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Report of the Working Group on the Effects of Extraction of Marine Sediments on the Marine Ecosystem (WGEXT)

18–21 April 2016

Gdansk, Poland

International Council for the Exploration of the Sea

Conseil International pour l'Exploration de la Mer

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Contents

Executive summary

The main objective of the Working Group on the Effects of Extraction of Marine Sediments on the Marine Ecosystem (WGEXT) is to provide a summary of data on marine sediment extraction (ToR A1), marine resource and habitat mapping, changes to the legal regime and policy, and research projects relevant to the assessment of environmental effects (ToR A2). The data on marine sediment extraction will be reported to OSPAR on a yearly basis in Interim Reports. The other items will be addressed in Final Reports.

During the Annual Meeting in 2013, at the beginning of the new 3-year period, WGEXT decides to formulate new Terms of Reference (ToRs), besides the existing ToRs A1 and A2, on topics which the group believe are important issues to be addressed. Nine new ToRs were formulated, most of them were intended for more than 3 years. The new Terms of Reference were: B (ICES aggregate database); C (Marine Strategy Framework directive); D (Publications); E (Mitigation); F (Deep sea mining); G (Harmonization); H (Cultural Heritage); I (Cumulative assessment); J (Environmental Impact Assessment).

During and between the annual meetings of 2014, 2015 and 2016 these ToRs were discussed and results were formulated. Contributions were provided by correspondence from members who could not attend.

Yearly for all ICES-countries data on marine sediment extraction, including amounts of extraction, spatial extent of licensed areas, spatial extent of extracted areas, geospatial shapefile information is published in the Annual Reports and delivered to OSPAR. This input is necessary for the Quality State Reports and for the Marine Strategy Framework Directive of the European Union.

The ICES database will be used for uploading the WGEXT information. A template for the WGEXT database was proposed. WGEXT will also continue to discuss the feasibility of developing the complexity of the database. Future expansion of the database is expected to be driven by inquiries from potential users.

Concerning the Marine Strategy framework Directive an inventory is made on the way marine sediment extraction is mentioned in the MSFD documents. A review article on "Marine Aggregate Extraction and Marine Strategy Framework Directive: A review of existing research" is nearly finished.

The possibility of recovery after sediment extraction should be acknowledged by incorporate it in the criteria and by taken it into account with the assessment of the Good Environmental Status.

At the ICES Annual Science Conference 2016 a session is initiated by WGEXT on "Making marine sediment extraction sustainable by mitigation of related processes with potential negative impacts".

On the item of harmonization only intensity of extraction is necessary to address. After discussions of the defining of intensity methods are developed to compare the intensity of extraction in different countries. This item will be incorporated in ToR I in the coming years. An inventory is made of procedures and legislation concerning aggregate extraction and cultural heritage for each ICES member country.

An inventory is made of the legal thresholds for an Environmental Impact Assessment for each ICES member country.

Terms of reference G, H and J are completed. The other Terms of Reference will continue.

New Terms of Reference are formulated on impacts of marine sediment extraction on fish and fisheries and on implications of marine spatial planning on marine sediment extraction.

1 Administrative details

Working Group name
Working Group on the Effects of Extraction of Marine Sediments on the Marine Ecosystem (WGEXT)
Year of Appointment
2014
Reporting year within current cycle (1, 2 or 3)
3
Chair(s)
Ad Stolk, the Netherlands
Meeting venue(s) and dates
2–5 June 2014, Reykjavik, Iceland (13 participants)
20–23 April 2015, Ostend, Belgium (10 participants)
18–21 April 2016, Gdansk, Poland (12 participants)

2 Terms of Reference and Summary of work plan

a) oR A Review annual data on marine extraction activities

A1. Review data on volumes, spatial areas and the collection of geospatial data on extraction locations in the form of shape files for OSPAR. To be produced every year (interim and final reports) and sent to OSPAR.

A2. Review of development in marine resource mapping, legal regime and policy, environmental impact assessment, research and monitoring and the use of ICES Guidelines on marine aggregate extraction. To be produced for the final year three report (2016).

b) ToR B Create an ICES aggregate database (linked to the ICES Data Centre) comprising all aggregate related data, including scientific research and EIA licensing and monitoring data. Overall lead from WGEXT: Johan Nyberg

B1. Year 1 (2013/2014) – creation of a template with data required from each country. Lead from WGEXT: Johan Nyberg, Ingemar Cato, Marcel Rozemeijer and Henry Bokuniewicz.

B2. Year 1 (2013/2014) – Check with ICES options for WGEXT database linked to ICES database Lead from WGEXT: Johan Nyberg.

B3. Year 1 (2013/2014) – Create an inventory of other WG contacted with regards databases of relevance to WGEXT to allow possible links to be created within the WGEXT database. Lead from WGEXT: Marcel Rozemeijer.

B4. Year 2 (2014/2015) – template to be finalized and populated for each country and sent for approval to ICES. Lead from WGEXT: All members, coordinated by Johan Nyberg.

c) ToR C Incorporate the MSFD into WGEXT. Overall lead from WGEXT: Ad Stolk C1. Years 2 and 3 (2014–2016) – Bringing forward the interpretation of GES descriptors 1, 4, 6, 7 and 11 of WGEXT to the EU. Lead from WGEXT: Ad Stolk

C2. Years 2 and 3 (2014–2016) - Collate the implications of GES descriptors 1, 4, 6, 7 and 11 for marine sediment extraction. Lead from WGEXT: Ad Stolk (with all members to provide country view)

C3. Year 3 (2015/2016) - Review the 2003 ICES guidelines on Marine Aggregate Extraction, specifically in relation to the GES descriptors of the MSFD in light of discussions concerning 1 and 2 above. Lead from WGEXT: Ad Stolk.

d) ToR D Ensure outputs of the WGEXT are accessible by publishing as a group and creating a webpage on the ICES website. Overall lead from WGEXT: Michel Desprez

D1. Years 2 and 3 (2014–2016) Publish outputs from ToR 6a concerning intensity Lead from WGEXT: Annelies de Backer and Keith Cooper.

D2. Years 1 to 3 (2013–2016) Investigate other outputs to publish. Lead from WGEXT: Michel Desprez.

D3. Year 1 (2013/2014) Populate webpage on the ICES website. Lead from WGEXT: Ad Stolk

D4. Year 3 (2015/16) Develop a proposal and organize a theme session at 2016 ICES Annual Science Conference. Lead from WGEXT: Ad Stolk and Keith Cooper (plus other members to present)

e) ToR E Discuss the mitigation that takes place across ICES countries and where lessons can be learnt or recommendations taken forward (years 2 and 3, 2014–2016). Overall lead from WGEXT: Keith Cooper

f) ToR F Study the implications of the growing interest in deep sea mining for the WGEXT (legislation/environmental/geological). Overall leads from WGEXT: Bryndis Robertsdottir and Brigitte Lauwaert

F1. Years 1 and 2 (2013–2015). Produce summary paper concerning deep sea mining (What is being mined, where this is occurring, techniques being developed, etc.). Lead from WGEXT: Bryndis Robertsdottir, Jan van Dalfsen and Rui Quartau.

g) ToR G Promote harmonization, where possible, of data across ICES countries. Overall lead from WGEXT: Jyrki Hämäläinen ToR G will involve ICES Data Centre where possible

G1. Year 2 (2014/2015) Define the interpretation of intensity across ICES countries. Lead from WGEXT: Annelies de Backer, Keith Cooper and Sander de Jong

G2. Years 1–3 (2013–2016) Define where else data can be harmonized with regards to aggregate extraction Lead from WGEXT: Jyrki Hämäläinen.

h) ToR H Identify the way archaeological, cultural and geomorphological values are taken into account. Overall lead from WGEXT: Michel Desprez

H1. Year 3 (2015/2016) All countries to provide details of how cultural values are taken into account. Lead from WGEXT: Michel Desprez.

i) ToR I Cumulative assessment guidance and framework for assessment should be developed. It is acknowledged that this work may be being developed within another ICES or OSPAR WG and steps should be taken to investigate and align guidance as appropriate. Overall lead from WGEXT: Jan van Dalfsen

I1. Years 1 and 2 (2013–2015) WGEXT to collate and review outputs from other WGs for relevance to WGEXT. Lead from WGEXT: Jan van Dalfsen.

j) ToR J Identify threshold conditions and associated reasoning for EIAs in different countries, discuss whether similar thresholds could apply in other countries (Year 3). Overall lead from WGEXT: Henry Bokuniewicz

3 Summary of Achievements of the WG during 3-year term

- Yearly Annual Report with data on marine sediment extraction, including amounts of extraction, spatial extent of licensed areas, spatial extent of extracted areas, geospatial shapefile information.
- Yearly delivery to OSPAR of the dataset on the extraction of marine sediments in the OSPAR Area. Both the amounts and the area of extraction is important for OSPAR to define the pressure of this activity to the ecosystem. This input is necessary for the Quality State Reports and for the Marine Strategy Framework Directive of the European Union.
- Cooperative Research Report (CRR 330) 'Effects of extraction of marine sediment on the marine environment 2005–2011.'
- ICES Annual Science Conference 2016. Session K: Making marine sediment extraction sustainable by mitigation of related processes with potential negative impacts.
- Introduction texts were published on the ICES website on WGEXT, CRR 330 and ASC 2016 theme session K.
- Inventory of procedures and legislation concerning aggregate extraction and cultural heritage for each ICES member country.

4 Final report on ToRs

ToR A1

Each year a summary table of national aggregate extraction activities is redacted. This table contains information on the total amount of extraction, and the amounts extracted for construction/industrial aggregates, beach replenishment (coastal nourishment), construction fill/land reclamation, non-aggregates (shells etc.) and exported aggregate.

It also contains information if there are taken place any changes in legislation, policy, resource mapping or activities connected with Environmental Assessment Impact Studies.

Besides this, yearly tables are given with information for each country about the area that is licensed and the area were actual extraction has taken place. This information is only available for a minority of the countries.

All these data are yearly gathered from all ICES countries. That is not always an easy job, but most countries deliver their data yearly. Information in the form of shapefiles on licensed areas is available in 9 countries, on extracted areas in 5 countries. The shapefiles are delivered to OSPAR.

ToR A2

In spite of several requests only from 6 countries information is received, mostly on resource mapping.

ToR B

To prepare the implementation of the WGEXT database, related to marine aggregates extractions, that would be linked to the ICES one (to ensure compliance with their guidelines and international standards), the group discussed about the information it should contain (see table in Annual Report 2016 (Annex A)). This table has also been presented to personnel working with the ICES database. ICES found the database of great interest and have now (2016) the time and resources to help WGEXT to create such a database.

The objective is to get easier access, both for the member countries to provide and deliver annual data in a standardized format and for e.g. ICES, OSPAR, scientists, policy-makers to retrieve data for e.g. marine pressure studies. Furthermore, during the OSPAR EIHA (Committee of environmental impact of human activities) 2016 meeting, it was decided not to develop a separate tool within the ODIMS (OSPAR data and information system) database, but OSPAR would in its activity be very much helped to be able to connect and linked to the ICES WGEXT coming database. This among other things is intended to avoid creating duplicate databases.

The ICES database will be used for uploading the WGEXT information. In terms of maintenance, the OSPAR data could be updated as part of ToR A1 completed during each Annual Meeting.

ToR C

During the Annual Meeting of 2014 it was decided to focus on the direct effects of marine sediment extraction (on descriptors 6, 7 and 11), but attention will also be placed on descriptors 1 and 4.

An inventory is made in several documents about the Marine Strategy Framework Directive (MSFD) on the incorporation of extraction as a human impact factor and in what way it is mentioned.

ToR D

ToR D1: Since the subject on harmonization of intensity is still under discussion and data from different countries is not readily available, no publication on the subject could be made during this three years cycle.

ToR D2 : In February 2016 the Cooperative Research Report (CRR 330) is published on 'Effects of extraction of marine sediment on the marine environment 2005–2011.'

The next CRR will cover the years 2012–2018.

A review article is prepared on Marine Aggregate Extraction and Marine Strategy Framework Directive: A review of existing research. This collaborative contribution of the WGEXT will provide information on research related to impacts of marine aggregate extraction, and their connection with the criteria for Good Environmental Status.

D3. The WGEXT page on the ICES website was reviewed. The text was brief but acceptable. The photograph will be changed, however.

To introduce the new Cooperative Research Report (330) of WGEXT, an introduction text was written for the ICES website and the press release.

D4. The ICES Annual Science Conference will be held in Latvia in September 2016.

The WGEXT proposal for a session was successful. We will have a WGEXT session there to fit into the ICES strategic plan.

ToR E

A questionnaire had been sent to all member countries during the 2014 Annual Meeting.

The WGEXT questionnaire included mitigation as might be proscribed in the Environmental Impact Assessments and specified in the license conditions. WGEXT members were asked to describe mitigation intended to address ecological concerns, interactions with commercial fisheries, historic environment mitigation, and potential interference with navigation. Best management practices and monitoring requirements may be also specified.

ToR F

This ToR was only initially started, with a discussion on the subject and the definition of deep sea mining, some presentations and the intention to send around a questionnaire.

ToR G

This ToR was the last three years mainly dedicated to harmonization of the use of dredging intensity across ICES countries. An official EMS data request was sent in March 2016 to the involved authorities of France, UK, the Netherlands, Denmark and Belgium. The questionnaire on how EMS data is collected and processed in the different countries, was updated. As such 8 countries, comprising the countries with the highest extraction amounts, filled out the questionnaire.

The original goals of the ToR were achieved by:

a) defining the intensity of extraction as volume/area/time, but the parameters needed for calculations are not readily available. As a result, we have decided that dredging time/area/ time period would be used as a surrogate for intensity.

b) recognizing the need for harmonized data throughout the member countries, especially regarding the yearly reporting and the database under development.

No new urgent other harmonization needs were discovered.

It was decided that the ToR G: Promote harmonization, where possible, of data across ICES countries will be considered as "finished".

The item 'Intensity' will be incorporated in ToR I.

ToR H

WGEXT has send a questionnaire around to compile an inventory of procedures and legislation concerning aggregate extraction and cultural heritage for each member country.

Nineteen ICES countries (out of 20) answered WGEXT request relative to Underwater Cultural Heritage (UCH). So a complete overview on the state of the art of this topic in the ICES countries is achieved.

ToR I

From a literature review a draft cumulative assessment guidance is written. ToR I1 has been completed.

In light of this review, the WGEXT decided that the topic is already adequately being covered by research programs and international working groups, e.g. within OSPAR. As a result, WGEXT will not work on the development of tools for Cumulative Impact Assessments (CIA). However, national progress on CIA of marine aggregates extractions (i.e. case studies, research projects etc.) will continue to be tracked by the WGEXT. WGEXT will continue ToR I to provide guidance ensuring that marine-aggregate extraction data is incorporated properly into the implementation of generic CIA models.

ToR J

WGEXT has compiled an inventory of thresholds that are currently used for Environmental Impact Assessments.

Reports on thresholds applied in member countries have been received from 12 countries.

5 Cooperation

- Cooperation with other WG

  Cooperation with WGMS on deep sea mining
- Cooperation with Advisory structures
- Cooperation with other IGOs

Cooperation with OSPAR by delivery of data on marine sediments extraction

6 Summary of Working Group evaluation and conclusions

A summary is given for the ToRs. For details see the Annual Report 2016 in Annex A.

ToR A1

The total amount of extraction in the ICES countries in the years 2012–2015 varied between 75 and 95 million m^3. No clear trend is seen over these years. The main differences are caused by large scale projects in the Netherlands.

Amounts of licensed areas are given for 9 countries. The data for each country are rather stable from year to year. More important for the assessment of the pressures of the extraction activities for the Quality State Reports (OSPAR) and the Marine Strategy Framework Directive (EU) are the areas that are really extracted. Up until now there are only useful figures for 3 countries. An important notice for the assessment of the pressure is that in most cases the extracted area is only a small part of the licensed area. For Belgium it is 32%, for the Netherlands 18% and for the UK 13%. And even these figures are rather high to assess the pressure, because in some countries 90% of the extraction is from a small part of the total extracted area.

ToR A1 will be continued.

ToR A2

The subjects of ToR A2 were incorporated every year in the Annual Reports of WGEXT and in every Cooperative Research Report. At the beginning of this 3-years period it was decided not to incorporate the items of ToR A2 in the Interim Reports, but only in the Final Report, because these items were not changing very fast. This did not work. The countries lost their standard procedure to deliver the information each year and despite several requests only 6 countries give some information for the Final Report and then most only on the item of resource mapping.

The items of ToR A2 contain important information and the ToR will be continued.

However, it has to be decided if the information will be in the Annual Reports again or in the Cooperative Research Reports only.

ToR B

The WGEXT database is proposed to be as concise as possible, so that data that is already collected (e.g., volume and spatial area tables from current Annual Reports) could be used, harmonized and easily incorporated into the database kept in an electronic format. WGEXT has also in this ToR prepared data of historical extraction volumes compiled from the WGEXT Annual Reports to be delivered to the database. ICES has decided that these data could be delivered for incorporation into the database after reviewing and final validation.

The database is proposed to contain two levels of information with associated data fields. The first level should contain information at the national scale for each year and each region on extracted amounts, licensed and extracted areas, and the application of

Environmental Impact Assessments, monitoring, black boxes/EMS-systems and mitigation.

The second level is more detailed and focused on licensed areas to make it possible for interested parties to contact the relevant WGEXT-member for further information concerning EIAs, monitoring and mitigation that are carried out and whether there is legislation and research ongoing in member countries.

This database second level would enable to be linked with the GIS ESRI shapefiles that WGEXT deliver annually to OSPAR.

ToR B will be continued. WGEXT will also continue to discuss the feasibility of developing the complexity of the database. Future expansion of the database is expected to be driven by inquiries from potential users.

ToR C

Although marine sediment extraction can have influence on the descriptors 1, 4, 6, 7 and 11 the main effects are via descriptor 6 on D1 and D4. Therefore in the discussions about the effects of marine sediment extraction within the MSFD the focus can be on D6. Nevertheless effects on D1 and D4 via D7 and D11 should not be ignored. Also direct effects on D1 and D4 are possible by an increasing amount of fines in the water column due to extraction activities.

The possibility of recovery after sediment extraction should be acknowledged by incorporate it in the criteria and by taken it into account with the assessment of the Good Environmental Status.

It is important to realize that biological/ecological recovery can be reached without recovery of the physical state. Even in the case of permanent loss of the original morphological state of the seafloor the benthic fauna can recover and the structure and functions of the ecosystems can be safeguarded and benthic ecosystems not adversely affected.

To bring forward the interpretation of GES Descriptors from the point of view of sediment extraction it is important that WGEXT joins the discussions on this subject in the workshops planned for 2017 and 2018, especially because in the Advice of ICES it is stated that the concept of switching to an approach based on functionality and recoverability should not be lost for future work.

After these workshops and the completion of the article on MSFD (ToR D) the ICES guidelines on Marine Aggregate Extraction can be reviewed. ToR C will be continued.

ToR D

The theme session on the ASC 2016 is on "Making marine sediment extraction sustainable by mitigation of related processes with potential negative impacts".

Conveners are WGEXT members: Ad Stolk (the Netherlands), Keith Cooper (UK), Michel Desprez (France).

The session consist of 15 oral presentations and 2 posters.

The aim of the session is to discuss how marine sediment extraction can become a more sustainable activity with minimal, and preferably temporal, effects on the ecosystem in line with the MSFD.

The review article: "Marine Aggregate Extraction and Marine Strategy Framework Directive: A review of existing research" is providing information on research aspects related to various effects of marine aggregate extraction on the seafloor and the water column, and the connection with criteria for good environmental status which is relevant to several descriptors of the MSFD: biological diversity (D1), commercial fishes (D3), marine food webs (D4), sea-floor integrity (D6), hydrographical conditions (D7) and underwater noise (D11).

This review also aims to highlight gaps to expand on the current knowledge to fulfil MSFD requirements.

The following table is summarizing the impacts on the marine ecosystem, developed in different chapters, and the links between these impacts and the descriptors.

Effects of aggregate extraction:	**Impact on:**	**Potentially influenced MSFD descriptors:**
Seabed removal	Topography/Bathymetry	(D1), D6, D7
	Sediment composition	D1, (D3), D6
	Habitat & biological communities	D1, (D3), D4, D6
Sediment plumes	Turbidity Deposition	D3, D4 D1, D3, D4, D6
Ship activities	Underwater noise	D11

ToR D is still ongoing. The article on MSFD is nearly achieved, but still needs further collaboration within WGEXT before this review can be submitted for publication.

WGEXT will stay alert on possibilities to publish on subjects that are related to the ToRs of this Expert Group.

ToR E

WGEXT would like to compile mitigation options and techniques from all ICES countries to investigate the comparability of techniques used, to determine whether they are site specific, or could be applied in multiple countries, as certain countries do not apply mitigation to aggregate extraction. In addition, WGEXT intends to update the 2003 guidelines on this item, should mitigation techniques have moved forward.

In the UK, the Netherlands, Belgium and France, operational mitigation requirements will typically be informed by the results of EIA. Explicit examples for UK and the Netherlands are given.

ToR E will be continued with (E1) a specific inventory in each member country of mitigation, compensation, and avoidance to prevent, reduce and offset any serious harmful effects, followed by (E2) an evaluation and assessment of these existing measures.

ToR F

Deep sea mining was previously raised as an emerging issue for the group (especially for countries such as Iceland, Portugal and some of the Baltic Sea countries). The group intends to produce a summary paper of the current state of deep sea mining across the 20 ICES countries (although it was noted that not all of the countries are involved in deep sea mining at present). The question of whether the paper should consider just the ICES area or also areas outside of ICES was posed. It was noted that currently, deep sea mining only occurs in the Azores. However, despite the Netherlands and Belgium being involved in projects outside of the ICES area and an interest in manganese and rare earth metals exploration taking place in the Baltic, there are few locations within Europe where deep sea mining is currently thought to be of economic value.

The group also discussed the term "deep sea mining". This term only covers activities in deeper waters and excludes mining for resources other than gravel, sand, maerl and shells. There may be other resources of interest available in ICES member states, such as (rare earth) metals and Seafloor Massive Sulphides (SMS) crusts. It was suggested that "marine mineral mining" or "marine mineral extraction" should replace "deep sea mining" to ensure it covers every type of resource, including those that are not located in deep sea locations.

After discussion, it was proposed the group would conduct the following actions over the coming years:

1) Compile an inventory of activities related to marine mineral mining by members states;
2) Compile an inventory to check if mining of resources other than sand, gravel, maerl and shell is foreseen within the national legislation within member states;
3) For the ToR, compile an inventory of whether mining outside the EEZ is included within the national legislation of member states.

This ToR will continue with a poll concerning the ICES-country's policies associated with deep-sea mining in both the national jurisdiction and High Seas.

WGEXT intends to continue to stay abreast of the situation and would be prepared to offer the WGEXT guidelines for marine extractions if and when they might be helpful.

ToR G

Last year it was decided to start a test study to get more insight in the subject of harmonization of dredging intensity in the ICES area.

This study was rather successful. Data from Belgium, the Netherlands, and UK were used for the test. It became clear that data from Denmark and more data from the Netherlands and UK could be incorporated.

WGEXT agreed that this type of information is very useful to incorporate in cumulative impact assessment, and that it gives a good view on the actual footprint of aggregate dredging, and it allows for comparison between countries. This type of information is for the moment the best available allowing comparison between countries but it should be kept in mind that dredging time per area does not take into account other important parameters such as the size of the dredging vessel, the type of material extracted whether screening takes place or not, etc. This kind of information is as well important for impact assessments at a wider regional scale e.g. in the framework of the MSFD. As such, it was decided to take the work on harmonizing EMS/AIS data further to the next three year period but to incorporate it under the ToR studying cumulative impacts (ToR I).

