low to moderate**	Areas with high natural sedimentation are less sensitive