ToR H

Fifteen countries take archaeological, cultural and geomorphological values into account in their national legislation, but it seems that only six have ratified the UNESCO Convention for the protection of Underwater Cultural Heritage (2001). Six have ratified the European Convention in Valletta, Malta on the Protection of Archaeological Heritage in 1992. Thirteen countries apply these values in EIAs, but only eight have a guidance note or a reporting protocol. Twelve countries have reported on present and/or past Research and Management projects.

With the achievement of a complete overview ToR (H) is now completed.

ToR I

WGEXT expects that information on the implementation of extraction in the Cumulative Impact Models (CIA) models will fill in the needs of the MSFD and of the MSPD for marine aggregate extraction. The work of WGEXT will be to define the information needed to such aims. Although ToR G on Harmonization has been concluded, the issue of intensity from ToR G will henceforth be included in the continuation of ToR I.

Over the next three years, WGEXT will direct its efforts under ToR I to define the information and guidelines needed by working groups within OSPAR and ICES for CIA by:

- (I1) Contacting OSPAR and ICES working groups on this issue (1st year)
- (I2) Continuing the development of defining the quantification of dredging intensity (2nd and 3rd year)
- (I3) providing the methodology needed to incorporate marine sediment extraction in CIA (3rd year).

ToR J

In general, there are provisions for a brief Environmental Assessment in advance of any more extensive EIA. The authority to require an EIA lies with the licensing authority, but recommendations can be provided to the licensing authority from other agencies, such as those responsible for fisheries. Some countries have numerical criteria either in law or policy that trigger EIAs. Others use professional judgment on a case-by-case basis, although of course, the professional experience includes informal, numerical criteria. Denmark, Sweden, France, Latvia, Poland and Belgium, require an EIA for all permits. Although reports were not received from all countries, the situations described are to be considered representative. This term of reference is completed.

Annex 1: List of participants and contributors 2013–2016

Name	Organization	Country
Laura Addington	Ministry of Environment and Food of Denmark	Denmark
Reidulv Boe	Leder Maringeologi	Norway
Henry Bokuniewicz	School of Marine and Atmospheric Sciences, Stony Brook University,Stony Brook NY	United States
Jose J. Buceta	Directorate for Coast and Sea Sustainability Ministry of Agriculture, Food and Environment	Spain
Ingemar Cato	Geological Survey of Sweden	Sweden
Keith Cooper	CEFAS	UK
Aldona Damusyte	Subdivision of Quaternary and Geology Processes Lithuanian Geological Survey	Lithuania
Annelies De Backer	Institute for Agricultural and Fisheries Research ILVO	Belgium
Maarten de Jong	Independent researcher	The Netherlands
Sander de Jong	Ministry of Infrastructure and the Environment Rijkswaterstaat Sea and Delta	The Netherlands
Michel Desprez	Independent researcher	France
Chris Dijkshoorn	Ministry of Infrastructure and the Environment Rijkswaterstaat Sea and Delta	The Netherlands
Algimantas Grigelis	NRC-GGI	Lithuania
Jyrki Hämäläinen	GTK Geological Survey of Finland	Finland
Kris Hostens	Institute for Agricultural and Fisheries Research ILVO	Belgium
Jochen Krause	German Federal Agency for Nature Conservation	Germany
Brigitte Lauwaert	Operational Directorate Nature Management Unit of the North Sea Mathematical Models (MUMM)	Belgium
Kurt Machetanz	Landesamt für Bergbau, Energie und Geologie	Germany
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Poul Erik Nielsen	Ministry of Environment and Food	Denmark
Johan Nyberg	Geological Survey of Sweden	Sweden
Rui Quartau	Instituto Português do Mar e da Atmosfera	Portugal
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Marcel Rozemeijer	WUR IMARES	The Netherlands
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Sten Suuroja	Geological Survey of Estonia	Estonia
Szymon Uścinowicz	Polish Geological Institute	Poland
Jan van Dalfsen	Independent researcher	The Netherlands
Camille Vogel	IFREMER Unite Manche-Ner du Nord	France
Rebecca Walker	CEFAS	UK

Annex 2: Recommendations

Recommendation	Adressed to
1. To ask the ICES-members to supply comprehensive information about their marine sediment extraction to ICES WGEXT. The use of electronic monitoring systems and 'black box' equipment is recommended.	ICES Data Centre
2. To inform WGEXT about workshops on MSFD descriptor 6 to be able to join the planned workshops in 2017 and 2018	ICES Secretariat
3. To bring forward to the gremia concerned that biological/ecological recovery after extraction can be reached without recovery of the physical state. The possibility of recovery after sediment extraction should be acknowledged by incorporate it in the criteria and by taken it into account with the assessment of the Good Environmental Status.	WGEXT via national networks
4. To put the Cooperative Research Reports also on the webpage of the Working group concerned.	ICES Secretariat

Annex 3: Copy of the Working Group self-evaluation

1) Working Group on the Effects of Extraction of Marine Sediments on the Marine Ecosystem

2) Year of appointment: 2014

3) Current Chair: Ad Stolk

4) Venues, dates and number of participants per meeting.

2–5 June 2014, Reykjavik, Iceland (13 participants)

20–23 April 2015, Ostend, Belgium (10 participants)

18–21 April 2016, Gdansk, Poland (12 participants)

Several members who could not attend the annual meetings contribute by correspondence.

WG Evaluation

5) If applicable, please indicate the research priorities (and sub priorities) of the Science Plan to which the WG make a significant contribution. Numbers refer to the version of the Science Plan at the start of the 3-year period: 1.2, 1.3, 1.5, 2.4, 3.3, 3.4.

6) In bullet form, highlight the main outcomes and achievements of the WG since their last evaluation. Outcomes including publications, advisory products, modelling outputs, methodological developments, etc. *

- Yearly Annual Report with data on marine sediment extraction, including amounts of extraction, spatial extent of licensed areas, spatial extent of extracted areas, geospatial shapefile information.
- Yearly delivery to OSPAR of the dataset on the extraction of marine sediments in the OSPAR Area. Both the amounts and the area of extraction is important for OSPAR to define the pressure of this activity to the ecosystem. This input is necessary for the Quality State Reports and for the Marine Strategy Framework Directive of the European Union.
- Triennial review of issues and relevant research being undertaken in ICES countries
- Cooperative Research Report (CRR 330) 'Effects of extraction of marine sediment on the marine environment 2005–2011.'
- ICES Annual Science Conference 2016. Session K: Making marine sediment extraction sustainable by mitigation of related processes with potential negative impacts.
- Inventory of procedures and legislation concerning aggregate extraction and cultural heritage for each ICES member country.
- Introduction texts were published on the ICES website on WGEXT, CRR 330 and ASC 2016 theme session K.

7) Has the WG contributed to Advisory needs? If so, please list when, to whom, and what was the essence of the advice.

Yearly delivery to OSPAR of the dataset on the extraction of marine sediments in the OSPAR Area. Both the amounts and the area of extraction is important for OSPAR to define the pressure of this activity to the ecosystem. This input is necessary for the Quality State Reports and for the Marine Strategy Framework Directive of the European Union. We have begun development of quantitative measures of dredging intensity and an historical database of extraction both of which will be continued in the next three-year period.

8) Please list any specific outreach activities of the WG outside the ICES network (unless listed in question 6). For example, EC projects directly emanating from the WG discussions, representation of the WG in meetings of outside organizations, contributions to other agencies' activities.

Besides the yearly delivery of data to OSPAR the activities are within the ICES network.

9) Please indicate what difficulties, if any, have been encountered in achieving the workplan.

The WG has formulated nine new ToRs in the beginning of this 3-year period. Most of them are extended for a longer period than 3 years. That means that time was needed for finding the right definitions for intensity of extraction, due to theoretical views and practical delivery of data (ToR G). The same is true for the establishing of a database (ToR B).

The subjects of ToR A2 were incorporated every year in the Annual Reports of WGEXT and in every Cooperative Research Report. At the beginning of this 3-years period it was decided not to incorporate the items of ToR A2 in the Interim Reports, but only in the Final Report, because these items were not changing very fast. This did not work. Without the benefit of an annual standard procedure to deliver the information each year, countries were hard pressed to recreate a three-year summary. Despite several requests only six countries give some information for the Final Report and then most only on the item of resource mapping. The items of ToR A2 contain important information and the ToR will be continued. However, the Working Group must reconsider whether the information is best provided in standard format in each Annual Report again, in the triennial Final Reports or only in the Cooperative Research Reports.

Future plans

10) Does the group think that a continuation of the WG beyond its current term is required? (If yes, please list the reasons)

Yes, because Term of Reference A1 and A2 are ongoing items to deliver data to OSPAR and share information between ICES-member countries. Also several other ToR that started in this 3-year period are ongoing, e.g. Developing measures of dredging intensity, organize and filling the database on marine extraction (ToR B), incorporation of MSFD in the guidelines (ToR C), publications (ToR D), methods of mitigation (ToR E), deep sea mining (ToR F), cumulative assessment (ToR I) and the new ToR on effects on fisheries and implication on Marine Spatial Planning.

11) If you are not requesting an extension, does the group consider that a new WG is required to further develop the science previously addressed by the existing WG.

(*If you answered YES to question 10 or 11, it is expected that a new Category 2 draft resolution will be submitted through the relevant SSG Chair or Secretariat*.)

12) What additional expertise would improve the ability of the new (or in case of renewal, existing) WG to fulfil its ToR?

The now established contact with the ICES Data Centre should be intensified to adjust our data input and the needs of OSPAR to the ICES Database.

13) Which conclusions/or knowledge acquired of the WG do you think should be used in the Advisory process, if not already used? (please be specific)

The members of the WG are not only scientists, but also based in legislation, policy and industry. This means that within the WG a broad view exists on marine sediment extraction and its effects from several points of view. This can enhance the contribution to the advisory process.

Annex 4: WGEXT resolution for multi-annual ToRs 2017–2019

The **Working Group on the Effects of Extraction of Marine Sediments on the Marine Ecosystem** (WGEXT), chaired by Ad Stolk, The Netherlands, will work on ToRs and generate deliverables as listed in the Table below.

	Meeting dates	Venue	Reporting details	Comments (change in Chair, etc.)
Year 2017	24–27 April	London, UK	Interim report by 30 June to SSGEPI	
Year 2018			Interim report by XXX to SSGEPI	
Year 2019			Final report by XXX to SCICOM	

ToR descriptors

ToR	Description	Background	Science Plan topics addressed	Duration	Expected Deliverables
A1	Review data on marine extraction activities. Provide a summary of data on marine sediment extraction for the OSPAR region to OSPAR.	a) OSPAR Requirements b) Advisory Requirements c) Inform other countries to optimize their policy and management	EPI 11 IEA 20	yearly	Annual extracted volumes and areas as a chapter in all Interim and Final Reports
A2	Review of development in marine resource mapping, legal regime and policy, environmental impact assessment, research and monitoring and the use of the ICES Guidelines on Marine Aggregate Extraction.	a) Advisory Requirements b) Inform other countries to optimize their policy and management	IEA 18, 20 IEOM 25, 27	Year 3	chapter in Final Report
B	Create an ICES aggregate database comprising all aggregate related data, including scientific research, EIA, licensing and monitoring data.	a) Advisory Requirements b) Inform other countries to optimize their policy and management c) Cooperation with other WG's d) Link to ICES database	EPI 11 IEA 20	Year 1,2,3	Year 1: review and validation historical data Year 2: finalise template for approval ICES Data Centre Year 3: template to ICES countires

C	Incorporate MSFD into WGEXT	a) Advisory Requirements b) Inform other countries to optimize their policy and management c) Tuning WGEXT and ICES guidelines with EU guidelines	EPI 11, 14 IEA 18	Year 2 and 3	Year 2and 3: participation in ICES workshops on MSFD D6 Year 3: review of ICES Guidelines on Marine Aggregate Extraction
D	Ensure outputs of the WGEXT are accessible by publishing as a group and creating a webpage on the ICES website.	a) Inform other countries to optimize their policy and management b) Contribute to the visibility and impact of ICES	EPI 14 IEA 20	Years 2,3	Year 2: submitting review manuscript on MSFD to a peer-reviewed journal Year 3: submitting manuscript on intensity of extraction to a peer-reviewed journal
E	Discuss the mitigation that takes place across ICES countries and where lessons can be learned or recommendations taken forward	a) Advisory Requirements b) Inform other countries to optimize their policy and management	EPI 12 IEA 19 IEOM 27	Year 2 and 3	Year 2: specific inventory on mitigation in ICES countries Year 3: evaluation and assessment of mitigation measures
F	Study the implications of the growing interest in deep sea mining for the WGEXT (legislation, environmental, geological)	a) Initiate the incorporation of this coming issue within ICES b) Inform other countries to optimize their policy and management	EPI 11, 12, 14	Year 1,3	Year 1: inventory of marine mineral mining by ICES countries Year 1: poll to ICES countries concerning policy and legislation on dep sea mining Year 3: report on the assessment of outcome of inventories
I	Cumulative assessment guidance and framework for assessment should be developed.	Contribute and working together with possible other ICES and OSPAR WG's that are involved in this subject	EPI 11 IEA 18, 19, 23 IEOM 27	Year 1,3	Year 1: contacting OSPAR and ICES working groups on the incorporation of marine sediment extraction in cumulative assessments Year 3: finalise the definition of quantification of dredging intensity Year 3: report on examples and a

					general methodology to incorporate marine sediment extraction in Cumulative Impact Assesments
K	Impacts of marine aggregate extraction on fish and fisheries	Contribute and working together with possible other ICES WG's that are involved in this subject	EPI 11, 12 IEOM 25	Year 2,3	Year 2: report on the inventory of policy of ICES countries Year 3: review of research
L	Implications of Marine Spatial Planning on marine sediment extraction	a) Advisory Requirements b) Inform other countries to optimize their policy and management	EPI 14	Year 2,3,	Year 2: report on the inventory of ICES countries policy development Year 3: review report on the incorporation of marine sediment extraction in Marine Spatial Planning in ICES member countries

Summary of the Work Plan

Year 1	A1, B, F, I
Year 2	A1, B, C, D, E, K, L
Year 3	A1, A2, B, C, D, E,F, I, K, L

Supporting information

Priority	The current activities of WGEXT will lead ICES into issues related to the ecosystem effects of marine aggregate extraction. Aggregate extraction is increasing in some countries and rather stable in others. This activity is connected to several Descriptors in the EU MSFD. The Report of WGEXT and the Guidelines are used in the management of this activity in the member countries. Consequently, these activities are considered to have a high priority.
Resource requirements	Notice that the activities of WGEXT are focussed on the use of existing research programmes (e.g. EIA monitoring) and data on extraction and management. The additional resource required to undertake additional activities in the framework of this group is negligible
Participants	The Group is normally attended by some 12–20 members and guests.
Secretariat facilities	None.
Financial	No financial implications.
Linkages to ACOM ar groups under ACOM	There are no obvious direct linkages.

Linkages to oth committees or groups	There is a potentially working relationship with all the groups of SCICOM. The coming years a cooperation with other WG's is planned on the subjects of cumulation of effects, create and use a database and the effects on fisheries. On deep sea mining there is cooperation with WGMS.
Linkages to oth organizations	Data on marine extraction are delivered to OSPAR

Annex 5: Detailed report of the WGEXT 2016 meeting

Summary

The Working Group on the effects of extraction of marine sediments on the marine ecosystem (WGEXT) met in Gdansk, Poland, 18–21 April 2016. Twelve participants from eight ICES member countries attended the meeting. Contributions were provided from six (Estonia, Ireland Norway, Portugal, Spain and the UK) countries whose representatives could not attend.

The objective of WGEXT is to provide a summary of data on marine sediment extraction (ToR A1), marine resource and habitat mapping, changes to the legal regime, and research projects relevant to the assessment of environmental effects (ToR A2). The data on marine sediment extraction will be reported annually. WGEXT previously defined nine other ToRs which WGEXT has identified as important issues to be addressed.

Data reports were reviewed from 16 (of 20) member countries. Although not all of the member countries provided reports, the available data is thought to provide a representative assessment of the overall total of material extracted from the ICES area.

Work had been ongoing during 2015 on the other ToRs (B–J). During 2015, inquiries were sent to member countries for ToRs B, E, G, H and J, with responses received from several member states. ToRs G, H and J have been completed. The others are continuing with modifications. Efforts will continue during 2016 to get responses from the remaining ICES countries. ICES WGEXT agreed to meet again in the United Kingdom 24–27 April, 2017 as guests of the BMAPA.

1. Opening of the meeting

The Working Group on the Effects of Extraction of Marine Sediments on the Marine Ecosystem (WGEXT) was welcomed to the Marine Geology Branch of the Polish Geological Institute by WGEXT member Szymon Uścinowicz who had organized the meeting in Gdansk, Poland. Dr Regina Kramarska, director of Marine Geology Branch of Polish Geological Institute-National Research Institute, welcomed the group and provided an introduction. The Institute includes marine geologists and hydrologists as well as technical experts in geohazards. The chair of WGEXT, Ad Stolk, thanked the Polish Geological Institute for hosting the meeting and all countries for providing national reports. The meeting included a fieldtrip in afternoon on 21 April.

Henry Bokuniewicz served as the rapporteur. Jochen Krause (Germany), Jan van Dalfsen (The Netherlands), Mark Russel and Keith Cooper (U.K.), Ingemar Cato (Sweden), Maarten de Jong (the Netherlands), Marcel Rozemeijer (The Netherlands); and Rui Quartau (Portugal) all sent their apologies for being unable to attend. Camille Vogel (IFREMER, France) and Laura Addington (Ministry of Environment and Food of Denmark) joined us and were welcomed to the group.

2. Adoption of the agenda

The 2016 annual meeting marks the third year of the three year ICES reporting period. The 2015 Interim Report has been published. The agenda was duly adopted by the WGEXT members in attendance (Annex 2).

3. Terms of Reference

The Terms of Reference for WGEXT 2013 to 2016 (agreed within the SICOM Steering Group on Human Interactions on Ecosystems Resolutions (SSGHIE 2013)) are:

a) **ToR A**

A1. Review data on marine extraction activities including volumes, spatial areas and the collection of geospatial data on extraction locations in the form of shape files for OSPAR. To be produced every year (interim and final reports) and sent to OSPAR.

A2. Review of development in marine resource mapping, legal regime and policy, environmental impact assessment, research and monitoring and the use of ICES Guidelines on marine aggregate extraction. To be produced every three years.

b) **ToR B** Create an ICES aggregate database (linked to the ICES Data Center) comprising all aggregate related data, including scientific research and EIA licensing and monitoring data. *Overall lead from WGEXT: Johan Nyberg*

ToR B is an engaging task. As a result, we expect that they will take over three years to construct. In the first instance, WGEXT wish to create a database which allows users to contact relevant organizations in each country and see what data are available (rather than access the data themselves through the data-base). WGEXT will contact other WGs to look at how they have constructed/formatted their databases:

B1. Year 1 (2013/2014) – creation of a template with data required from each country. *Lead from WGEXT: Johan Nyberg, Ingemar Cato, Marcel Rozemeijer and Henry Bokuniewicz.*

B2. Year 1 (2013/2014) – Check with ICES options for WGEXT database linked to ICES database *Lead from WGEXT: Johan Nyberg.*

B3. Year 1 (2013/2014) – Create an inventory of other WG contacted with regards databases of relevance to WGEXT to allow possible links to be created within the WGEXT database. *Lead from WGEXT: Marcel Rozemeijer.*

B4. Year 2 (2014/2015) – template to be finalized and populated for each country and sent for approval to ICES. *Lead from WGEXT: All members, coordinated by Johan Nyberg.*

c) **ToR C** Incorporate the MSFD into WGEXT. *Overall lead from WGEXT: Ad Stolk*

C1. Years 2 and 3 (2014–2016) - Bringing forward the interpretation of GES descriptors 1, 4, 6, 7 and 11 of WGEXT to the EU. *Lead from WGEXT: Ad Stolk.*

C2. Years 2 and 3 (2014–2016) - Collate the implications of GES descriptors 1, 4, 6, 7 and 11 for marine sediment extraction. *Lead from WGEXT: Ad Stolk (with all members to provide country view)*

C3. Year 3 (2015/2016) - Review the 2003 ICES guidelines on Marine Aggregate Extraction, specifically in relation to the GES descriptors of the MSFD in light of discussions concerning 1 and 2 above. *Lead from WGEXT: Ad Stolk*.

d) **ToR D** Ensure outputs of the WGEXT are accessible by publishing as a group and creating a webpage on the ICES website. *Overall lead from WGEXT: Michel Desprez.*

D1. Years 2 and 3 (2014–2016) Publish outputs from ToR G concerning intensity *Lead from WGEXT*: *Annelies de Backer and Keith Cooper.*

D2. Years 1 to 3 (2013–2016) Investigate other outputs to publish. *Lead from WGEXT: Michel Desprez.*

D3. Year 1 (2013/2014) Populate webpage on the ICES website. *Lead from WGEXT: Ad Stolk*

D4. Year 3 (2015/16) Develop a proposal and organize a theme session at 2016 ICES Annual Science Conference. *Lead from WGEXT*: *Ad Stolk and Keith Cooper (plus other members to present)*

e) **ToR E** Discuss the mitigation that takes place across ICES countries and where lessons can be learnt or recommendations taken forward (years 2 and 3, 2014–2016). *Overall lead from WGEXT: Keith Cooper.*

f) **ToR F** Study the implications of the growing interest in deep sea mining for the WGEXT (legislation/environmental/geological). *Overall leads from WGEXT: Bryndis Robertsdottir and Brigitte Lauwaert.*

F1. Years 1 and 2 (2013–2015). Produce summary paper concerning deep sea mining (What is being mined, where this is occurring, techniques being developed, etc.). *Lead from WGEXT: Bryndis Robertsdottir, Jan van Dalfsen and Rui Quartau.*

g) **ToR G** Promote harmonization, where possible, of data across ICES countries. *Overall lead from WGEXT: Jyrki Hämäläinen*. ToR G will involve ICES Data Centre where possible.

G1. Year 2 (2014/2015) – Define the interpretation of intensity across ICES countries. *Lead from WGEXT: Annelies de Backer, Keith Cooper and Sander de Jong*

G2. Years 1–3 (2013–2016) – Define where else data can be harmonized with regards to aggregate extraction *Lead from WGEXT: Jyrki Hämäläinen.*

h) **ToR H** Identify the way archaeological, cultural and geomorphological values are taken into account. *Overall lead from WGEXT: Michel Desprez.*

H1. Year 3 (2015/2016) All countries to provide details of how cultural values are taken into account. *Lead from WGEXT: Michel Desprez.*

i) **ToR I** Cumulative assessment guidance and framework for assessment should be developed. It is acknowledged that this work may be being developed within another ICES or OSPAR WG and steps should be taken to investigate and align guidance as appropriate. *Overall lead from WGEXT: Jan van Dalfsen*

I1. Years 1 and 2 (2013 – 2015) WGEXT to collate and review outputs from other WGs for relevance to WGEXT. *Lead from WGEXT: Jan van Dalfsen.*

j) **ToR J** Identify threshold conditions and associated reasoning for EIAs in different countries, discuss whether similar thresholds could apply in other countries (Year 3). *Overall lead from WGEXT: Henry Bokuniewicz*

4. Term of Reference A1: Review annual data on marine extraction activities including volumes, spatial areas and the collection of geospatial data on extraction locations in the form of shapefiles

ICES WGEXT have again attempted to provide information for all ICES countries on the annual amounts of sand and gravel extracted but have still found difficulty in obtaining information from countries not regularly represented in person at ICES WGEXT meetings. WGEXT members again attempted to contact those countries who were unable to submit data for inclusion in the annual report (Annex 10). A summary of available information is included in Table 4.1a and 4.1b.

Table 4.1a. Summary Table of National Aggregate Extraction Activities in 2015.

Country	A) Construction/ industrial aggregates (m^3)	B) Beach replenishment (m^3)	C) Construction fill/ land reclamation (m^3)	D) Non-aggregate (m^3)	E) Total Extracted (m3)	F) Aggregate exported (m^3)
Belgium (OSPAR)	2,330,000	481,000	0	0	2,810,000	1.079,000
Canada	N/d	N/d	N/d	N/d	N/d	N/d
Denmark[2,9] (HELCOM)	2,197,364	80,706	201,454	0	2,707,071	12,980
Denmark[2,9] (OSPAR)	1,462,353	1,953,120	1,280,773	0	4,896,947	317,901
Denmark (total)	3,481,557	2,033,473	1, 491,497	0	7,006,527	321,081
Estonia (HELCOM)	0	0	0	0	0	0
Finland (HELCOM)	0	0	0	0	0	0
France[3] (OSPAR)	2 692 628	N/d [11]	N/d	250 800[12]	2 943 428	0
France (Med)	0	N/d [11]	N/d	0	N/d	0
Germany (HELCOM)	476,958	308,631	0	0	785,598	0
Germany (OSPAR)	20,558	1,494,980	0	0	1,515,538	0
Greenland and Faroes (OSPAR)	N/d	N/d	N/d	N/d	N/d	N/d
Iceland (OSPAR)	N/d	N/d	N/d	N/d	N/d	0
Ireland (OSPAR)	0	0	0	0	0	0
Latvia (HELCOM)	N/d	N/d	N/d	N/d	N/d	N/d
Lithuania (HELCOM)	0	0	0	0	0	0
Netherlands4 (OSPAR)	6,666,118	17,772,647	1,457,010	204,873	26,100,648	3,182,940
Norway (OSPAR)	0	0	0	few thousand	few thousand	0
Poland (HELCOM)	269 167	355 500	0	0	624 667	0
Portugal (OSPAR)	161,201	140,000	0	0	392,201	0
Spain (OSPAR)	0	261,457	0	0	261,457	0
Spain (MED)	0	0	0	0	0	0

Spain (Canary Islands)	0	0	0	0	0	0
Sweden (OSPAR)	0	0	0	0	0	0
Sweden (HELCOM)	0	0	0	0	0	0
United Kingdom[6] (OSPAR)	15,589,613	1,247,593	1,088,348	0	19,467,275	1,297,076
United States	0	8,428,825	0	1,100,959	9.529,784	0

Table 4.1b. Summary Table of National Aggregate Extraction Activities in 2015 (continued).

Country	New Maps/Data available*	New legislation	New Policy	EIA initiated	EIA ongoing	EIA finished	EIA published
Belgium (OSPAR)	Yes[1]	No	Yes	No	No	No	No
Canada	N/d	N/d	N/d	N/d	N/d	N/d	N/d
Denmark[2](HELCOM)	Yes	Yes	No	Yes	Yes	Yes	Yes
Denmark[2] (OSPAR)	Yes	Yes	No	Yes	Yes	Yes	Yes
Denmark							
Estonia (HELCOM)	Yes	N/d	N/d	Yes	Yes	N/d	N/d
Finland (HELCOM)	Yes	No	No	No	No	No	No
France 3 (OSPAR)	Yes	No	No	No	Yes	Yes	Yes
France (Med)	No	No	No	No	No	Yes	Yes
Germany (HELCOM)	N/d	N/d	N/d	N/d	N/d	N/d	N/d
Germany (OSPAR)	N/d	N/d	N/d	N/d	N/d	N/d	N/d
Greenland and Faroes (OSPAR)	N/d	N/d	N/d	N/d	N/d	N/d	N/d
Iceland (OSPAR)	No	Yes?	No	No	No	No	No
Ireland (OSPAR)	N/d	N/d	N/d	N/d	N/d	N/d	N/d
Latvia (HELCOM)	N/d	N/d	N/d	N/d	N/d	N/d	N/d
Lithuania (HELCOM)	N/d	N/d	N/d	N/d	N/d	N/d	N/d
Netherlands (OSPAR)	No[1]	No	Yes	No	No	No	No
Norway (OSPAR)	N/d	N/d	N/d	N/d	N/d	N/d	N/d
Poland (HELCOM)	Yes	No	No	N/d	N/d	N/d	N/d
Portugal (OSPAR)	No	No	No	No	No	No	No
Spain (OSPAR)	N/d	N/d	N/d	N/d	N/d	N/d	N/d
Spain (MED)	N/d	N/d	N/d	N/d	N/d	N/d	N/d
Spain (Canary Islands)	N/d	N/d	N/d	N/d	N/d	N/d	N/d
Sweden (OSPAR)	Yes	No	No	Yes	Yes	No	No
Sweden (HELCOM)	Yes	No	No	Yes	Yes	No	No

United Kingdom[6] (OSPAR)	Yes	No	No	Yes	Yes	Yes	Yes
United States	No	No	No	No	Yes	No	No

Table Definitions and notes:

A. Construction/industrial aggregates - marine sand and/or gravel used as a raw material for the construction industry for building purposes, primarily for use in the manufacture of concrete but also for more general construction products.

B. Beach replenishment/coastal protection – marine sand and/or gravel used to support large-scale soft engineering projects to prevent coastal erosion and to protect coastal communities and infrastructure.

C. Construction fill/land reclamation – marine sediment used to support large scale civil engineering projects, where large volumes of bulk material are required to fill void spaces prior to construction commencing or to create new land surfaces.

D. Non-aggregates – comprising rock, shell or maerl.

E. Total Extracted – total marine sediment extracted by Member Countries

F. Aggregates Exported - the proportion of the total extracted which has been exported i.e. landed out-side of the country where it was extracted.

*** "maps" refer to resource maps, not extraction area maps**

[1] Data continually updated and new maps available on demand from database

[2] The OSPAR area and the HELCOM area are overlapping in Denmark. The Kattegat area from Skagen to north of Fyn-Sjælland is included in both Conventions. Therefore the figures from the two Convention-areas cannot be added. Therefore the total for Denmark is given separately.

[3] For the first time the extraction quantities of France are the actual extracted volumes, not the licensed volumes.

[4] Total shell extraction including Western Scheldt and Wadden Sea

[5] Quantity estimated based on feedback from license holders

[6] Conversion from reported tonnes to m^3 achieved using density / specific gravity conversion factor of 1.66

[7] Figures reported for USA pertain to north eastern Seaboard only

[8] Total sand-extraction figures exclude 161,458 m3 of shells as non-aggregate material

[9] In previous reports estimated amounts of Denmark for 2013 and 2014 were given. The exact figures for 2013 and 2014 will be reported in the Annual Report in 2017.

[10] Conversion factor for Poland, due to the deposits extracted, is 1T = 1.75m^3

Iceland: The total volume for A and C is 182,15 m^3, estimated 15% in A and 85% in C. New data are available for the physical properties of marine aggregates from the Kollafjördur extraction area.

[11] No information is available for extraction quantities although sand extraction for beach replenishment is likely to have occurred.

[12] Licensed data (maximum permitted) because extracted data is subject to statistical confidentiality.

WGEXT will again circulate a copy of the WGEXT 2016 interim report to contact points provided by OSPAR in order that the accuracy of the information presented can be assured. Data has never been received to date from Greenland and the Faroes.

Similar to previous years, Table 4.2 provides information on countries with data adjustments.

Table 4.2. Specific matters highlighted in response to OSPAR request for ICES WGEXT to supply national data.

DATA ADJUSTMENTS FOR SPECIFIC COUNTRIES NECESSARY TO DISTINGUISH DATA FOR THE OSPAR REGION	
SPAIN	Atlantic coast activities only (note separation of Mediterranean data)
FRANCE	Atlantic and Channel coast activities only (note separation of Mediterranean data)
GERMANY	North Sea activities only (exclude Baltic)
SWEDEN	Delineate activities in the Baltic area (Kattegat) which fall within the boundaries of the OSPAR
DENMARK	As for Sweden

Table 4.3a and 4.3b summarizes information on spatial extent of areas licensed for extraction where available, for ICES WGEXT member countries. Although the data are incomplete at this time, it is important to note that the areas in which extraction occurred were much smaller than the areas licensed and the actual spatial footprint should be used to assess impacts.

Table 4.3a. Spatial extent of areas licensed for extraction.

Country	2006	2007/08	2009	2010	2011	2012	2013	2014	2015
	Licensed Area Km^2								
Belgium	273	273	273	273	319	319	319	203.2	203.20
Denmark	N/d	429	430	789	650	700	N/d	N/d	N/d
Finland	N/d	N/d	N/d	N/d	N/d	N/d	12	12	12.1
France[1]	73.08[2]	72.97/74.97[2]	74.87[2]	67.87[2]	67.87[2]	135.34[2]	168.539[2]	165.44	169.4
Iceland	N/d	N/d	20.55	20.50	20.57	20.57	20.55	20.57	
Netherlands[5]	453	456/585	564	490	456	439	462	470	480
Poland	51.10	51.10	51.10	51.10	25.66	25.66	25.66	25.66	
Portugal	N/d This is not controlled in Portugal.								
Sweden	0	0	0	0	9.70	0	0	9.70	9.70
UK	1316	1278	1286	1291	1274	711	739	726	912

Table 4.3b. Actual areas over which extraction occurs.

Country	2006	2007/08	2009	2010	2011	2012	2013	2014	2015
	Area in which extraction activities occur km²								
Belgium	N/d	N/d	N/d	N/d	105.7	106.2	113.7	61.5	61.5
Denmark	N/d	N/d	N/d	N/d	N/d	N/d	N/d	N/d	N/d
Finland	N/d	N/d	N/d	N/d	N/d	N/d	0	0	0
France[1]	N/d	N/d	N/d	N/d	N/d	N/d	N/d	N/d	N/d
Iceland	N/d	N/d	N/d	N/d	N/d	N/d	N/d	N/d	N/d
Netherlands [5]	47[3]	383/ 35.3[3]	86[3]	86[3]	71[3]	64	86[3]	90	88
Poland	N/d	N/d	N/d	N/d	N/d	N/d	N/d	N/d	
Portugal	N/d This is not controlled in Portugal.								
Sweden	0	0	0	0	9.70	0	0	9.70	0
UK	141[4]	138	124	105	114	97	99	86	

Table 4.3a and 4.3b Notes

[1] French dredging vessels are fitted with EMS but the information is not treated to make area in which extraction activity occur available.
[2] 53.89 sand-and-gravel extraction area and 21.08 non-aggregate extraction area in 2009. 46.79 sand and gravel extraction area and 21.08 non aggregate area in 2010 and 2011, 128.14 sand and gravel extraction area and 7.2 non aggregate area in 2012, 162.96 sand and gravel extraction area and 5.579 non aggregate area in 2013, 162.96 sand and gravel extraction area and 2.48 non aggregate area in 2014 and 162.96 sand and gravel extraction area and 6.48 non aggregate area in 2015.
[3] 90% of material extracted in the Netherlands is taken from 7.5 km2 (2006) and 9.2 km2 (2007) and 8.3km2 (2008), and 23 km2 (2009), 38 km2 (2010), 23 km² (2011) and 45 km² (2013)
[4] 90% of material extracted in UK is taken from 46km2 (2003) and 43km2 (2004), 49.2 km2 (2006) 49.95 (2007), and 39.2 km² (2013)
[5] Excludes the non-aggregate shell-extraction areas due to the very small operational areas on the North Sea and not really marine extraction in the Western Scheldt and Wadden Sea.
[7]Annual report will be available in June.

WGEXT again noted that this type of information has to be taken from an analysis of electronic monitoring data and this is not a straightforward task to achieve and therefore not possible for all WGEXT members to provide.

The last part of the ToR A1 concerns the collection of geospatial data on licensed and extraction locations in the form of shape files. OSPAR is currently working on the OSPAR Data and Information Management Strategy, which will include a web portal and metadata catalogue for all OSPAR data streams. OSPAR requested these data as shapefiles; if exact data is not available, OSPAR asks if approximate shapefiles can be created and sent. Ultimately, they will be aiming to undertake a full cumulative effects assessment which will require pressure layers for all human activities and for that it will be essential to have spatial data.

Countries that have shapefiles are listed in Table 4.4. OSPAR countries are asked to provide available shapefiles for 2015 to OSPAR at < Chris.moulton@ospar.org > or

< John.mouat@ospar.org > by 1 October, 2016. WGEXT requests that shapefiles be provided on the WGEXT SharePoint site in the “06 Data” folder annually from all ICES countries including those which are not in OSPAR, and reported to both < Johan.nyberg@sgu.se > and to < ad.stolk@rws.nl >.

Table 4.4. Geospatial Shapefile information.

COUNTRY	Shapefiles licensed	Shapefiles extracted	Delivered to ICES/OSPAR
Belgium	Yes	Yes	Yes/Yes
Canada	No	No	No/No
Denmark	Yes	No	Yes/Yes
Estonia	N/d	N/d	No/No
Finland	Yes	No	No/No
France	Yes	No	Yes/Yes
Germany	Yes	Yes	No/No
Greenland and Faroes	N/d	N/d	No/No
Iceland	Yes	No	No/No
Ireland	N/d	N/d	No/No
Latvia	N/d	N/d	No/No
Lithuania	N/d	N/d	No/No
Netherlands	Yes	Yes	Yes/Yes
Norway	No	No	No/No
Poland	No	No	No/No
Portugal	N/d	N/d	No/No
Spain	N/d	N/d	No/No
Sweden	Yes	Yes	No/No
United Kingdom	Yes	Yes	Yes/Yes
United States	No	No	No/No

More details on Terms of Reference A1 and A2 are given in Annex 5 (sections 11 and 12).

5. Terms of Reference B – J: Updates on Progress

The following section provides a narrative of discussions concerning each ToR and outputs from the 2016 meeting.

5.1. ToR B: Create an ICES aggregate database comprising all aggregate related data, including scientific research and EIA licensing and monitoring data

To prepare the implementation of the WGEXT database, related to marine aggregates extractions, that would be linked to the ICES one (to ensure compliance with their guidelines and international standards), the group discussed about the information it should contain (see tables below). This table has also been presented to personnel working with the ICES database. ICES found the database of great interest and have now the time and resources to help WGEXT to create such a database. The objective is to get easier access, both for the member countries to provide and deliver annual data in a standardized format and for e.g. ICES, OSPAR, scientists, policy-makers to retrieve data for e.g. marine pressure studies. Furthermore, during the OSPAR EIHA (Committee of environmental impact of human activities) 2016 meeting, it was decided not to develop a separate tool within the ODIMS (OSPAR data and information system) database, but OSPAR would in its activity be very much helped to be able to connect and linked to the ICES WGEXT coming database. This among other things is intended to avoid creating duplicate databases. According to OSPAR, all OSPAR Contracting Parties should strictly implement the ICES guidelines and supply comprehensive information about their marine aggregate industries to the ICES WGEXT; particularly information relating to annual production rates, the area of seabed licensed and the area of seabed dredged. The use of electronic monitoring systems and “black box” equipment is recommended in this regard. A uniform reporting format is recommended to facilitate inter-comparison.

The database is also adapted to other similar databases on aggregates resources and extractions, e.g., the two EU-financed projects EMODNet-Geology and EMODNet-Human activity), to allow comparability but also to prevent similar data being collected.

The WGEXT database is proposed to be as concise as possible, so that data that is already collected (e.g., volume and spatial area tables from current annual reports) could be used, harmonized and easily incorporated into the database kept in an electronic format. WGEXT has also in this ToR prepared data of historical extraction volumes compiled from the WGEXT annual reports to be delivered to the database. ICES has decided that these data could be delivered for incorporation into the database after reviewing and final validation.

The database is proposed to contain two levels of information with associated data fields. The first level should contain information at the national scale for each year and each region (Table 5.1).

Table 5.1. Information proposed for the first-level (national scale) database.

FIELDS FOR WGEXT DATABASE	"FLAGS"	COMMENTS FOR ICES DATABASE MANAGERS
Country		
Region (Convention)		i.e. HELCOM, OSPAR BARCELONA if applicable "TOTAL per country" (special case of Denmark with overlap of HELCOM and OSPAR, for others countries "total" is the sum of the values for each regions),
Contact point for the national level per country		Institute of reference
Legislative Authority		Add a link to official website
Year		Year of the data for

				extraction (link to the annual WGEXT report >year N+1)
Total extracted (m3) within HELCOM area	Real value	Maximum permitted	Estimate value	
Total extracted (m3) within OSPAR area	Real value	Maximum permitted	Estimate value	
Total extracted (m3) within Mediterranean (Barcelona) area	Real value	Maximum permitted	Estimate value	
Total extracted per country (m3)	Real value	Maximum permitted	Estimate value	
Construction/Industrial (m3) within HELCOM area	Real value	Maximum permitted	Estimate value	
Construction/Industrial (m3) within OSPAR area	Real value	Maximum permitted	Estimate value	
Construction/Industrial (m3) within Mediterranean (Barcelona) area	Real value	Maximum permitted	Estimate value	
Total Construction/Industrial (m3) per country	Real value	Maximum permitted	Estimate value	
Beach replenishment (m3) within HELCOM area	Real value	Maximum permitted	Estimate value	
Beach replenishment (m3) within OSPAR area	Real value	Maximum permitted	Estimate value	
Beach replenishment (m3) within Mediterranean (Barcelona) area	Real value	Maximum permitted	Estimate value	
Total Beach replenishment (m3) per country	Real value	Maximum permitted	Estimate value	
Fill/land reclamation (m3) within HELCOM area	Real value	Maximum permitted	Estimate value	
Fill/land reclamation (m3) within OSPAR area	Real value	Maximum permitted	Estimate value	
Fill/land reclamation (m3) within Mediterranean (Barcelona) area	Real value	Maximum permitted	Estimate value	
Total Fill/land reclamation (m3) per country	Real value	Maximum permitted	Estimate value	
Non aggregate (m3) within HELCOM area	Real value	Maximum permitted	Estimate value	
Non aggregate (m3) within OSPAR area	Real value	Maximum permitted	Estimate value	
Non aggregate (m3) within Mediterranean (Barcelona) area	Real value	Maximum permitted	Estimate value	
Total Non-aggregate (m3) per country	Real value	Maximum permitted	Estimate value	
Licensed Area (km2)				Area of the permit

Area extracted (km2)	The area within the area of permit where extraction takes place
EIA required (Y/N)	
Monitoring in place (Y/N)	
Black box/EMS data (Y/N)	
Mitigation (Y/N)	

The second level, which is more detailed and focused on licensed areas, is proposed to contain the information listed below. Here it would also be possible to store more detailed information concerning whether EIAs, monitoring and mitigation that are carried out and whether there is legislation and research ongoing in member countries. It will then be possible for interested parties to contact the relevant WGEXT member for further information if required. This database second level would enable to be linked with the GIS ESRI shapefiles that WGEXT deliver annually to OSPAR.

Table 5.2. Information proposed for the second-level (licensed area) database (link to shape file for visualization).

FIELDS FOR WGEXT DATABASE	"FLAGS"			COMMENTS FOR ICES DATABASE MANAGERS
Country				
Point Latitude Coordinate	Coord. System	Estimate position	Central point of polygon	
Point Longitude Coordinate	Coord. System	Estimate position	Central point of polygon	
Contact point for the regional level				(Local authority; i.e lander in Germany)
Name/code of license area				Unique code per licensed area (IT-XXX)
Permitting Authority				
Year				
Grain size/Type (i.e Sand, Gravel..)				
End Use				(i.e. Beach Replenishment, Construction...)
Licensed Area (km2)				
Area extracted (km2)				?
EIA required				?
Monitoring in place				?
Black box/EMS data				?
Mitigation				?

The ICES database will be used for uploading the WGEXT information. In terms of maintenance, the OSPAR data could be updated as part of ToR A completed during each annual meeting. WGEXT will also continue to discuss the feasibility of developing the complexity of the database. Future expansion of the database is expected to be driven by inquiries from potential users.

The time schedule is that the already collated historical data is validated by members in the group and that, together with the proposed database with associated fields, is accepted by ICES. The technical issues, such as, templates for delivery of data to the database, formats of GIS ESRI shapefiles for automatic linkage to level 1 and 2 to the database will be solved.

5.2. ToR C: Incorporate the MSFD into WGEXT

During the Annual meeting of 2014 it was decided to focus on the direct effects of marine sediment extraction (on descriptors 6, 7 and 11), but attention will also be placed on descriptors 1 and 4.

An inventory is made in several documents about the Marine Strategy Framework Directive (MSFD) on the incorporation of extraction as a human impact factor and in what way it is mentioned.

In Annex III of the MSFD extraction of minerals (rock, metal ores, gravel, sand, shell) is mentioned as a human activity affecting the marine environment (EC, 2016c).

Often the descriptors 1 (biodiversity), 3 (commercial fish and fisheries products), 4 (food webs) and 6 (seabed integrity) are combined into one integrated descriptor: 'marine ecosystem' (I&E and EA, 2015). In documents on D1 and D4 marine sediment extraction is mostly not directly mentioned as a pressure. For D6 it is clearer that marine sediment extraction can influence the integrity of the sea-floor. That can also be case for altering of hydrographical conditions (D7). As a sound producing activity dredging can influence D11 as well.

See for more detail on the scientific aspects of MSFD ToR D and the article mentioned there (Annex 11).

GES Descriptor 1 Biodiversity

<u>Descriptor 1</u>

The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.

The most important criteria for species are already formulated in the Habitat Directive, but in draft 4 of the Proposal for a Commission Decision on GES Criteria (EC, 2016b) the extra criteria under MSFD are formulated:

- D1C1: Species distributional range and, where relevant, patterns is in line with prevailing physiographic, geographic and climatic conditions

- D1C2: Population abundance (numbers and/or biomass) of the species is not adversely affected due to anthropogenic pressures, such that its long-term viability is ensured

- D1C3: population demographic [and physiological] characteristics (e.g. body size or age class structure, sex ratio, fecundity, survival and mortality rates) of the species are indicative of a natural population which is not adversely affected due to anthropogenic pressures

- D1C4: the habitat for the species has the necessary extent and condition to support the different stages in the life history of the species

- D1C5: The condition of the habitat type, including its biotic (typical species composition and their relative abundance) and abiotic structure, and its functions, is not adversely affected.

The interconnection between Descriptor 1 and Descriptor 6 is showed by almost the same wording for D1C5 (for pelagic species) and D6C5 (for benthic species).

In EC (2015a) pressures are not indicated, but it is mentioned that there are strong links with descriptors that do indicate pressures like D6 and D7.

Also in later documents, e.g. EC (2016b) the link between D1, D4 and D6 is present.

GES Descriptor 4 Food Webs

<u>Descriptor 4</u>

All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.

In draft 4 of the Proposal for a Commission Decision on GES Criteria (EC, 2016b) four criteria related to anthropogenic pressures are mentioned. They are focussed on:

- D4C1: species distribution and their relative abundance (diversity) of the tropic guild
- D4C2: abundance (numbers of biomass) across trophic guilds
- D4C3: size distribution of individuals across relevant species of the trophic guild
- D4C4: productivity of the trophic guild.

In the ICES Special Request Advice (20/03/2015) (ICES, 2015) on the EU request on revisions to MSFD manuals for D3, 4 and 6 it is mentioned that only a few EU-countries mention pressures of food web components, in particular fisheries. Extraction as such is not mentioned.

But physical disturbance of the habitat and (benthic) fauna is currently the most determining factor for the status of the marine ecosystem and therefore also decisive for the functioning of food webs (I&E and EA, 2015).

GES Descriptor 6 Sea-floor Integrity

<u>Descriptor 6</u>

Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.

The opinion of WGEXT is formulated in Annual Reports 2011 and 2012: WGEXT suggest that in defining 'adverse' it should be accepted that direct changes to the physical structure of the seabed will result from the extraction of marine sediments. Defining 'adverse' as being no environmental change from the existing (pre-dredge) conditions would, in the opinion of the group, be inappropriate and detrimental to the continued ability of member countries to extract marine sediments from their seabed.

The later discussions and conclusions in e.g. ICES workshops on D6 were in line with this approach.

Regarding Descriptor 6 an ICES workshop was held in February 2015 (ICES ACOM Committee, 2015). Aggregate extraction is mentioned as one of the pressures that are causing physical habitat loss and damage and can influence the integrity of the seafloor. To judge the pressures spatial and time-scales are crucial. Mostly physical damage is mentioned as the main pressure, but it was put forward to integrate physico-chemical disturbances (e.g. anoxic seafloors in the Baltic Sea).

The main topic was the incorporation of the newly proposed criteria 'Functionality' and 'Recoverability' in combination with the existing criteria 'Physical damage' and 'Benthic conditions' in D6. It was proposed to adopt a concept including three criteria themes (i.e. pressure, state and impact) linked with the existing and newly suggested criteria (figure 1).

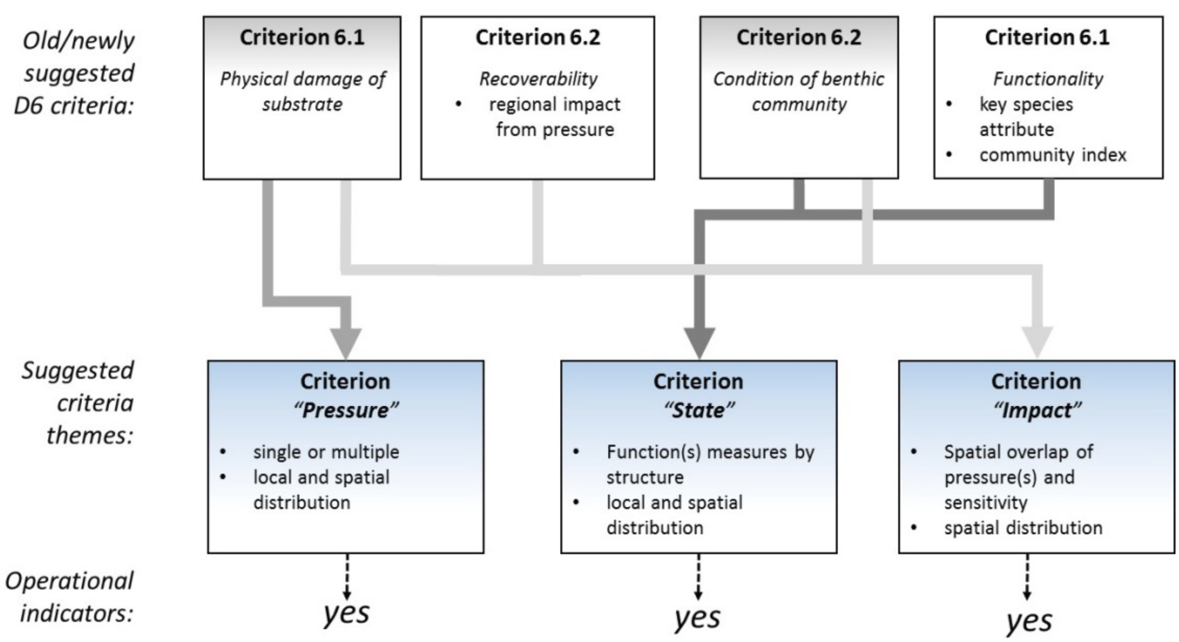

Figure 1. Conceptual diagram illustrating how work under both the old (2010) and the newly suggested (2014) criteria can be merged for a conceptually stronger assessment and use of existing indicators/data to measure progress towards GES for seafloor integrity (ICES ACOM, 2015)

From the point of view of marine sediment extraction this is a good approach. Because even when the benthos is completely removed, total recovery by recolonization is possible. Therefore the criteria theme 'recovery' is important for marine sediment extraction.

The idea to incorporate recovery in the formulation of criteria has not survived so far. In the document on Progress on art.8 MSFD assessment guidance (EC, 2016a) three criteria are mentioned:

- D6C1: Spatial extent and distribution of physical disturbance

- D6C2: Spatial extent of adverse effect of physical disturbance per habitat type

- D6C3: Spatial extent and distribution of physical loss.

Only the second one gives room for the acknowledgement of recovery.

In draft 4 of the Proposal for a Commission Decision on GES Criteria (EC, 2016b) the formulation and numbering are slightly different:

- D6C1: Spatial extent and distribution of physical loss (permanent change) of the natural seabed.

- D6C2: Spatial extent and distribution of physical disturbance pressures affecting the seabed.

- D6C3: Spatial extent of each habitat type which is adversely affected trough change in its structure and function (species composition and their relative abundance, absence of particularly sensitive or fragile species or species providing a key function, size structure of species) by physical disturbance.
The areas must be expressed as a proportion (%) of the total area (D6C1, D6C2) or as proportion (%) per habitat type (D6C3).

In this proposal physical loss is regarded as a permanent change to the seabed which has or is expected to last for a period of two reporting cycles (12 years) or more. This seems to give room for recovery, but it should be mentioned that biological/ecological recovery can be reached without recovery of the physical state.

In the Proposal for a Commission Decision (EC, 2016b) two extra criteria about benthic habitats are mentioned that are related to both D1 and D6.

- D6C4: The extent of loss of the habitat type, resulting from anthropogenic pressures, does not exceed a specified proportion of the natural extent of the habitat type in the assessment area. In cases where the loss exceeded this value in the reference year baseline used for the Initial Assessment in 2012, there shall be no further loss of the habitat type.

- D6C5: The condition of the habitat type, including its biotic (typical species composition and their relative abundance, absence of particularly sensitive or fragile species or species providing a key function, size structure of species) and abiotic structure, and its functions, is not adversely affected.

Although the formulation of this last two criteria, especially D6C5, sound more like descriptors the idea is to operationalise these criteria by setting values for the proportion (in %) for the extent of loss and thresholds for the condition of habitats.

In the *ICES Special Request Advice (20/03/2015)* (ICES, 2015) on the EU request on revisions to MSFD manuals for D3,4 and 6 three actions are proposed:

- Develop and test standards for human pressure on benthic habitats.

- Address the role of scale and connectivity in setting boundaries for the sea-floor.

- Assessment of recoverability of sea-floor integrity.

Workshops are planned for 2017 and 2018. It is important that WGEXT join the discussions on this subject, especially because in the Advice is stated that the concept of switching to an approach based on functionality and recoverability should not be lost for future work.

GES Descriptor 7 Hydrographical Conditions

Descriptor 7

Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems.

In draft 4 of the Proposal for a Commission Decision on GES Criteria (EC, 2016b) the criteria are formulated:

- D7C1: Spatial extent and distribution of hydrographical conditions (e.g. changes in wave action, currents, salinity, temperature, oxygen) to the seabed and water column, associated in particular with physical losses (permanent changes) to the seabed.

- D7C2: Spatial extent of each benthic habitat type adversely affected (physical and hydrological characteristics and associated biological communities) due to permanent alteration of hydrographical conditions.

In EC (2015b) changes of the morphology of the seabed is mentioned as one of the pressures. Sediment extraction will, at least temporally, change the morphology. An important point is the spatial and temporal scale of this change and the scale of its effects. The document also mentions the ICES Guidelines on marine sediment extraction (OSPAR, 2003).

D7 is a pressure descriptor that focusses on the permanently altered hydrographical conditions. The pressure is change in morphology of the seabed/coast or change in habitat (e.g. from sediment to hard substrate) (EC, 2015c). In this sense marine sediment extraction can be a pressure for D7, especially when it is a large scale extraction or an extraction in a specific vulnerable area.

Related to D7C2 is the risk of oxygen depletion in case of extractions with a large depth below the seabed and/or in case of very low dynamic waters.

GES Descriptor 11 Underwater Noise

Descriptor 11

Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.

In draft 4 of the Proposal for a Commission Decision on GES Criteria (EC, 2016b) the criteria are formulated;

- D11C1: The spatial distribution, temporal extent (number of days and their distribution within a calendar year) and the levels of anthropogenic sound sources do not exceed values that are likely to adversely affect marine animals.

-D11C2: Levels of anthropogenic continuous low-frequency sound, in two '1/3-octave bands' do not exceed values that are likely to adversely affect marine animals.

In EC (2015d) shipping and dredging are mentioned as pressures.

The attention to underwater sound in relation to dredging and sediment extraction is increasing during the last years. In the UK a report on underwater noise from marine aggregate extraction is published (Robinson *et al.*, 2011). The Central Dredging Association (CEDA, 2011) pays attention to underwater noise in papers and congresses.

During the reclamation works for the enlargement of the harbour of Rotterdam, the Netherlands, a monitoring program on underwater sound was executed. Measuring the noise from a large range of trailer suction hopper dredgers (in power and in volume, 2000 to 22000 m^3) showed that for all frequencies the noise of dredging and dumping was less than the noise of transit. The conclusion is that, at least in these area and circumstances, sand extraction is contributing to the noise of shipping, but introduces no negative effects from the extraction and dumping itself (Heinis, 2013).

Conclusion

Although marine sediment extraction can have influence on the descriptors 1, 4, 6, 7 and 11 the main effects are via descriptor 6 on D1 and D4. Therefore in the discussions about the effects of marine sediment extraction within the MSFD the focus can be on D6. Nevertheless effects on D1 and D4 via D7 and D11 should not be ignored. Also direct effects on D1 and D4 are possible by an increasing amount of fines in the water column due to extraction activities.

The possibility of recovery after sediment extraction should be acknowledged by incorporate it in the criteria and by taken it into account with the assessment of the Good Environmental Status.

It is important to realize that biological/ecological recovery can be reached without recovery of the physical state. Even in the case of permanent loss of the original morphological state of the seafloor the benthic fauna can recover and the structure and functions of the ecosystems can be safeguarded and benthic ecosystems not adversely affected.

To bring the forward the interpretation of GES Descriptors from the point of view of sediment extraction it is important that WGEXT joins the discussions on this subject in the workshops planned for 2017 and 2018, especially because in the Advice of ICES it is stated that the concept of switching to an approach based on functionality and recoverability should not be lost for future work.

Following these workshops and the completion of the article on MSFD (ToR D) the ICES guidelines on Marine Aggregate Extraction can be reviewed.

References

CEDA (2011)

Underwater sound in relation to dredging. CEDA Position paper- 7 November 2011, 6p.

EC (2015a)

Template for the review of Decision 2010/477/EU concerning MSFD criteria for assessing good environmental status according to the review technical manual Descriptor 1 (version 4, 08/04/15), 53 p.

EC (2015b)

Template for the review of Decision 2010/477/EU concerning MSFD criteria for assessing good environmental status according to the review technical manual Descriptor 7 (version 6.0, 27/03/15)

EC (2015c)

Review of the Commission Decision 2010/477/EU concerning MSFD criteria for assessing good environmental status. Descriptor 7. JCR Technical Report of MSFD Network on MSFD Descriptor 7, 28 p.

(EC (2015d)

Possible approach to amend Decision 2010/477/EU Descriptor 11; Energy, including underwater noise (version 7.1, 18/03/15), 13p.

EC (2016a)

Progress on art.8 MSFD assessment guidance. GES_15–2016–02. European Commission, 28p.

EC (2016b)

Proposal for a Commission Decision on GES Criteria draft v4. CTTEE 14–2016–03. European Commission, 38p.

EC (2016c)

Proposal for a Commission Directive replacing of Annex III MSFD draft v5. CTTEE 14–2016–04. European Commission, 7p.

Heinis, F. (2013)

Effect monitoring for Maasvlakte 2. Underwater sound during construction and the impact on marine mammals and fish.

Maasvlakte Project Organisation, World Port Centre, Rotterdam, 39 p.

I&E and EA (2015)

Marine Strategy for the Dutch part of the North Sea 2012–2020. Part 3. MSFD programme of measures. Ministry of Infrastructure and the Environment and Ministry of Economic Affairs, The Hague, The Netherlands. 137 p.

ICES ACOM Committee (2015)

Report of the Workshop on guidance for the review of MSFD decision descriptor 6 - seafloor integrity II (WKCMSFDD6-II). 16–19 February, ICES Headquarters, Denmark

OSPAR (2003)

OSPAR Agreement 03/17/1. ICES Guidelines on marine sediment extraction.

Robinson, S.P., P.D. Theobald, G. Hayman, L.S. Wang, P.A. Lepper, V. Humphry, S. Mumford (2011)

Measurement of underwater noise arising from marine aggregate dredging operations.

Report MALSF MEPF 09/P108, Marine Aggregate Levy Sustainability Fund (MALSF), 144 p.

5.3 ToR D: Ensure outputs of the WGEXT are accessible by publishing as a group and creating a webpage on the ICES website.

ToR D1: Since the subject on harmonization of intensity is still under discussion and data from different countries is not readily available, no publication on the subject could be made during this three years cycle. However, this subject recurs under ToR I of cumulative impacts in the next three years cycle.

ToR D2: In February 2016 the Cooperative Research Report (CRR 330) is published on *'Effects of extraction of marine sediment on the marine environment 2005–2011.'*

The next CRR will cover the years 2012–2018.

Michel Desprez has prepared a review article on *Marine Aggregate Extraction and Marine Strategy Framework Directive: A review of existing research*. This collaborative contribution of the WGEXT will provide information on research related to impacts of marine aggregate extraction, and their connection with the criteria for Good Environmental Status. The information in this article is relevant to several descriptors of the MSFD: biological diversity (D1), commercial fishes (D3), marine food webs (D4), sea-floor integrity (D6), hydrographical conditions (D7) and underwater noise (D11).

Impacts on the marine ecosystem which will be developed in separate sections (Table 5.3).

Table 5.3 Division of ecostystem impacts.

Effects of aggregate extraction:	**Impact on:**	**Potentially influenced MSFD descriptors:**
Seabed removal	Topography/Bathymetry	D1, D6, D7
	Sediment composition	D1, D3, D4, D6
	Habitat & biological communities	D1, D3, D4, D6
Sediment plumes (water column)	Turbidity	D1, D3, D4
Sediment deposition (plume & screening)	Sediment composition	D1, D3, D4, D6
Ship activities	Underwater noise	D11

This review not only highlights gaps to expand on the current knowledge to fulfill MSFD requirements, but also considers that the geographical scale at which the MSFD operates is much larger than single project assessments. Because extraction is often takes place in a relative small area, and often only for a limited amount of time, the spatial and temporal components of the activity and related pressures and impact are limited.

This ToR is still ongoing. After compilation of the recent literature (2000–2015), redaction of chapters on sediment plumes and ship activities is achieved, but the chapter on seabed removal is still in progress. The article is nearly achieved, but still needs further collaboration within WGEXT before this review can be submitted for publication. The draft of the article is included in this report as Annex 11.

D3. The WGEXT page on the ICES website was reviewed. The text was brief but acceptable. The photograph will be changed, however.

The text on http://www.ices.dk/community/groups/Pages/WGEXT.aspx :

WGEXT develops the understanding to ensure that marine sand and gravel extraction is managed in a sustainable manner and that any ecosystem effects are understood in order to adopt mitigative measures where appropriate.

The objective of ICES Working Group on the Effects of Extraction of Marine Sediments on the Marine Ecosystem (WGEXT) is to provide a summary of data on marine sediment extraction, marine resource and habitat mapping, changes to the legal regime, and research projects relevant to the assessment of environmental effects.

Research into the impacts and effects of marine sediment extraction take place across member countries and a mix of national/regional focused and multi-national programmes exist.

New Terms of Reference have been defined on databases and harmonization of data, MSFD, publishing, deep sea mining, cultural and geomorphologic values, thresholds for EIAs, mitigation and a cumulative assessment guidance.

The cooperative report is now available on the ICES website in the list of co-operative reports, but not on the WGEXT page. WGEXT will recommend that it be also available on the WGEXT page.

To introduce the new Cooperative Research Report (330) of WGEXT, the following text was written for the ICES website and the press release.

The report focuses on the field of marine sediment extraction, the removal of sand, gravel, shells, minerals and other sediments from the sea bed for such uses as construction and beach nourishment. This activity has shown a spectacular recent increase in the North Atlantic, including in the Baltic and North seas, with extraction rising from a few hundred thousand cubic metres annually in the early 1970s, to millions in the 1990s, and hundreds of millions in recent years.

In a strict sense, the extraction of marine sediments is not sustainable, because the extracted minerals are lost for the marine system. Taking out these sediments can even have negative effects on the surrounding environment through the removal of seabed organisms, the introduction of a sand blanket in the vicinity, the introduction of high concentrations of suspended matter in the nearby area, and an increase in the level of underwater sound.

Nevertheless, extraction can be sustainable in the sense that the effects on the ecosystem are minimized by mitigation measures beneficial for the recolonization of benthic fauna, ensuring recovery is fulfilled in acceptable time after the extraction.

To ensure mitigation goals are reached, extensive monitoring programmes are carried out in areas such as suspended matter, recolonization, underwater sound, and on effects on other use of the sea and coastal defence.

The CRR was compiled by members of ICES Working Group on the Effects of Extraction of Marine Sediments on the Marine Ecosystem (WGEXT), which develops the understanding to ensure that extraction is managed in a sustainable manner and that any ecosystem effects are understood in order to adopt appropriate mitigative measures.

The report provides an overview on the developments and results of the aforementioned themes across ICES Member Countries between 2005 and 2011.

D4. The ICES Annual Science Conference will be held in Latvia in September 2016.

The WGEXT proposal for a session was successful. We will have a WGEXT session there to fit into the ICES strategic plan.

The session is introduced as follows on http://www.ices.dk/news-and-events/asc/ASC2016/Pages/Theme-session-K.aspx :

Theme session K

Making marine sediment extraction sustainable by mitigation of related processes with potential negative impacts

Conveners:
Ad Stolk (the Netherlands), Keith Cooper (UK), Michel Desprez (France)

Marine sediment extraction in the North Atlantic, including the Baltic and North seas, has shown a spectacular increase from a few hundred thousand m^3 per year in the early 1970s to millions in the 1990s and hundreds of millions m^3 in recent years.

In the strict sense, marine mineral extraction is not sustainable as the extracted minerals are lost for the marine system. Extraction of marine sediments can also cause negative effects on the marine environment. Accompanied processes, such as the removal of sediments including benthic fauna, introduce a sand blanket in the vicinity of the extraction and high concentrations of suspended matter in the surrounding area, as well as increase the level of underwater sound.

Nevertheless, the mineral extraction process can be sustainable in the sense that negative effects on the ecosystem are minimized by mitigation measures that are beneficial for the recolonization of the benthic fauna and recovery is achieved within an acceptable period of time.

To ensure the goals of mitigation are reached, extensive monitoring programmes are executed on suspended matter, recolonization, underwater noise, effects on other uses of the sea, and coastal defence amongst others.

The aim of this session is to discuss how marine sediment extraction can become a more sustainable activity with minimal, and preferably temporal, effects on the ecosystem in line with the MSFD. Connected to this goal is the actualization of the ICES Guidelines on the extraction of marine sediments which will provide better advice to policy and legislation authorities and a code of practice for the industry.

In this session, the following topics will be addressed:

- Recent results from monitoring after large extractions
- Marine sediment extraction: resource mapping, mitigation measures, harmonization of data, incorporate data on amounts, intensity and areas of extraction in a database (as required by OSPAR), incorporation of archaeological and cultural heritage values, guidelines for EIA's and changing policy and legislation in the member countries
- Upcoming topics: deep-sea mineral extraction

The session consist of 15 oral presentations and 2 posters. Details of the session are given at:

http://www.ices.dk/news-and-events/asc/ASC2016/Pages/ThemeSessionDetail.aspx?ThemeSession=K :

Title: Introduction session. Make marine sediment extraction sustainable by mitigation of related processes with potential negative impacts. **Author:** Ad Stolk

Title: Robust Marine Protected Area designation through the use of marine aggregate sector environmental data. **Authors:** Ian Reach, Stuart Lowe, Mark Russell, Andrew Bellamy, Joseph Holcroft, Louise Mann, Dafydd Lloyd Jones, Rob Langman

Title: Quantifying the resource potential of Quaternary sands on the Belgian Continental Shelf: a 3D voxel modelling approach. **Authors:** Vasileios Hademenos, Lars Kint, Tine Missiaen, Jan Stafleu, Vera Van Lancker

Title: Identifying, assessment and adaptive environmental management of environmental effects between UK dredging areas and herring Clupea harengus spawning habitat. **Authors:** Ian Reach, Phil Latto, Dafydd Lloyd Jones, Rob Langman, Caroline Chambers, Iain Warner, Mark Russell

Title: Marine sand and gravel extraction for Helsinki harbor – monitoring the impact of the extraction works. **Author:** Jyrki Hämäläinen

Title: Large scale sand extraction. Monitoring effects on morphology and ecosystem. **Author:** Ad Stolk

Title: Impact of dredging activity on the distribution and diet of demersal fish species in a commercial marine aggregate extraction site of the eastern Channel (Dieppe, France). **Author:** Michel Desprez

Title: Ecosystem based design rules for sand extraction sites. **Authors:** Maarten de Jong, Martin Baptist, Bas Borsje, Daan Rijks

Title: Relation between dredging intensity and frequency and its impact on a benthic sandy habitat. **Authors:** Annelies De Backer, Kris Hostens

Title: The role of extraction strategy on the recovery of biological communities in two French sites of marine aggregate extraction in the eastern Channel. Management implications for sustainability. **Author:** Michel Desprez

Title: Marine aggregate dredging: a new monitoring approach to meet the needs of the Marine Strategy Framework Directive. **Authors:** Keith Cooper, Jon Barry, Claire Mason

Title: Optimization of monitoring and modelling frameworks to mitigate negative effects of aggregate extraction, Belgian part of the North Sea. **Authors:** Nathan Terseleer, N. Terseleer, M. Roche, K. Degrendele, D. Van den Eynde, V.R.M. Van Lancker

Title: Minimisation of the impact of sand extraction on the Belgian part of the North Sea by the introduction of a newly defined reference surface. **Authors:** Koen Degrendele, Marc Roche

Title: Changes in bottom shear stress, due to aggregate extraction, in the area of the Hinder Banks (Belgian Continental Shelf). **Authors:** Dries Van den Eynde, Matthias Baeye, Michael Fettweis, Frederic Francken, Vera R.M. Van Lancker

Title: Developments in cumulative impact assessment from a marine minerals extraction view. **Authors:** Jan A. van Dalfsen

Title: Combining measured and visually observed granulometric characteristics in updatable voxel models of seabed sediment. **Author:** Sytze van Heteren

Title: MSFD-compliant investigative monitoring of the effects of intensive aggregate extraction on a far offshore sandbank, Belgian part of the North Sea. **Authors:** V.R.M. Van Lancker, M. Baeye, D. Evangelinos, G. Montereale-Gavazzi, N. Terseleer, D. Van den Eynde

5.4. ToR E: Discuss the mitigation that takes place across ICES countries and where lessons can be learned or recommendations taken forward

The WGEXT questionnaire included mitigation as might be proscribed in the EIA and specified in the license conditions. WGEXT members were asked to describe mitigation intended to address ecological concerns, interactions with commercial fisheries, historic environment mitigation, and potential interference with navigation. Best management practices and monitoring requirements may be also specified. The questionnaire had been sent to all member countries during the 2014 meeting. WGEXT would like to compile mitigation options and techniques from all ICES countries to investigate the comparability of techniques used, to determine whether they are site specific, or could be applied in multiple countries, as certain countries do not apply mitigation to aggregate extraction. In addition, WGEXT intends to update the 2003 guidelines, should mitigation techniques have moved forward.

In the UK, Netherlands, Belgium and France, operational mitigation requirements will typically be informed by the results of EIA. In the UK for example, dredgers are required to extract all the resource in one licensed zone before moving to the next in order to minimize the spatial extent of any impact. This also minimizes the potential spatial impacts on other marine users, such as fishermen. The EIA process will also determine whether screening is permitted to take place or not, depending on the presence/absence of sensitive receptors, such as features of nature conservation interest. Exclusion zones will be defined to protect existing pipelines, cables etc. and also to mitigate any potential impacts on features of maritime heritage value identified. Exclusion zones may also be used to protect features of nature conservation interest, although the application will be dependent on the features exposure and sensitivity to the dredging pressure. Research over the last 20 years has informed understanding of recovery, post-extraction, and this now underpins many of the impact hypotheses used in the UK EIA process – particularly the importance of maintaining similar seabed condition. This has resulted in a change in emphasis for both operational mitigation and compliance monitoring, which now focuses on the seabed conditions required to enable benthic recovery of dredged areas post-extraction, rather than simply reducing or monitoring impacts. This approach is now being applied by the industry on a regional scale, with each licensee contributing to the monitoring program. In the Netherlands, extraction cannot occur in water less than 20 m deep. This prevents disturbance of *Natura 2000* areas which are all in shallower water. This mitigation also prevents adverse impacts on coastal protection. Pits are dredged in order to minimize the footprint of the extraction site, but the side slopes are also specified. Slopes are intended to be steep enough to minimize the area disturbed, but not so steep that low oxygen conditions develop. The appropriate values had been determined by monitoring studies. The orientation of the pit is also important. It is intended that the sediment type is not changed by the dredging and extractors are typically required to monitor conditions and benthic recolonization.

ToR E will be continued with (E1) a specific inventory in each member country of mitigation, compensation, and avoidance to prevent, reduce and offset any serious harmful effects, followed by (E2) an evaluation and assessment of these existing measures.

5.5. ToR F: Study the implications of the growing interest in deep sea mining for the WGEXT (legislation/environmental/geological)

Deep sea mining was previously raised as an emerging issue for the group (especially for countries such as Iceland, Portugal and some of the Baltic Sea countries). The group intends to produce a summary paper of the current state of deep sea mining across the 20 ICES countries (although it was noted that not all of the countries are involved in deep sea mining at present). The question of whether the paper should consider just the ICES area or also areas outside of ICES was posed. It was noted that currently, deep sea mining only occurs in the Azores. However, despite the Netherlands and Belgium being involved in projects outside of the ICES area and an interest in manganese and rare earth metals exploration taking place in the Baltic, there are few locations within Europe where deep sea mining is currently thought to be of economic value.

Several companies from member states intend to be involved in mineral mining outside of their exclusive economic zone (EEZ) and requirements to do so were discussed. Exploration related to mining of the seabed, ocean floor and subsoil in areas of the ocean that lie beyond the limits of national jurisdiction (known as "The Area") is regulated by the International Seabed Authority (ISA). The ISA was established in 1994 under the 1982 United Nations Convention on the Law of the Sea (UNCLOS), and operates a strict system of rules, regulations and procedures "to ensure effective protection of the marine environment from harmful effects". Exploration for marine minerals outside of territorial waters, requires a permit from the ISA. In order to obtain this permit, there must be suitable provision within the legislation of the flag state of the company. In other words, within the boundaries of national jurisdiction, seabed mining activities fall under State rules and regulations, and UNCLOS states that these regulations should be "no less effective" than those developed for The Area. In addition, it was noted that Belgium had to develop their own legislation to enable a company to apply for a license to explore for manganese nodules.

The group also discussed the term "deep sea mining". This term only covers activities in deeper waters and excludes mining for resources other than gravel, sand, maerl and shells. There may be other resources of interest available in ICES member states, such as (rare earth) metals and Seafloor Massive Sulphides (SMS) crusts. It was suggested that "marine mineral mining" or "marine mineral extraction" should replace "deep sea mining" to ensure it covers every type of resource, including those that are not located in deep sea locations. The group noted that the term "non-living resources" is used in Belgium. Further discussions will continue about the best term to be used, as 'minerals' include gravel, sand, maerl and shells and the specifics concerning 'deep sea mining' may be lost with the adoption of the two possible terms above (marine mineral mining and marine mineral extraction).

WGEXT intends to continue to stay abreast of the situation and would be prepared to offer the WGEXT guidelines for marine extractions if and when they might be helpful. Brigitte presented a brief review of the current situation with respect to deep sea mining workshop in 2016. The marine mineral resources from the deep sea are Manganese nodules, Cobalt crusts and massive sulphides. Mn-nodules are expected to be mined by seabed rakes with the product air-lifted to the surface. These areas tend to have a high species diversity, but low biomass. The benthic communities tend to be composed of very long-lived individuals, slow-growing in extremely stable conditions.

Cobalt crusts are ingrown with the substrate and cannot be collected as easily as Mn-nodules. Cobalt crusts are hotspots of biodiversity; they have very diverse species (including corals). They are in complex ecosystems. The potential impacts for mining cobalt crusts are expected to be less because of a smaller area thought to be available for exploitation.

Massive sulphides can be found on (i) active vents with many endemic species, high biomass, low biodiversity, linear distribution and relatively fast regeneration; and on (ii) inactive vents with high biodiversity, lower biomass and probably more wide-spread distribution. Mining of massive sulfides seems impractical at the moment; the areas are too small, too deep and of low grade.

The large areas of the ocean floor outside of National waters are to be regulated by the International Seabed Authority. The Authority was established in 1994 and composed of representatives from 166 countries. They have regulations for prospecting and exploration, but a code for exploitation is under development.

After discussion, it was proposed the group would conduct the following actions over the coming years:

1. Compile an inventory of activities related to marine mineral mining by members states;
2. Compile an inventory to check if mining of resources other than sand, gravel, maerl and shell is foreseen within the national legislation within member states;
3. For the ToR, compile an inventory of whether mining outside the EEZ is included within the national legislation of member states.

This ToR will continue with a poll concerning the ICES-country's policies associated with deep-sea mining in both the national jurisdiction and High Seas.

5.6. ToR G: Promote harmonization, where possible, of data across ICES countries.

This ToR was the last three years mainly dedicated to harmonization of the use of dredging intensity across ICES countries. For discussions on the intensity topic from the previous year, WGEXT refers to the interim reports of 2014 and 2015. The questionnaire on how EMS data is collected and processed in the different countries, was updated with information of Denmark during the 2016 meeting. As such 8 countries, comprising the countries with the highest extraction amounts, filled out the questionnaire (Annex 5).

Last year it was decided to start a test study to get more insight in the subject of harmonization of dredging intensity in the ICES area. As agreed last year, we had an informal meeting on this subject on the EMSAGG conference in Delft in June 2015 with representatives of Denmark, UK, Netherlands and Belgium. All were willing to cooperate but needed to check the possibilities of this type of data provision. An official EMS data request was sent in March 2016 to the involved authorities of France, UK, the Netherlands, Denmark and Belgium. All countries responded on the official request but only Belgium and the Netherlands were able to provide EMS data in raw format. EMS data provided by the Netherlands were only from commercial licenses, so no EMS data was available from extraction for beach replenishment. UK could not provide the raw EMS data since the data are commercially sensitive. However, they provided us with processed data after the meeting which could be incorporated in the analysis. France could not respond to the request since the EMS data are diffuse and spread at different regional scales. First, a harmonization on national level is needed in France in order to provide the data. Denmark works with AIS data and before the meeting it was not clear whether these could be incorporated in the test study. However, UK, France and Denmark all provided shape files of their extraction areas.

The test case was as such run on Belgian EMS data and the commercial EMS data of the Netherlands, both for the year 2014. Later on, processed data of the UK provided by Kevin O'Shea (Royal Haskoning DHV) were added. The spatial scale chosen was 50x50m and the temporal scale was one calendar year. However, it would be possible to adjust spatial and temporal scale if needed. The output are maps presenting total time dredged (in classes of < 15min, 15 min-1h, 1h-2h and > 2h) in an area of 50x50m over the course of the year 2014. The result was presented to the WGEXT group (see FIG and shapes available on request), and we discussed whether this is a useful exercise, and thus important to continue to work on this topic and try to incorporate more data such as the AIS data of Denmark. During the meeting it became clear that it would be possible to analyze the AIS data of Denmark in the same way as was done for the Belgian and Dutch data. Inclusion of the UK data is possible when the Crown Estate is asked to make the calculation themselves and non-commercial data of the Netherlands could be added as well.

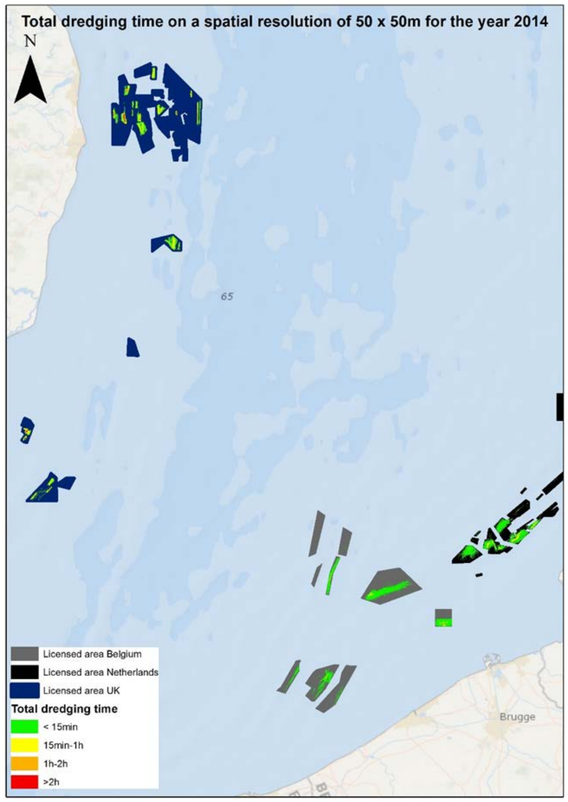

Figure 1. Dredging pressure at UK, Dutch and Belgian extraction sites at a resolution of 50x50 m for the 2014.

After discussion with all members, WGEXT agreed that this type of information is very useful to incorporate in cumulative impact assessment, and that it gives a good view on the actual footprint of aggregate dredging, and it allows for comparison between countries. This type of information is for the moment the best available allowing comparison between countries but it should be kept in mind that dredging time per area does not take into account other important parameters such as the size of the dredging vessel, the type of material extracted whether screening takes place or not,... This kind of information is as well important for impact assessments at a wider regional scale e.g. in the framework of the MSFD. As such, it was decided to take the work on harmonizing EMS/AIS data further to the next three year period but to incorporate it under the ToR studying cumulative impacts (ToR I).

For the other part of this ToR, no new urgent other harmonization needs were discovered. It was agreed that the original goals of the ToR were achieved by:

a) defining the intensity of extraction as volume/area/time, but the parameters needed for calculations are not readily available. As a result, we have decided that dredging time/ area/ time period would be used as a surrogate for intensity.

b) recognizing the need for harmonized data throughout the member countries, especially regarding the yearly reporting and the database under development.

It was decided that the ToR G: Promote harmonization, where possible, of data across ICES countries will be considered as "finished".

ToR G to *Promote harmonization, where possible, of data across ICES countries* is completed.

5.7. ToR H: Identify the way archaeological, cultural and geomorphological values are taken into account by member countries

Nineteen countries answered the WGEXT request relative to Underwater Cultural Heritage (UCH). Fifteen countries take archaeological, cultural and geomorphological values into account in their national legislation, but it seems that only six have ratified the UNESCO Convention for the protection of UCH (2001). Six have ratified the European Convention in Valleta, Malta on the Protection of Archaeological Heritage in 1992. Thirteen countries apply these values in EIAs, but only eight have a guidance note or a reporting protocol. Twelve countries have reported on present and/or past Research and Management projects. Finally, this work was the opportunity to collect e-mail addresses of fifteen contact people with the helpful assistance of Jeroen Vermeersch (Flanders Heritage Agency). ToR (H) is now completed (Annex 6).

5.8. ToR I: Cumulative assessment guidance and framework for assessment should be developed

Cumulative Impact Assessment (CIA) is being studied by ICES BEWG and the WGMHM. Different models have been developed for CIA, some of which have been listed by OSPAR EIHA (Committee for the Environmental Impact of Human Activities) for marine ecosystems impact assessment Furthermore, CIA is included in studies related to the development of offshore wind energy in Europe and it is addressed in EU FP7 projects as ODEMM, Knowseas, and COEXIST. The different aspects of CIA for marine aggregate extraction are discussed, in depth, in the literature review (Annex 7). ToR I1 has now been completed.

In light of this review, the WGEXT decided that the topic is already adequately being covered by such research programs and international working groups. As a result, WGEXT will not work on the development of tools for CIA. However, national progress on CIA of marine aggregates extractions (i.e. case studies, research projects etc.) will continue to be tracked by the WGEXT. WGEXT will continue ToR I to provide guidance ensuring that marine-aggregate extraction data is incorporated properly into the implementation of generic CIA models. WGEXT experience will be used to assess the quality of the data. The WGEXT expects that this information will fill in the needs of the MSFD and of the MSPD for marine aggregate extraction. The work of WGEXT will be to define the information needed to such aims. Although ToR G on Harmonization has been concluded, the issue of intensity from ToR G will henceforth be included in the continuation of ToR I.

Over the next three years, WGEXT will direct its efforts under ToR I to define the information and guidelines needed by working groups within OSPAR and ICES for CIA by:

- (I1) Contacting OSPAR and ICES working groups on this issue (1st year)
- (I2) Continuing the development of defining the quantification of dredging intensity (2nd and 3rd year)
- (I3) providing the methodology needed to incorporate marine sediment extraction in CIA (3rd year).

5.9. ToR J: Identify threshold conditions and associated reasoning for EIAs in different countries; discuss whether similar thresholds could apply in other countries.

WGEXT intend to investigate what, by compiling an inventory of thresholds that are currently used, before looking at the applicability of these thresholds for other countries. The ToR is due to be reported in the Final Report (2016), however, work began in 2013.

Reports on thresholds applied in member countries have been received from Denmark, Estonia, Finland, France, Latvia, the Netherlands, Poland, Portugal, Spain, Sweden, the United Kingdom, and the USA (Annex 8). In general, there are provisions for a brief Environmental Assessment in advance of any more extensive EIA. The authority to require an EIA lies with the licensing authority, but recommendations can be provided to the licensing authority from other agencies, such as those responsible for fisheries. Some countries (Table 5.4) have numerical criteria either in law or policy that trigger EIAs. Others use professional judgment on a case-by-case basis, although of course, the professional experience includes informal, numerical criteria. Denmark, Sweden, France, Latvia, Poland and Belgium, require an EIA for all permits. Although reports were not received from all countries, the situations described are to be considered representative. This term of reference complete.

Table 5.4. Requirements for EIAs from ICES countries.

	ALWAYS REQUIRED	VOLUME	AREA	DEPTH	PROFESSIONAL JUDGEMENT
Belgium	*				*
Denmark	*				
Estonia		*	*	*	*
Finland		*	*		
France	*				*
Latvia	*				*
The Netherlands		*	*	*	
Poland	*				
Portugal					*
Spain		*	*		

Sweden	*				*
UK		*			*
USA					*

6. Revision of ToRs and new ToRs for 2016 to 2018

- Item B2 of ToR B: Providing a template for reporting parameters to be included in the database
- Item E3 in ToR E: Potential environmental enhancements of marine sediment extraction
- ToR G is ended. Intensity will become part of ToR I
- ToR K: Impacts of marine aggregate extraction on fish and fisheries. K1: inventory of countries' policy. K2: review of research. Overall lead: Michel Desprez
- ToR L: Implications of Marine Spatial Planning on marine sediment extraction. L1: Inventory of countries policy development. L2: Review the incorporation of marine sediment extraction in Marine Spatial Planning in member countries

7. Presentations given to the WGEXT

Presentations were given to WGEXT by Brigitte Lauwaert, Laura Addington, Johan Nyberg, Michel Desprez, and Szymon Uścinowicz (Annex 9). The presenters are asked to provide their Power Point presentations on the WGEXT SharePoint site.

8. Closure of the Meeting and Adoption of the Report

The group moved to adopt the final draft annual report and the meeting was formally closed by the chair. He thanked members of WGEXT for attending and again offered thanks to the Polish Geological Institute as well as Szymon Uścinowicz for all his hard work in hosting the meeting and Henry Bokuniewicz for continuing to serve as rapporteur.

The Working Group on the Effects of Extraction of Marine Sediments on the Marine Ecosystem (WGEXT), chaired by Ad Stolk, will meet again. We hope to have the 2017 meeting in the London at Mineral Products Association and BMAPA between 24 and 27 April, 2017. The 2018 meeting may be in Copenhagen; Laura Addington will explore the options.

9. List of participants and contributors 2016

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10. WGEXT Agenda Annual Meeting 2016

Mon. 18th April 2016	
09.30 – 09.45	Meet at the Marine Geology Branch of the Polish Geological Institute, Gdansk
09.45 – 10.30	Welcome by dr Regina Kramarska - director of Marine Geological Branch of Polish Geological Institute - National Research Institute
	Welcome by WGEXT Chair
	Apologies for absence
	Overview of Terms of Reference
	Adoption of Agenda
10.30 – 10.45	Coffee break
10.45 – 12.00	Term of Reference (ToR) A1a (OSPAR Summary of Extraction Statistics)
12.00 – 12.30	ToR H (cultural heritage), ToR J (EIA thresholds)
13.00 – 13.30	Lunch
13.30 – 14.30	Visit Institute
14.30 – 15.30	Overview historical extraction data (from 1988 onwards) Subgroup discussions on several ToRs
15.30 – 15.45	Coffee break
15.45 - 17.15	ToR A1b: Review data on marine extraction activities. Plenary discussion and finalising of A1a and A1b.
17.15 – 18.00	Subgroup discussions on several ToRs
Tue. 19th April 2016	
09.00 – 10.30	Plenary discussion ToR G (harmonisation, intensity)
10.30 – 10.45	Coffee and tea
10.45 – 12.30	Subgroup discussions on several ToRs
12.30 – 13.30	Lunch
13.30 – 14.30	Subgroup discussions on several ToRs
14.30 – 15.30	Plenary discussion ToR B (database)
15.30 – 15.45	Coffee break
15.45 – 18.00	Plenary discussion ToR B (database), I (cumulative assessment)
Wed. 20th April 2016	
09.00 – 11.00	Presentations
11.00 – 11.15	Coffee break
11.15 – 12.30	Plenary discussion ToR E (mitigation), F (deep sea mining)
12.30 – 13.30	Lunch

13.30 – 14.30	Plenary discussion ToR C (MFSD), D (publishing)
14.30 – 15.30	Subgroups ToRs preparing text Final Report
15.30 – 15.45	Coffee break
15.45 – 18.00	Subgroups ToRs preparing text Final Report
Thu. 21th April 2016	
09.00 – 10.30	Agree initial text of WGEXT draft Final Report 2016
10.30 – 10.45	Coffee break
10.45 – 12.30	New ToRs; next meeting; outstanding actions, closing remarks
13.00 - 13.30	Lunch
13.45 – 16.30	Field excursion to Orlowo Cliff in Gdynia

11. ToR A1: Review of National Marine Aggregate Extraction Activities

A detailed breakdown of each country's sediment extraction dredging activities is provided here.

Belgium

Due to the change to the marine sand and gravel legislation by the entry into force of the marine spatial plan (12 June 2014), the maximum amount which can be extracted from zone 2 – which is laying in a habitat area - during 2015 is 1.646.000 m3. This amount decreases every year (from 2014 till 2019 by 1%, i.e. 17.000m³ per year). In zone 2 it is also prohibited to extract gravel.

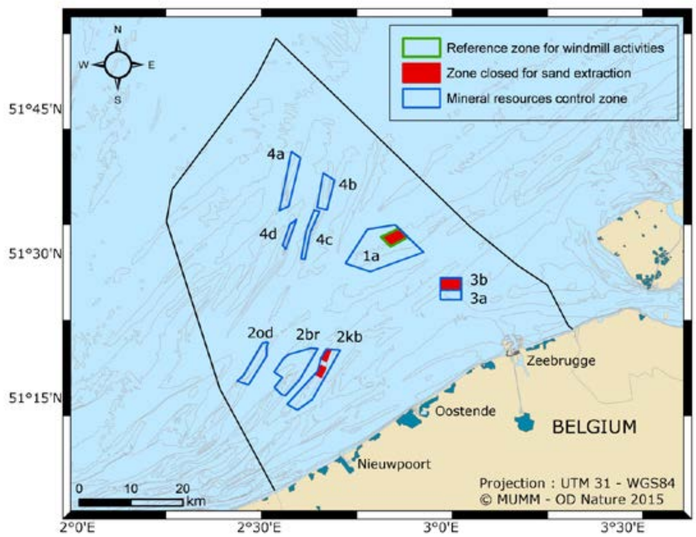


Figure 1. Extraction areas on the Belgian part of the North Sea, from 12th of June 2014 onwards.

In 2015, a total amount of 2 810 254 m³ sand and no gravel was extracted from the Belgian Continental Shelf both by the private sector and the Flemish Region, Coastal Division and Division Maritime Access.

The private sector extracted 2 327 289 m³ sand by 12 private license holders, which is mainly used for industrial purposes. Two licenses were also granted to the Flemish Region, Coastal Division and Division Maritime Access.

The licenses for the Flemish Region have the same conditions (reporting, black-boxes, etc.) as licenses for the private sector with the exception that they are exempted from the fee system. The Flemish Region-Coastal Division extracted 482 965 m³ sand, which was used solely for beach nourishment and originated mainly from zone 3a and zone 4c. The decrease of the total amount extracted in 2015 compared to 2014 was mainly due to the decreased extraction for beach nourishment. In Table 1, an overview is given of extracted amounts per area.

Table 1. Marine aggregate extraction figures for 2015 from FOD Economie, KMO, Middenstand en Energie (Includes aggregate extraction for beach nourishment).

Dredging area	Amount (m^3)
Thorntonbank (1a)	1 562 000
Gootebank (1b)	0
Kwintebank (2ab)	41 000
Buiten Ratel (2c)	371 000
Oostdyck (2c)	249 000
Sierra Ventana (3a)	331 000
Hinderbanken (4c)	254 000
TOTAL	**2 810 000**

In 2015, 1 079 000 m³ of sand for industrial purposes was exported to our neighbouring countries France, UK and the Netherlands (Table 2). The other 1 248 000 m³ of industrial sand was landed in the Belgian coastal harbours of Brugge (including the harbour of Zeebrugge), Oostende and Nieuwpoort.

Table 2. Export of marine aggregates in 2015 from FOD Economie, KMO, Middenstand en Energie.

Landing country	Amount (m^3)
France	178 000
UK	143 000
Netherlands	758 000
TOTAL	**1 079 000**

Sand extraction on the Belgian Continental Shelf started in 1976 and data are available since then (Figure 3). From 2007 onwards the extra quantities extracted by the Flemish Region are included in the graph.

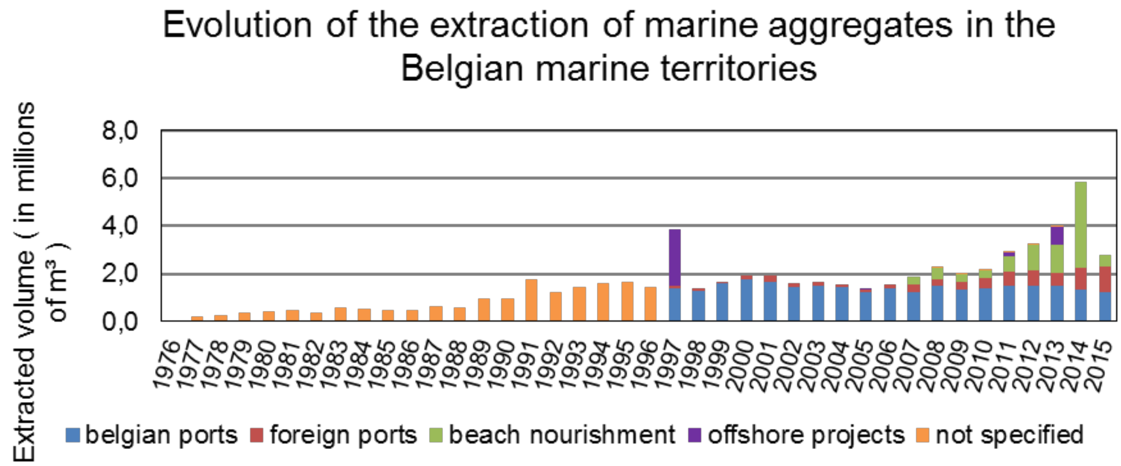


Figure 2. Volumes of sand and gravel extracted from the Belgian Continental Shelf between 1976 and 2015.

During 2014 a new EMS system was installed on all vessels after a pilot project of two years. Figure 3 gives a schematic overview of the EMS2.0 with the possible interactions. This system allows faster transmission of data, faster data treatment and faster reporting.

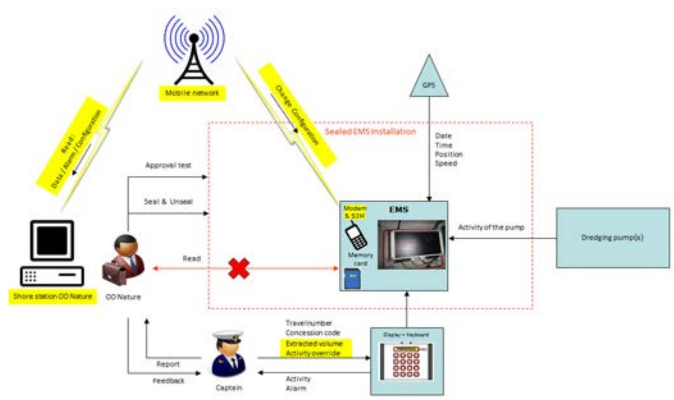


Figure 3. Schematic overview of the new EMS system (EMS2.0), the interaction with the system and the changes to the (former) EMS1.0 system (in yellow).

Black-box data can be used for intensity maps: see figure 5 (2014) and figure 6 (2015).

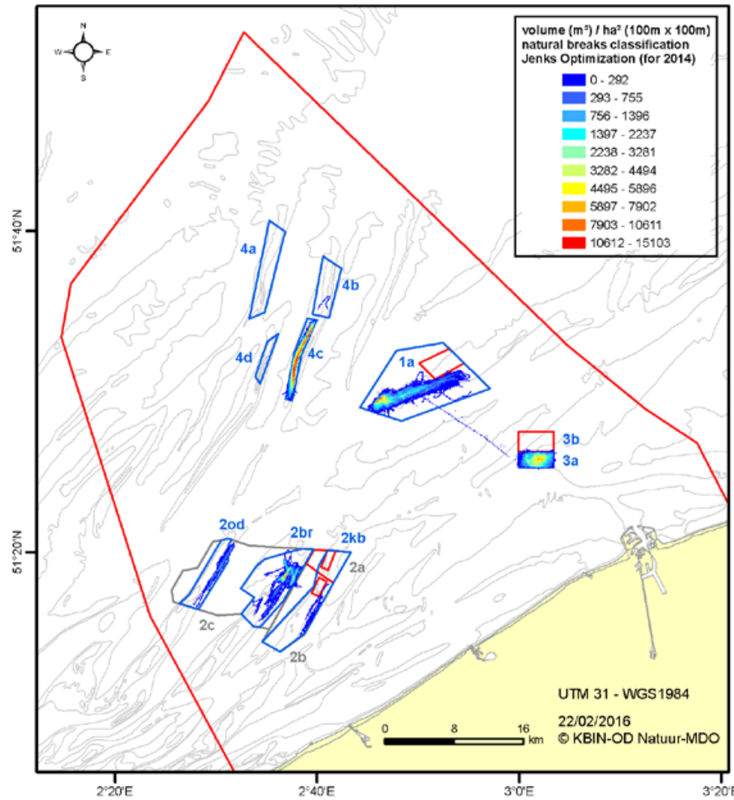


Figure 5. Intensity of extraction during the year 2014.

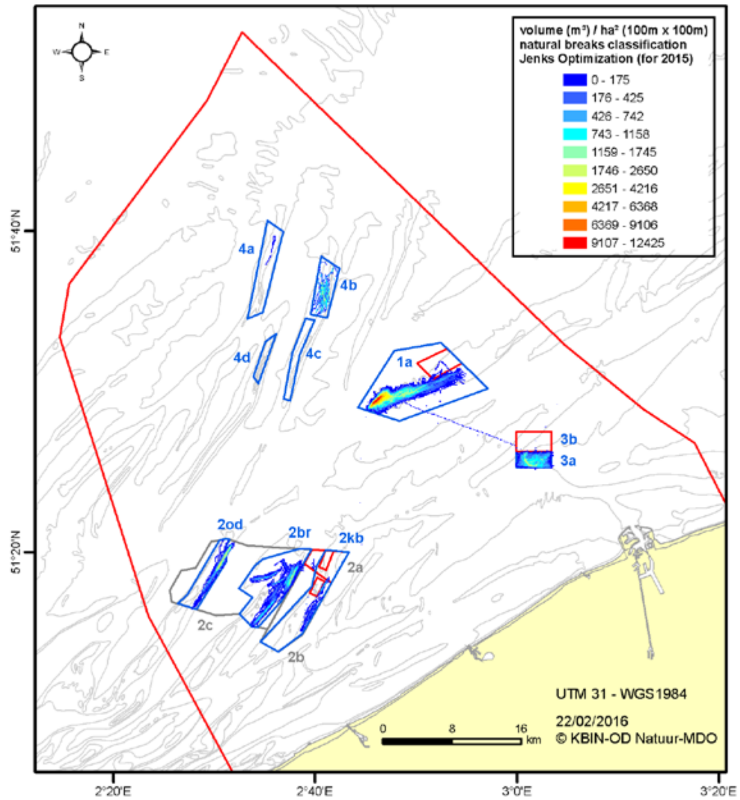


Figure 6. Intensity of extraction during the year 2015.

Canada

No report.

Denmark

Country	A) Construction/ industrial aggregates (m^3)	B) Beach replenishment (m^3)	C) Construction fill/ land reclamation (m^3)
Denmark (HELCOM)	2197364	80706	201454
Denmark (OSPAR)	1462353	1953120	1280773
Denmark (total)	3481557	2033473	1491497

Country	D) Non-aggregate (m^3)	E) Total extracted (m^3)	F) Aggregate exported (m^3)
Denmark (HELCOM)	0	2707071	12980
Denmark (OSPAR)	0	4896947	317901
Denmark (total)	0	7006527	321081

Estonia

No extractions in 2015.

Finland

There was no extraction in 2015. However, there are plans to extract 700 000 m3 for the City of Helsinki, but the possible extraction was postponed to 2017 at least.

Table 1. Historic patterns of marine aggregate extraction (m3).

YEAR	AMOUNT	YEAR	AMOUNT
2001	0	2009	0
2002	0	2010	0
2003	0	2011	0
2004	1,600,000	2012	5,800
2005	2,388,000	2013	0
2006	2,196,707	2014	0
2007	0	2015	0
2008	0	Total (2001–2015)	6,190,507

Description of historic extraction activities for 1995–2015.

Sand and gravel extraction from Finnish coastal areas between 1995 and 2004 was negligible. The Port of Helsinki extracted 1.6 million m3 off Helsinki (Gulf of Finland) in 2004, 2.4 million m3 in 2005 and 2.2 million m3 in 2006. Since then there has been only a small experimental dredging operation in 2010 and a 5 800 m3 test extraction in 2012 in the Loviisa area, Eastern Gulf of Finland.

Summary of current licensed areas and forecasts for future exploitation of marine aggregates

There are four licenses issued by the Regional State Administrative Agencies (AVI).

Loviisa: A permission to extract 8 million m3 of marine sand from the Loviisa-Mustasaari area was accepted in April 2007 by the Environment Permit Authority to Morenia Ltd. However there was a complaint against the decision and the case was under hearing of Administrative Court of Vaasa. The decision on December 31, 2008 was favorable for the extraction. Extraction has not yet started besides a small experimental dredging exercise in May 2010 and another feasibility test exercise of 5800 m3 in 2012. The license is valid until 30 April 2017.

Soratonttu and Itä-Tonttu (offshore of Helsinki): In 2010 The Regional State Administrative Agency of Southern Finland issued a license to Morenia Ltd. for extracting 5 Mm3 marine sand and gravel in the Itä-Tonttu and Soratonttu areas off the city of Helsinki. According to the license, the extraction should start within 4 years of issuing the license. The license is valid until 31 August 2020. In 2014 The Regional State

Administrative Agency of Southern Finland gave a new decision, extending the starting time for extraction until 20 June 2020.

Yppäri

A license application was sent by Morenia Ltd. to authorities in December 2011 concerning the extraction of 10 Mm3 of material within the next 15 years in the Yppäri area (1,1 km2), the Bay of Bothnia. After the request by the authorities, Morenia Ltd. has conducted additional studies and delivered further information concerning the application in 2012. The work was undertaken and a license was issued for 10 years in 2013. However, there was a complaint against the license decision, but the Administrative Court of Vaasa decided in October not to take up the subject. Thus, the license is now valid.

Iijoki river mouth

Southern Ii partition unit sent an application in October 2015 to extract 240 000 m3 of sand within next 12 years in Iijoki river mouth, Bay of Bothnia. The Regional State Administrative Agency of Northern Finland issued the license in March 2016 to extract the applied amount of material within an area of 10 hectares. The license is valid until 31 December 2027.

Forecast for future exploitation of marine aggregates

In the Helsinki metropolitan area there are currently several major tunnel construction sites, e.g. the metro line extension to west of Helsinki and the new railway route to the airport. As a consequence, a lot of crushed rock material from tunnel works has been available in the area, reducing the need for marine aggregates. However, there are plans for several large building projects around Helsinki area, possibly increasing the need of construction aggregates in near future.

A nuclear power plant is planned to be built in Pyhäjoki, on the coast of the Bay of Bothnia. If the project goes ahead, marine aggregates may be used from the nearby Yppäri area.

France

a) Construction industrial aggregate (sand and gravel) extraction figures for 2015

DREDGING AREA	AMOUNT *
Channel	689 367 m^3
Atlantic	2 003 261 m^3
Brittany	0 m^3

Description of construction industrial aggregate (sand and gravel) extraction in 2015

b) Amount of material extracted for beach replenishment projects in 2015.

DREDGING AREA	MATERIAL	AMOUNT *

Description of beach replenishment schemes in 2015

France does extract sand for beach replenishment but data is not available because these extractions are in the jurisdiction of the local/regional authority and license is not require.

c) Construction fill/ land reclamation (m^3) extraction figures for 2015

DREDGING AREA	MATERIAL	AMOUNT *

*** Please insert units (e.g. m^3 or Tonnes).**

Description of construction fill/ land reclamation in 2015

No data available for construction fill or land reclamation in France

d) Non-aggregate (e.g. shell, maerl, boulders etc.) extraction figures for 2015.

DREDGING AREA	MATERIAL	AMOUNT *
Brittany	Shelly sand	250 800 m^3 [(1)]

[1] Licensed data (maximum permitted) because extracted data is subject to statistical confidentiality

Description of non-aggregate extraction activities in 2015

No extraction of maerl took place in 2015. Maerl extraction was prohibited by the end of 2013.

e) Exports of marine aggregate in 2015

No export of marine aggregate.

Marine aggregate exports in 2014 *(please add text to supplement table (c) as necessary).*

f) Historic patterns of marine aggregate extraction.

Description of historic extraction activities for 2010–2015 (*please add text to supplement table (e) as necessary*).

Year	Quantities extracted (m^3)			Total extracted (m^3)	Maximum quantities permitted by Authorities (m^3)
	Chanel	*Brittany*	*Atlantic*		
2010	545 881	225 400	2 598 423	3 369 704	6 448 662
2011	592 539	196 393	2 688 844	3 477 776	6 550 746
2012	406 594	175 264	2 750 178	3 332 036	11 320 746
2013	768 999	230 068	2 557 782	3 556 849	10 597 877
2014	358 686	200 800 (1)	2 157 738	2 700 629	12 431 000
2015	689 367	250 800 (1)	2 003 261	2 943 428	13 184 800

[1] Licensed data (maximum permitted) because extracted data is subject to statistical confidentiality

g) Summary of current licence position and forecasts for future exploitation of marine aggregates

17 extraction licences (169.44 km^2), 1 research license (53.27 km^2) and 1 prospection (42 km^2) authorisation have been issued by local administration (Préfectures).

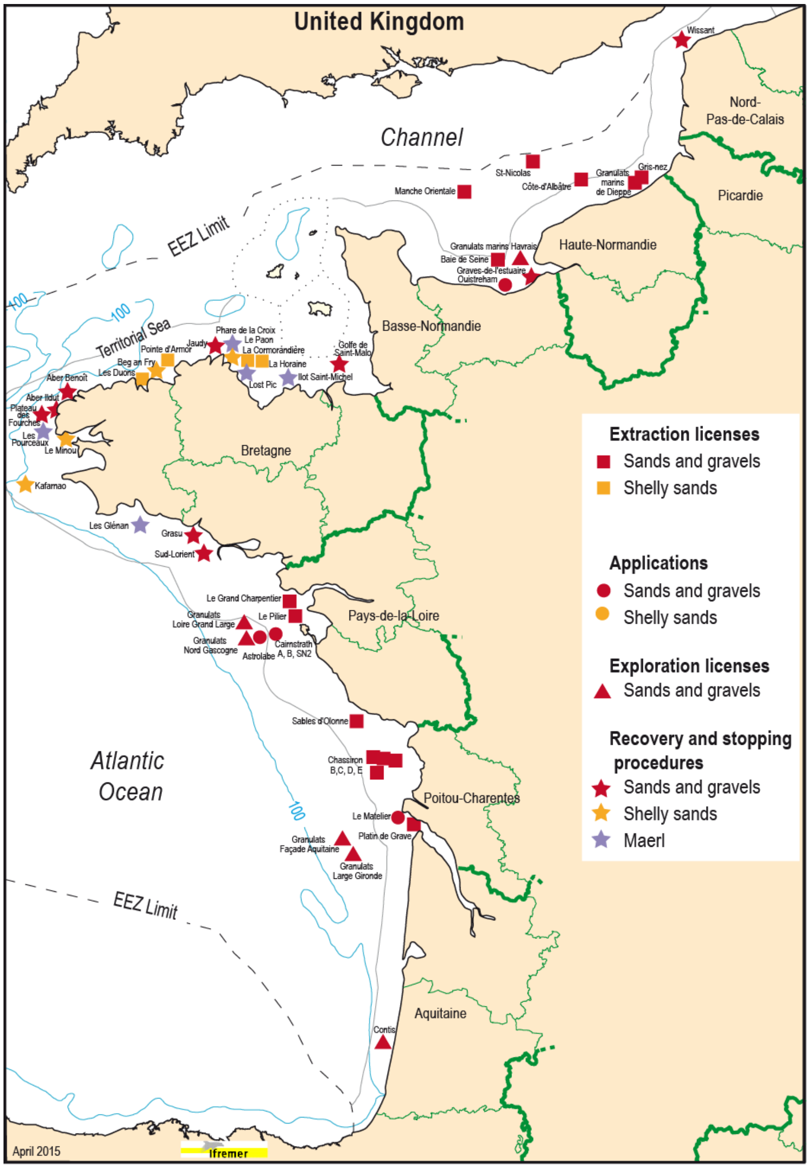
10 applications (4 for exploration, 1 on actual extraction area for a renewal of license, 5 on new extraction perimeter) for aggregate extraction are being considered by Economy Ministry. These 10 applications represent 1364.53 km^2 for research perimeters and 27.374 km^2 for extraction sites (with a potential increase for new licensed area of 26.244 km^2).

Please include information as per following table adding columns for additional years:

Country	**Licensed Area Km²***				**Area in which extraction activities occur Km²**			
	2012	**2013**	**2014**	**2015**	**2012**	**2013**	**2014**	**2015**
FRANCE	230.61[1]	263.809[1]	260.71[1]	264.71[1]	No data[2]	No data[2]	No data[2]	No data[2]

[1] Includes 95.27 research licenses and 135.34 extraction licenses in 2012, 95.27 research licenses and 168.539 extraction licenses in 2013, 95.27 research licenses and 165.44 extraction licenses in 2014 and 95.27 research licenses and 169.44 extraction licenses in 2014.

[2] French dredging vessels are fitted with EMS but the information is not treated to make area in which extraction activity occur available.



Additional Notes and Explanation

Information supplied is used to compile the following table which will represent one of the formal outputs of the WGEXT to OSPAR.

In a bid to ensure consistency in the way figures are calculated please refer the following additional explanation of the column headings.

Germany

Marine aggregate (sand) extraction figures for 2015

OSPAR AREA	
Replenishment	1 494 980 m^3
Construction	20 558 m^3
Total	1 515 538 m^3
HELCOM area	
Replenishment:	308 631 m^3
Construction	476 958 m^3
Total	785 589 m^3

Greenland and the Faeroe

No report.

Iceland

No report.

Ireland

There was no extraction in Ireland in 2015.

Latvia

No report.

Lithuania

No extraction was done in 2015.

The Netherlands

Marine aggregate (sand) extraction figures for 2015

DREDGING AREA	AMOUNT (m^3)
Euro-/Maas access-channel to Rotterdam	0*
IJ-access-channel to Amsterdam	0*
Dutch Continental Shelf	6,666,118
Dutch Continental Shelf / Maasvlakte 2 project	1,457,010
TOTAL	**8,123,128**

*** Sand extraction for commercial use was none, therefore maintenance dredging was done**

Non-aggregate (shell) extraction figures for 2015

DREDGING AREA	MATERIAL	AMOUNT (m^3)

Wadden Sea	Shells	66 583
Wadden Sea inlets	Shells	0
Western Scheldt	Shells	720
Voordelta of the North Sea	Shells	8640
North Sea	Shells	128 930
TOTAL	**Shells**	**204 873**

Description of non-aggregate extraction activities in 2015:

Based on National Policy for shell extraction there are maximum permissible amounts defined.

These permissible amounts (in m^3) of shells to be extracted yearly from:

- the Wadden Sea max. 85 000 (but no more than 50% of the total quantity (The Wadden Sea and Sea Inlets))
- the Voordelta (North Sea) 40 000
- the Western Scheldt 40 000
- the rest of the North Sea outside -5 m water depth until a distance of 50 km offshore is unlimited.

Exports of marine aggregate in 2015

DESTINATION (landing)	AMOUNT (m^3)
Belgium	3,085,922
France	85,221
United Kingdom	11,797
TOTAL	**3,182,940**

Amount of material extracted for beach replenishment projects in 2015:

DREDGING AREA	MATERIAL	AMOUNT (m^3)
Netherlands coast (general)	sand	12,369,398
Weak links North Holland	sand	5,403,249
TOTAL	**sand**	**17,772,647**

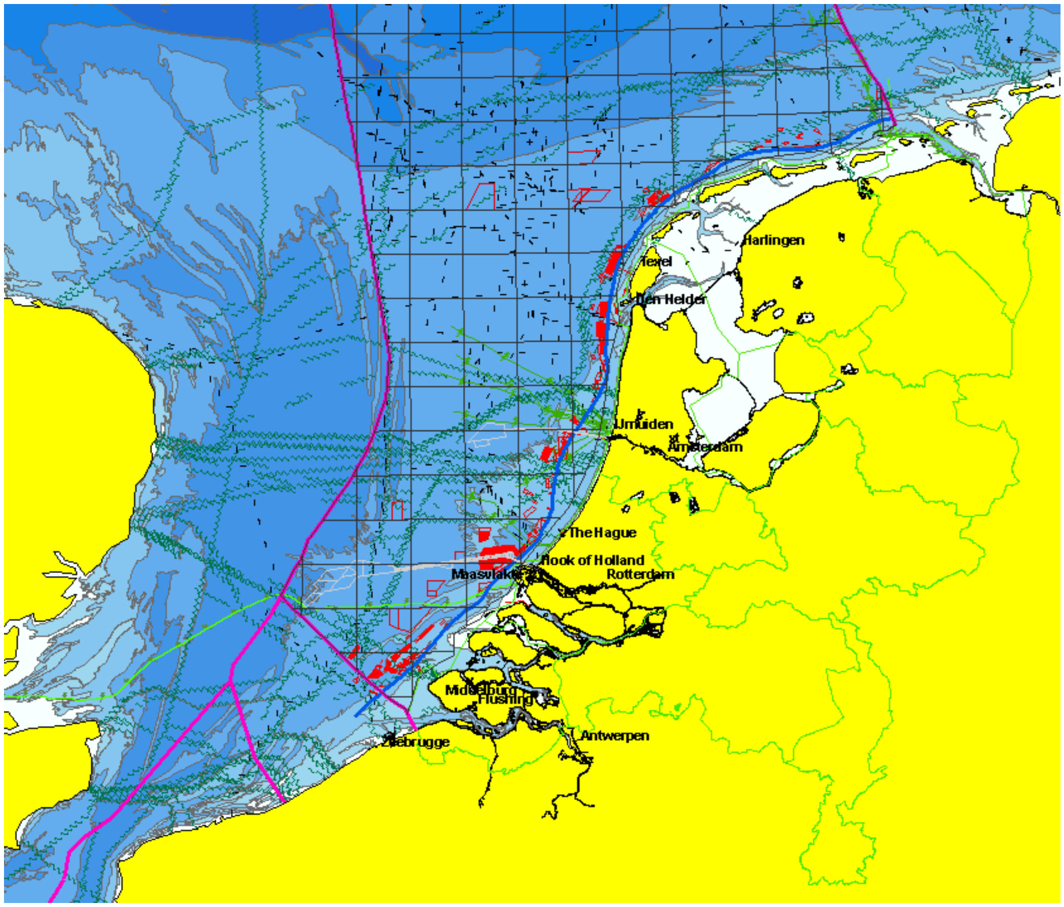


Figure 11.4. Licensed sand extraction areas 2015.

Historic patterns of marine aggregate extraction in Mm^3.

Extraction Area	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Euro-/Maas channel	2,32	0,49	0,65	1,94	1,22	0,06	0,32	0	0,8	1,8	0
IJ-channel	4,31	0	0	0	0	0	0,75	0,83	1,5	1,2	0
Channel Voordelta	-	-	-	-	-	-	-	0,05	-	0,03	0
Dutch Continental Shelf	22,13	22,88	28,25	24,53	119,59	122,47	68,88	66,89	10,63	8,9	8,1
Total extracted	28,76	23,37	28,9	26,47	120,81	122,53	69,95	67,87	12,96	12,1	8,1

Dutch sand extraction (Commercial and beach replenishment) 1974 - 2015

YEAR	TOTAL EXTRACTED m3	YEAR	TOTAL EXTRACTED m3
1974	2,787,962	1995	16,832,471
1975	2,230,889	1996	23,149,633
1976	1,902,409	1997	22,751,152

1977	757,130	1998	22,506,588
1978	3,353,468	1999	22,396,786
1979	2,709,703	2000	25,419,842
1980	2,864,907	2001	36,445,624
1981	2,372,337	2002	33,834,478
1982	1,456,748	2003	23,887,937
1983	2,252,118	2004	23,589,846
1984	2,666,949	2005	28,757,673
1985	2,724,057	2006	23,366,410
1986	1,955,491	2007	28,790,954
1987	4,346,131	2008	26,360,374
1988	6,954,216	2009	120,700,339
1989	8,426,896	2010	122,532,435
1990	13,356,764	2011	62,948,704
1991	12,769,685	2012	41,899,276
1992	14,795,025	2013	23,167,720
1993	13,019,441	2014	51,271,582
1994	13,554,273	2015	25,895,775

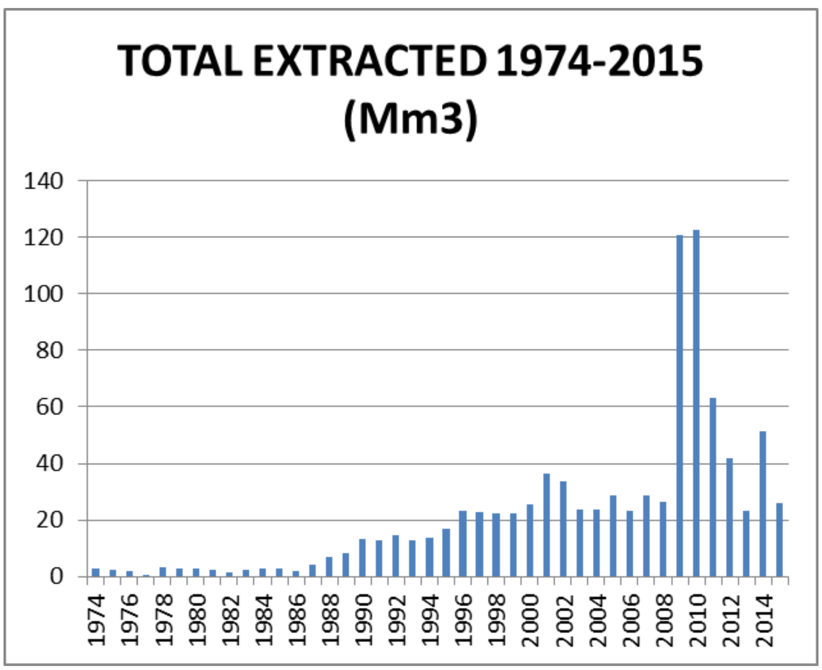


Figure 11.5. Dutch sand extraction (Commercial and beach replenishment) 1974 – 2015.

Licences considered and issued licences Rijkswaterstaat North Sea

In the year:	Amount	In the year:	Amount
1998	35	2007	24
1999	30	2008	38
2000	25	2009	23
2001	25	2010	15
2002	42	2011	26
2003	26	2012	10
2004	20	2013	19*
2005	33	2014	20*
2006	33	2015	15*

*** one of the issued licenses is a general permit for beach nourishments/replenishments in which several extraction areas for the next 5 years are covered in one single permit.**

Norway

The situation remains the same as in previous years (2014, 2015). Extraction is very limited in Norway.

Poland

Year	Beach Nourishment	Construction Aggregate	Total
1990	1 046 358	0	**1 046 358**
1991	766 450	0	**766 450**
1992	817 056	17 270	**834 326**
1993	974798	0	**974 798**
1994	251 410	2 222	**253 632**
1995	280 720	0	**280 720**
1996	134 000	0	**134 000**
1997	247 310	1 112	**248 422**
1998	88 870	0	**88 870**
1999	375 860	70 000	**445 860**
2000	241 000	265 556	**506 556**
2001	100 253	85 000	**185 253**
2002	365 000	112 222	**477 222**
2003	438 414	0	**438 414**
2004	1 042 896	0	**1 042 896**
2005	1 043 925	0	**1 043 925**
2006	548 856	0	**548 856**
2007	977 358	0	**977 358**

2008	238 948	51 667	**290 615**
2009	702 590	0	**702 590**
2010	970 923	0	**970 923**
2011	531 218	316 111	**847329**
2012	396 086	155 000	**551086**
2013	232 695	161 111	**393 806**
2014	457 731	429 000	**886 731**
2015	355 500	269 167	**624 667**

Portugal

History of extractions in Portugal

Year	Construction Aggregate, m³		Beach Nourishment, m³	
	Azores archipelago	Madeira archipelago	Administração da região hidrográfica do Tejo[1]	Administração da região hidrográfica do Algarve[2]
1998				1,285,000
1999	6,083			
2000	145,519			
2001	146,791			
2002	115,613	562,353		
2003	176,285	683,521		
2004	197,636	910,179		
2005	159,968	703,620		
2006	181,691	478,473		370,000
2007	141,991	369,008	500,000	
2008	144,647	345,890	1,000,000	
2009	134,021	291,290	1,000,000	
2010	124,132	276,090		1,250,000
2011	126,381	210,720		600,000
2012	69,392	114,360		
2013	50,729	117,980		
2014	45,964	115,262	1,000,000	340,000
2015	61,266	100,935		140,000

[1] Southern central continental shelf.

[2] Southern continental shelf.

There were no extractions reported in the four other districts: Administração da região hidrográfica do Norte (Northern continental shelf), Administração da região hidrográfica do Centro (Central continental shelf), Administração da região hidrográfica do Tejo (near Lisbon) and Administração da região hidrográfica do Alentejo (Southwestern continental shelf)

Spain

National Marine Aggregate Extraction Activities

A total amount of 693.301 m^3 of sand was placed on beaches (383.469 m^3 in the OSPAR area, 309.832 m^3 in the Mediterranean area). The sources of these materials were essentially the marine deposits, the sand redistribution within the beach and harbours dredged material.

During 2015 seven extraction activities from marine sand deposits have been carried out in Spain: one in Pontevedra and six in Cádiz (all of them in OSPAR area)

No activities were developed in Canary Islands.

Figures 1 and 2 show the distribution of the material source in both coastal sides.

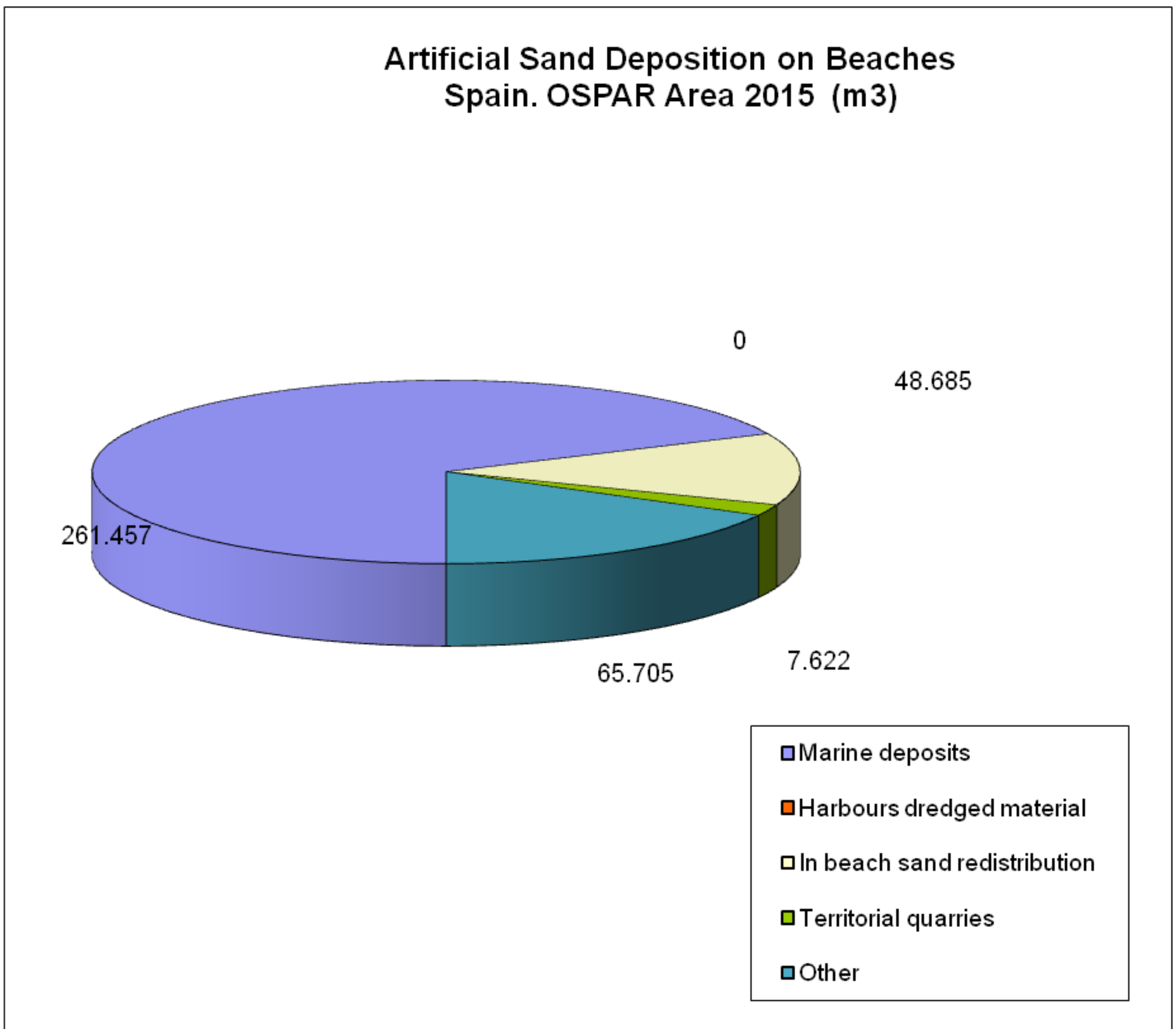


Figure 1.

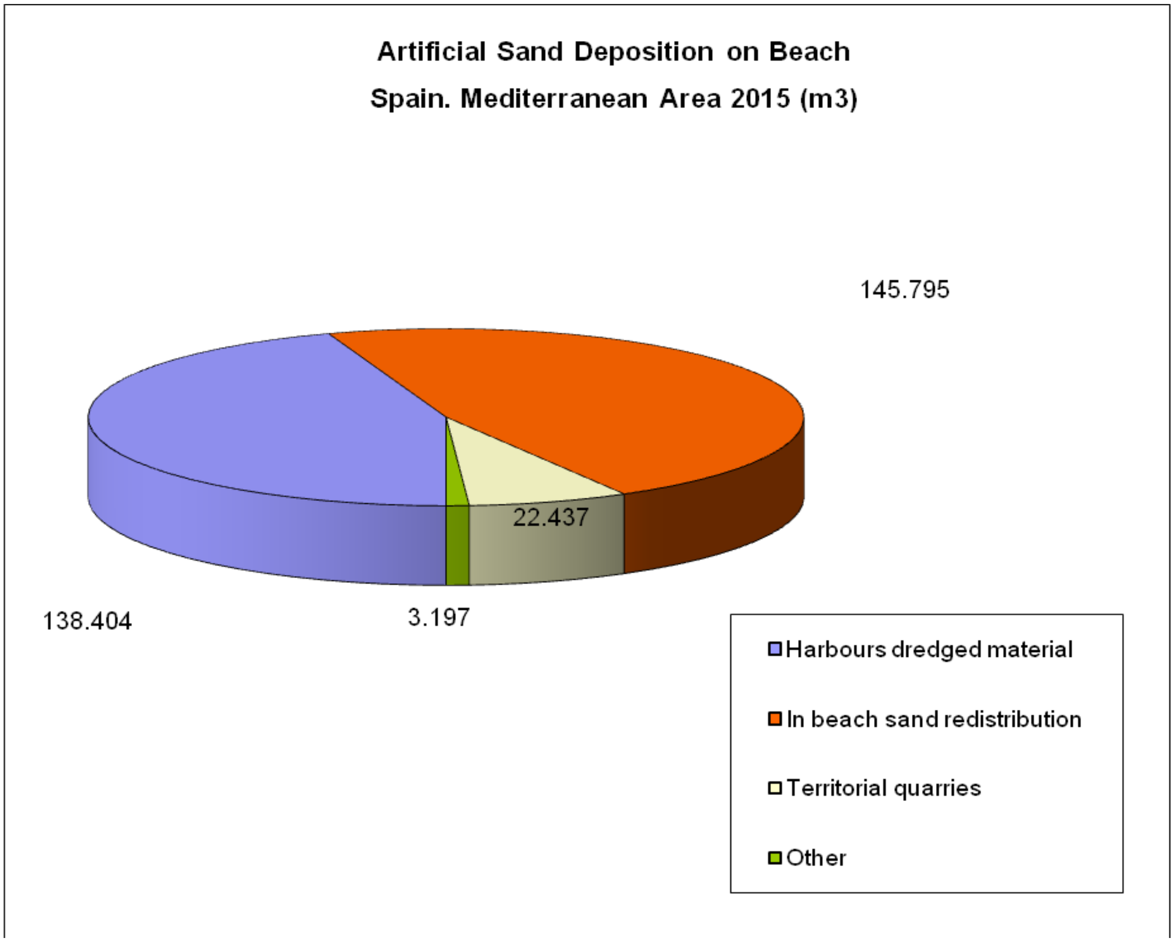


Figure 2.

Sweden

No extractions in 2015.

United Kingdom

Marine aggregate (sand and gravel) extraction figures for 2015 from The Crown Estate ownership (Includes aggregate and material for beach replenishment and reclamation fill)

Dredging Area	Amount (tonnes)
Humber	1,944,606
East Coast	4,474,629
Thames Estuary	2,663,512
East English Channel	3,674,197
South Coast	3,332,257
South West	1,131,751
North West	2,046,899

Miscellaneous and rivers	199,424
TOTAL	19,467,275

Extraction tonnage for reclamation fill and beach replenishment were as follows:

- Reclamation Fill: 1 806 657 tonnes
- Beach Replenishment: 2 071 005 tonnes

Non-aggregate (e.g. shell, maerl, boulders etc.) extraction figures for 2015: None

Exports of marine aggregate in 2015 from The Crown Estate ownership (tonnage)

Antwerp	462 546
Boulogne	17 612
Breskens	1281
Bruges	149 131
Calais	59 145
Dunkirk	120 536
Flushing	684 580
Harlingen	44 143
Honfleur	24 656
Ostend	432 306
Sluiskil	5800
Zeebrugge	151 410
Total tonnage	**2 153 146**

Amount (tonnage) of material extracted for beach replenishment and reclamation fill projects in 2015 from The Crown Estate ownership.

Beach replenishment	
Bournemouth	179,910
Clacton	1,160,168
Eastbourne	15,054
Lincshore	626,472
Littlestone	30,946
Pevensey	58,455
Total tonnage	2,071,005

Reclamation fill	
Canary Wharf	20,407
Liverpool 2	1,786,250
Total tonnage	**1,806,657**

Historic patterns of marine aggregate extraction (tonnes) from The Crown Estate ownership. (Figures exclude beach replenishment and reclamation fills) 1998–2015.

Historic patterns of marine aggregate extraction (tonnes) from The Crown Estate Ownership.

	1998	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	
Humber	2,694,977	2,840,261	3,122,080	2,933,623	2,710,881	2,928,366	3,031,699	3,392,015	3,521,737	
East Coast	8,923,562	9,131,512	9,129,635	9,636,697	9,011,323	8,611,199	8,538,073	7,881,670	8,006,736	
Thames Estuary	862,834	971,960	854,483	909,141	1,291,103	838,185	758,257	696,012	899,852	
East English Channel	2,180,099	1,958,476	1,387,450	875,000	1,163,892	1,212,951	457,102	474,553	323,824	
South Coast	3,641,602	3,926,856	4,226,088	4,752,978	4,235,188	4,445,311	4,691,857	4,914,793	5,127,989	
South West	1,886,289	1,719,803	1,602,394	1,549,431	1,467,122	1,515,241	1,633,383	1,591,610	1,545,275	
North West	275,590	355,044	316,090	421,068	482,270	470,962	558,398	611,983	608,314	
Rivers & Misc.	6,238	6,273	46,120	73,047	78,597	85,153	99,079	124,506	111,687	
Yearly Total	**20,471,191**	**20,910,185**	**20,684,340**	**21,151,015**	**20,440,376**	**20,107,368**	**1,767,848**	**19,687,142**	**20,145,414**	
	2007	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**Total**
Humber	3,184,814	3,154,070	2,524,328	2,622,126	2,175,846	1,451,742	1,528,399	1,566,850	1,318,134	46,701,948
East Coast	7,715,428	6,075,899	5,637,296	5,637,296	5,275,569	3,564,464	4,249,110	4,720,088	4,474,629	126,220,186
Thames Estuary	977,027	1,735,141	405,484	518,881	664,629	1,090,559	737,464	591,766	1,503,344	16,306,122
East English Channel	1,961,035	2,443,367	2,256,919	2,409,476	4,317,153	3,553,379	3,402,686	3,620,229	3,653,790	37,651,381
South Coast	4,752,843	3,934,692	3,492,424	3,430,463	3,917,315	3,629,352	3,397,803	2,966,107	3,047,892	72,531,553
South West	1,769,197	1,470,719	1,019,174	931,151	956,102	1,067,526	1,024,357	1,087,277	1,131,751	24,967,802
North West	633,405	432,889	271,598	307,509	314,098	285,368	378,813	251,424	260,649	7,235,472
Rivers & Misc.	109,399	87,787	92,263	39,438	0	0	45,522	67,018	199,424	1,271,551
Yearly Total	**21,203,148**	**19,334,564**	**15,699,487**	**15,131,307**	**17,620,712**	**14,642,390**	**14,764,154**	**14,870,759**	**15,589,613**	**332,886,015**

Summary of current / future licensed area position of marine aggregates within The Crown Estate ownership.

TYPE	STATUS	NUMBER
Production Agreements	Extraction licenses	63
Applications	New applications	14
Prospecting	Prospecting licenses	11

United States

Marine aggregate (sand and gravel) extraction figures for 2015. None

The only active operating for the extraction of marine sand to be used for aggregate continues to be that done by a private company, Amboy Aggregates went out of business in 2014.

An additional 2 133 108 cubic meters of mud, sand, gravel and rock were dredged from navigation channels in and around New York harbour; this dredged sediment (see table below) was used as submarine capping material in the restoration of a former, offshore disposal site known as the Historic Area Remediation Site (HARS), approximately 22 km outside on New York harbour.

Non-aggregate (e.g. shell, maerl, boulders, etc.) extraction figures for 2015.

Dredged Area	Material	Volume Cubic meters
Port of New York and New Jersey Federal Channel Deepening	mixed	383 807
Perth Amboy, New Jersey	mixed	49 696
NY Harbor Sandy Hook Channel	mixed	326 465
American Sugar refining Co,	mixed	29 818
Manhattan Cruise terminal	mixed	242 364
U.S. Naval Weapons Station, Earle, NJ	mixed	1 100 959

Description of non-aggregate extraction activities in 2015. This material was dredged from navigation channels in New York harbour both for routine maintenance and channel-deepening. The dredged material used to cap an abandoned, offshore, dredged sediment disposal site. The site is on the shelf 22 km outside on New York Harbour. The disposal site, when active, was referred to as the “Mud Dump” site. It is now the HARS (Historic Area Remediation Site).

Exports of marine aggregate in 2014: None.

Amount of material extracted for beach replenishment projects in 2015.

Beach nourishment site	Material	Volume Cubic meters
Smith Point County Park, New York	sand	1,146,833
Robert Moses State Park, New York	sand	1,106,311
Sea Bright to Ocean Township, New Jersey	sand	1,037,795
Long Beach Island, New Jersey (estimated)	sand	6,116,440
Oakwood Beach, New Jersey (estimated)	sand	264,536
Assateague Island, Maryland	sand	60,006
Stratmere/Ocean City, Maryland (estimated)	sand	1,987,843
TOTAL		8,428,825

Historic patterns of marine aggregate extraction in millions of cubic.

Year	Millions of m^3
1990	0.2
1991	0.8
1992	0.8
1993	1.5
1994	1.7
1995	1.4
1996	1.4
1997	1.4
1998	1.3
1999	1.3
2000	1.1
2001	1.3
2002	1.1
2003	1.4
2004	1.6
2005	1.4
2006	1.2
2007	1.2
2008	1.0
2009	0.7
2010	0.8
2011	0.8
2012	0.8
2013	0.8
2014	0.2
2015	0

12. ToR A2: Review of development in marine resource mapping, legal regime and policy, environmental impact assessment, research and monitoring and the use of ICES Guidelines on marine aggregate extraction

Belgium

Resource mapping in Belgium and the Netherlands

In the framework of the research project TILES (Transnational and Integrated Long-term Marine Exploitation Strategies), a geological knowledge base is being built for the Belgian and southern Netherlands part of the North Sea. Voxel models of the subsurface are used for predictions on sand and gravel quantities and qualities, to ensure long-term resource use. The voxels are filled with geological data from boreholes and seismic lines, but other information can be added also. The geology provides boundary conditions needed to run environmental impact models that calculate resource depletion and regeneration under various scenarios of aggregate extraction. Such analyses are important in monitoring progress towards good environmental status, as outlined in the Marine Strategy Framework Directive. By including uncertainty, data products can be generated with confidence limits, which is critical for assessing the significance of changes in the habitat or in any other resource-relevant parameter. All of the information is integrated into a cross-domain, multi-criteria decision support system optimised for user-friendliness and online visualisation. More information: http://odnature.naturalsciences.be/tiles

Partners: Royal Belgian Institute of Natural Sciences; Ghent University, Dep. of Geology and Dep. of Telecommunications and Information Processing; and TNO - Geological Survey of the Netherlands. Active cooperation with FPS Economy, Continental Shelf Service.

Reference

Van Lancker, V., Francken, F., Kint, L., Terseleer, N., Van den Eynde, D., De Mol, L., De Tré, G., De Mol, R., Missiaen, T., Chademenos, V., Bakker, M., Maljers, D., Stafleu, J. & van Heteren, S. (in press). Building a 4D Voxel-Based Decision Support System for a Sustainable Management of Marine Geological Resources. In: Diviacco, P., Leadbetter, A. & Glaves, H. (eds.). Oceanographic and Marine Cross-Domain Data Management for Sustainable Development. IGI Global.

Canada. No report.

Denmark. No report.

Estonia. No report.

Finland

Organisation undertaking seabed mapping programme:

Geological Survey of Finland (GTK)

Scope of seabed mapping programme being undertaken in 2012–2015

A study of marine geology by the Geological Survey of Finland (GTK) concerning late-Quaternary deposits on the seabed is being conducted using acoustic and seismic methods: echo sounders, single-channel seismic and side-scan sonar and multibeam sonar equipment. Investigations are supplemented with seabed sampling and visual observations. The basic scope of the study is to acquire data on the distribution and thickness of various types of sediments and information on stratigraphy, mineralogy and geochemistry of the deposits. New methods of sounding and sampling as well as data processing and analyses of samples are also developed and tested.

The aim of the study is also to increase knowledge of the physical properties and the geochemical variations in seabed sediments induced by both nature and human activity. Also the demand of various practical and scientific needs arising in a surrounding community should be met.

During years 2012–2015 the main focus of mapping activities was in the Sea of Bothnia. One of the largest projects was the mapping of the offshore areas of a Nuclear power plant under development. This project covered an area of about 1000 km².

The Finnish Inventory Programme for the Underwater Marine Environment (VELMU) which ran during 2004–2015 collected data on the diversity of underwater marine biotopes and species. One of the main actions of the project was marine geological mapping performed by GTK. The inventories were conducted in all of the Finnish sea areas in cooperation between several different institutes and partners. The results of the VELMU programme are presented in a map service that is open for public in http://paikkatieto.ymparisto.fi/velmu/.

Completed seabed resource maps in 2012–2015

The marine geological mapping index is shown in Figure XX.X. The mapping information as well as a generalized seabed substrate map is also available using GTK's map service Hakku http://hakku.gtk.fi/fi/.

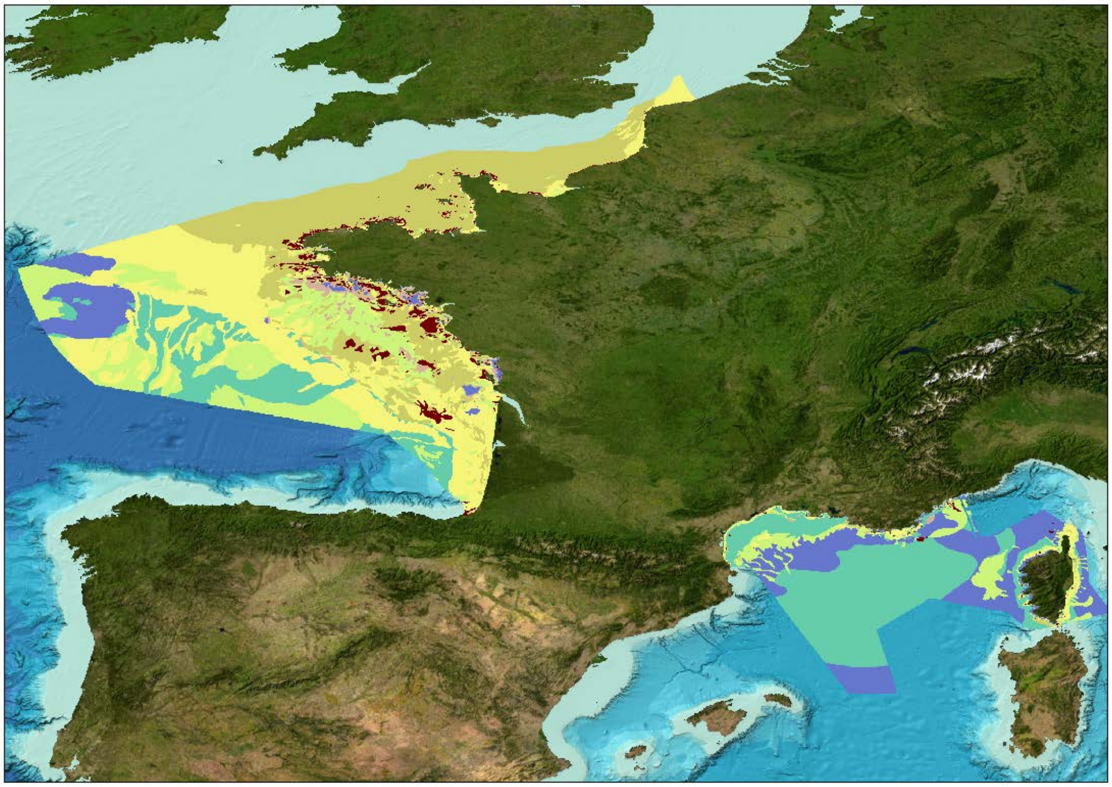
France

Marine resource mapping

National organizations responsible for seabed mapping are:

- Institut Français de Recherche pour l'Exploitation de la Mer (Ifremer), Z.I. Pointe du Diable, CS 10070, 29280 Plouzané, France. Contact person: Laure Simplet; e-mail: laure.simplet@ifremer.fr.
- Service Hydrographique et Océanographique de la Marine (SHOM), CS 92803–29 228 BREST Cedex 2, France. Contact person: Thierry Garlan , email: thierry.garlan@shom.fr.

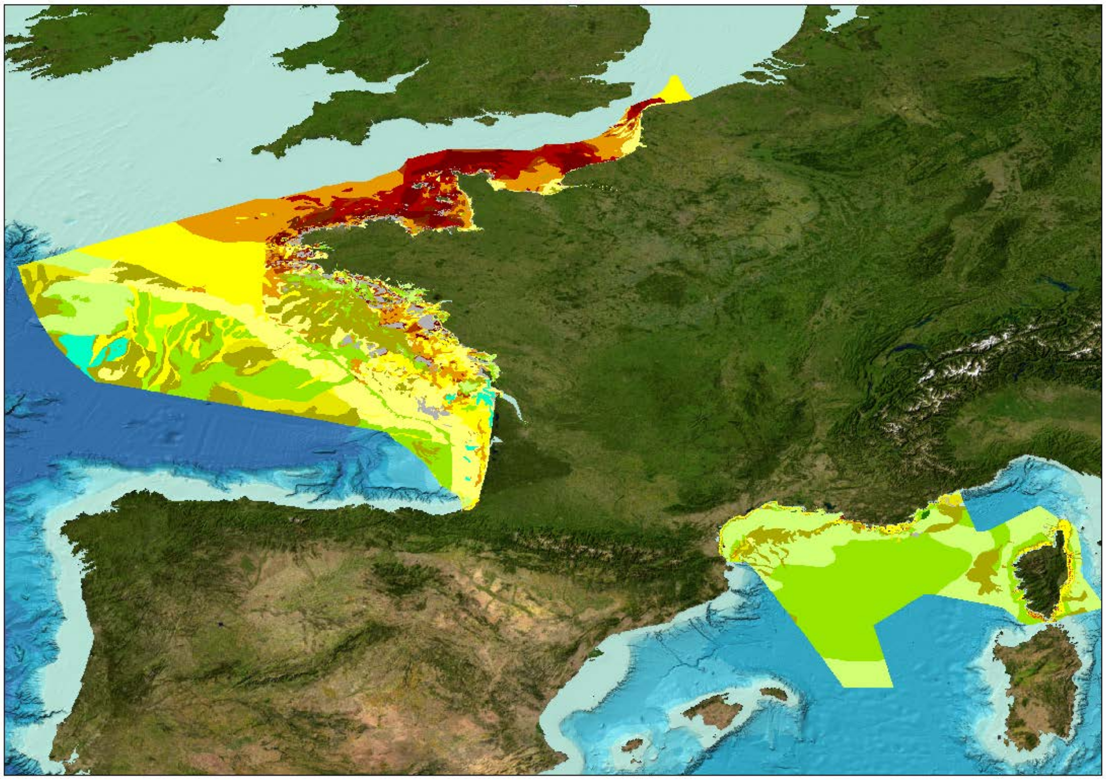
- Bureau de Recherches Géologiques et Minières (BRGM), 3 avenue Claude Guillemin, BP 36009, 45060 Orléans Cedex 2, France. Contact persons: Isabelle Thinon: tel: +33 2 38643345; e-mail: i.thinon@brgm.fr, and Fabien Paquet: e-mail: f.paquet@brgm.fr.
- Ifremer is in charge of mapping offshore aggregates and publishing atlases of coastal areas dealing with seabed type, morpho-bathymetry, morpho-sedimentary, geology, sediment thickness, and bedrock morphology. Ifremer is also involved in mapping the continental shelf, slope, and abyssal plain.
- The French Naval Hydrographic and Oceanographic Service (SHOM) is in charge of bathymetric surveys dedicated to marine safety. Their nautical charts and seabed sedimentological charts (“G” type maps) cover the area between 5 and 15 nautical miles from the coast at various scales (typically 1:50 000). These are compiled from existing data, for example, derived from tallow lead samples that cover 95% of the continental shelf, grab samples, cores, sidescan sonar, multibeam bathymetry and reflectivity, and aerial photography, in collaboration with universities and national organisations.
- BRGM (French Geological Survey) is in charge of the offshore geological (“hard substrate geology”) mapping of the continental shelf at scales of 1:50 000, 1:250 000, and 1:1 000 000. The geological mapping of the continental shelf continues through the RGF national programme (Référentiel Géologique de la France)
- BRGM and Ifremer are involved in the second phase of the EMODnet Geology Project (2013–2016). Seafloor geology and seabed substrate mapping, at 1: 1 million and 1: 250 000 scales, is ongoing within the French EEZ for european seas. These data can be downloaded on EMODnet-Geology portal (http://www.emodnet-geology.eu/emodnet/srv/eng/home).



EMODNet Geology Seabed substrate map on scale 1: 1 000 000.

SHOM published maps on sediment substrate at a 1: 1 million scale in response to the European Marine Strategy Framework Directive (MSFD); (Garlan T. and Marches E., 2012). These maps are free access and can be downloaded at:

http://sextant.ifremer.fr/fr/web/dcsmm/geoportail/sextant#/search?fast=index&_content_type=json&sortBy=popularity&from=1&to=20&any=nature%20des%20fonds&_groupPublished=DCSMM_EVALUATION_INITIALE&orgName=SHOM



MSFD Seabed substrate map on scale 1: 1 000 000 (SHOM, 2012).

Since 2011, 6 seabed mapping reports have been issued by Ifremer:

Augris C. et Clabaut P. (coord.), 2013. Cartographie morpho-sédimentaire des petits fonds marins du cap d'Antifer au cap d'Ailly, Haute-Normandie. Partenariat Ifremer - Réseau d'Observation du Littoral Normand et Picard. *Éd. Quae*. 6 cartes, échelle 1/20 000, livret d'accompagnement, 80 pages.

Clabaut P. et Augris C. (coord.), 2014. Les fonds marins de Corse. Cartographie biomorphosédimentaire. *Éd. Quae*. 25 cartes, échelle 1/20 000, livret d'accompagnement, 79 pages.

Clabaut P. et Augris C. (coord.), 2014. Les fonds marins de Corse. Cartographie biomorphosédimentaire. *Éd. Quae*. 25 cartes, échelle 1/20 000, livret d'accompagnement, 79 pages.

Ehrhold A. (coord.), 2014. Cartes sédimentologiques de Bretagne Sud. Entre baie de Vilaine et archipel de Glénan. *Éd. Quae*. 4 cartes, échelle 1/20 000, livret d'accompagnement, 80 pages.

Menier D., Augris C. et Briend C. (coord.), 2014. Les réseaux fluviatiles anciens sur le plateau continental de Bretagne Sud. *Éd. Quae*. 104 pages.

Ehrhold A. (coord.), 2015. Cartes sédimentologiques et morpho-bathymétriques de la baie de Morlaix et de sa région.. *Éd. Quae*. 3 feuilles, échelle 1/30 000 et une clé USB.

Publications can be ordered from:

- IFREMER: Editions QUAE (http://www.quae.com/fr/index.html).
- BRGM: Editions (http://www.brgm.fr/editions.jsp).
- SHOM: Editions (http://www.shom.fr/les-produits/produits-nautiques).

Further information is available online at:

- http://sextant.ifremer.fr/fr/
- http://sextant.ifremer.fr/fr/web/granulats-marins
- http://infoterre.brgm.fr/viewer/MainTileForward.do
- http://data.shom.fr/

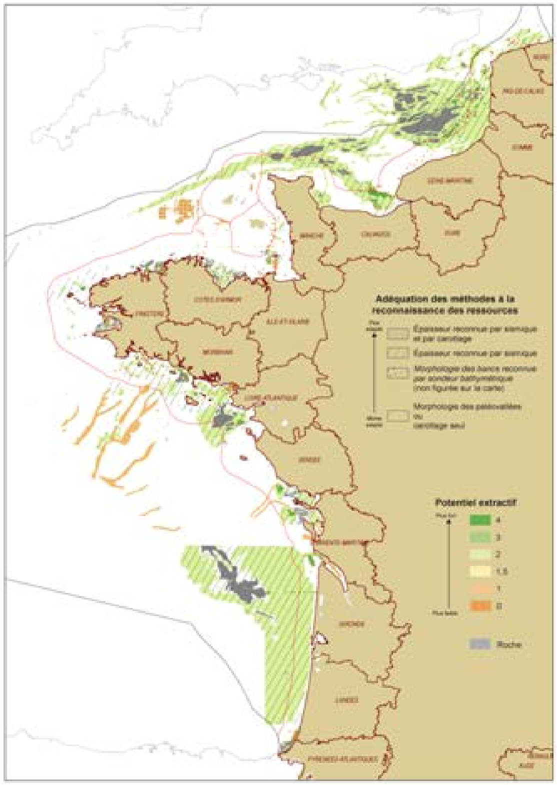
Legal regime and policy

No change in legal regime or policy to report.

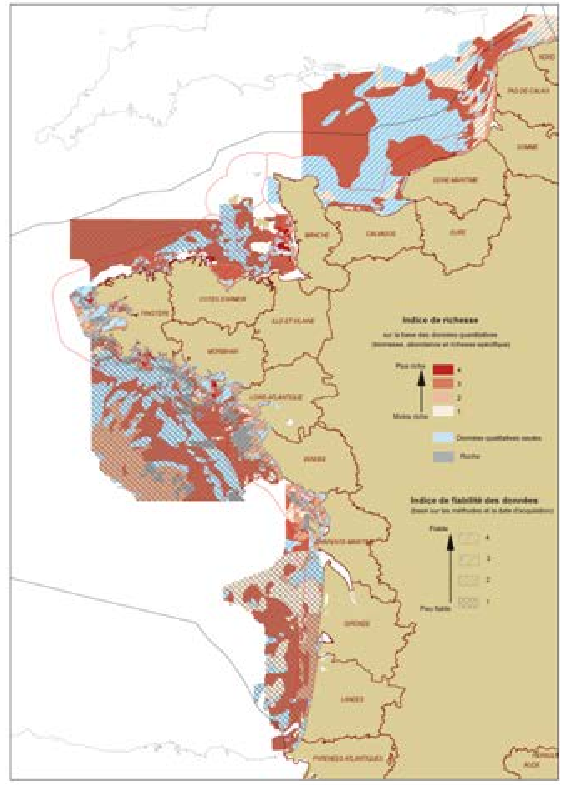
Environmental impact assessment, research and monitoring

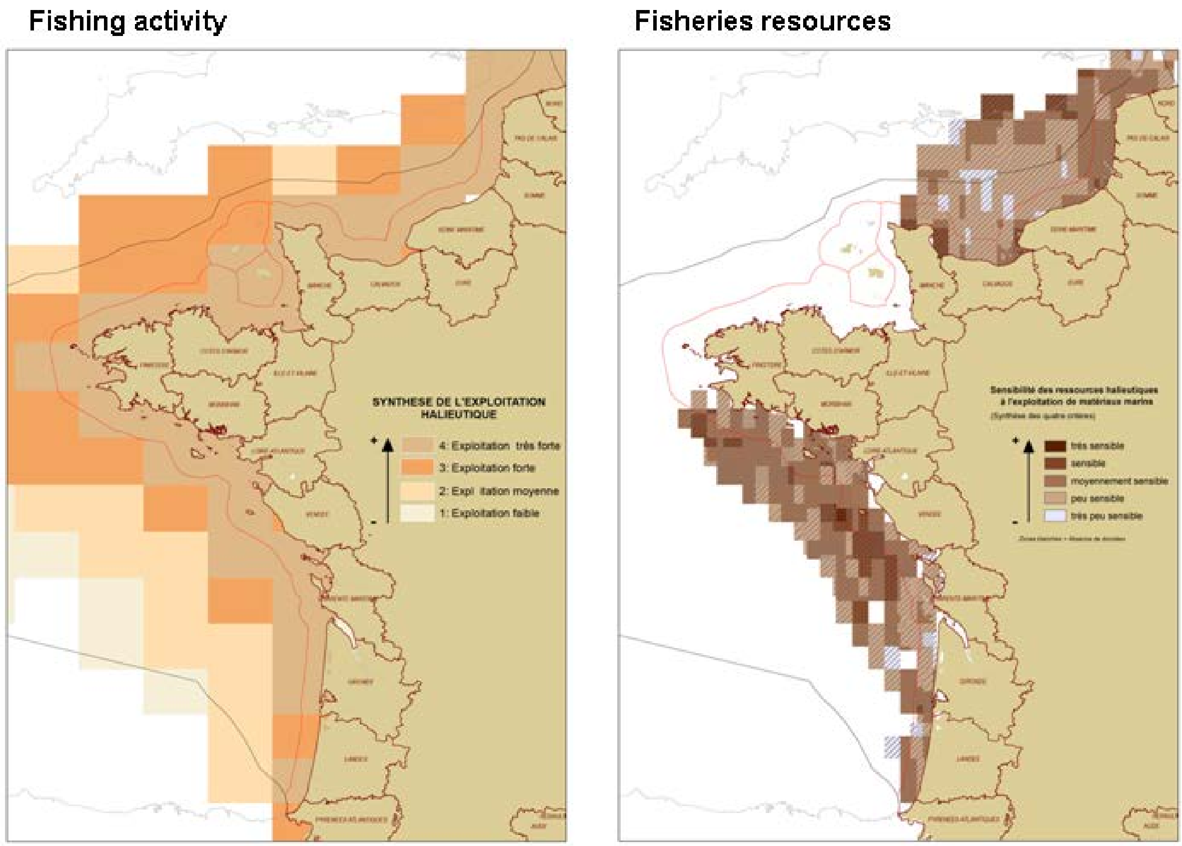
Ifremer completed a study, commissioned by French Environment Ministry, whose aim was to define and identify areas for sand and gravel extraction with minimal constraints for benthic fauna, fishing activity and fisheries resources. The results are available at: http://sextant.ifremer.fr/fr/web/granulats-marins.

Aggregates resources



Benthic community





Synthesis maps for aggregates resources, benthic fauna, fishing activity and fisheries resources (Ifremer 2005–2012).

The ESPEXS project, leaded by the Languedoc-Rousillon Regional authority with the collaboration of Ifremer and the university of Perpignan, published its final reports. This project aimed to complete knowledge on marine environment and to define environmental issues on 2 areas of potential sand extraction for beach replenishment identified in the european project BEACHMED. Reports can be downloaded at: http://littoral.languedocroussillon.fr/ESPEXS-Phase-2.html

The SCOOTER project studied the effect of marine aggregate extraction on water quality due to the remobilization of contaminants from sediments. The objectives of this project were:

- (1) to bring information on the kinetic of contaminant remobilization within the dredging-induced turbid plume and on the fate of contaminant between the dissolved and particulate phase and

- (2) to examine water quality evolution under natural and dredging conditions to identify the need or not for long-term monitoring (period covered by the mining license). Final report can be downloaded at: http://archimer.ifremer.fr/doc/00310/42078/41381.pdf

Use of the ICES Guidelines on Marine Aggregate Extraction

France does not incorporate ICES Guidelines in a formal way in its legal regime but take into account all of them for its marine aggregate extraction management (EIA before authorization, monitoring prior to and during the period covered by the license and after the extraction takes place to examine restoration of the area).

Germany. No report.

Greenland and the Faeroes. No report.

Iceland. No report.

Ireland

The Infomar mapping programme is ongoing and by far the best source of information is here http://www.infomar.ie/ There are no EIA's for MA's as far as I know. The policy/legal environment has been undergoing major revisions. These are not however finalised yet.

Latvia. No report.

Lithuania. No report.

The Netherlands

Resource mapping

An overview of the monitoring of resource mapping in the Netherlands is given in Annex 12 (Stolk, 2015).

In the framework of the research project TILES (Transnational and Integrated Long-term Marine Exploitation Strategies) a geological knowledge base is built for the Belgium and southern Netherlands part of the North Sea. For details see 12.1 Belgium.

Legal regime and policy

The main development in policy in the last years is the regulation of other activities in the area reserved for sand extraction. In the Policy Document on the North Sea 2016–2021 (I&E and EA, 2015) it is formulated as follows:

The zone between the continuous NAP -20m isobath and the 12-mile boundary is regarded as a reserve area for sand extraction for the purposes of coastal replenishment and flood protection as well as for sand extraction for filling purposes and concrete and masonry sand for construction and infrastructure.

The spatial pressure in this area will increase due to the construction of wind farms at sea and the laying of electric cables through the areas with the most cost-effective sand reserves and where sand extraction has the highest priority.

If parties engaged in other activities of national interest, such as oil and gas extraction and wind energy, wish to use the area reserved for sand extraction, then a solution tailored to the specific situation will be sought.

In the case of cables and pipelines, including interconnector and telecommunications cables, the following will be examined in succession: 1) whether a route is possible with the new cables and pipelines being bundled with existing cables and pipelines; and 2) whether a route is possible without appreciably affecting the supply of extractable sand. These preferred routes are shown on the framework vision map and are based on:

- location of less suitable sand extraction zones (thin package);
- existing bundling of cables and pipelines, enabling maintenance zone to be limited;
- landing points for gas, oil and electricity;
- location of sand extraction sites that have already been depleted.

If use of a preferred route is impossible for economic or environmental reasons, or if no route has been designated in an area, then customised work will be necessary. In exceptional cases it may be possible to extract sand in this area prior to it being used for cables or pipelines. If this is not possible and the new route will force the sand extraction activities out to another site entailing extra costs, the initiator will have to compensate these extra costs.

Monitoring and research

An overview of the monitoring of the effects of sand extraction in the Netherlands is given in Annex 12 (Stolk, 2015).

The far-field effects on benthos of the sand extraction (ca.200 million m^3) for the construction of Maasvlakte 2, an extension of Rotterdam harbour, are analysed by Heinis and Van Tongeren (2016). The main conclusion is that, in the area where a significant increase was seen in the silt content in the second and third years of sand extraction (the high-impact area), there was a small change in the composition of the benthos. However, this was a subtle change involving a slight increase in the biomass of a small number of silt-tolerant species and a slight decrease in the biomass of species that are averse to silt. In the area with significantly increased silt content (high-impact area), there was no emergence or disappearance of species that could not be accounted for by autonomous development (emerging from a comparison of the baseline years and the effect years). The conclusion with respect to the possible knock-on effect on animals higher in the food chain (including birds) is that any possible effects of a higher silt content in the seabed can be excluded.

In the framework of 'Building with Nature' inside the deep (20m) extraction pit of the sand extraction for Maasvlakte 2 a small part was not extracted. As a result a ridge was formed in the pit. On and around this ridge research was done on fish and benthic fauna to investigate the short-term effects of deep sand extraction and ecological landscaping (De Jong, 2016).

Literature

De Jong, M.F. (2016) The ecological effects of deep sand extraction on the Dutch Continental shelf. Implication for future sand extraction. PhD Thesis, Wageningen University, Wageningen, The Netherlands, 164 p.

Heinis, F. and O.F.R. van Tongeren (2016) Monitoring of the effects of Maasvlakte 2. Far-field effects on benthos of the construction of Maasvlakte 2. Maasvlakte 2 Project Organisation, World Port Center, Rotterdam, 53 p.

I&E and EA (2015) Policy Document on the North Sea 2016–2021, including the Netherlands' Maritime Spatial Plan. Appendix to the National Water Plan 2016–2021.

The Dutch Ministry of Infrastructure and the Environment and the Dutch Ministry of Economic Affairs, The Hague, The Netherlands, 119 p.

Stolk, A. (2015) Synthesis and future course of monitoring marine sand extraction in the Netherlands.

Proceedings EMSAGG 2015 Conference: Marine sand and gravel – finding common grounds, 4–5 June 2015, Delft, The Netherlands.

Norway. No report.

Poland. No report.

Portugal. No new information to report.

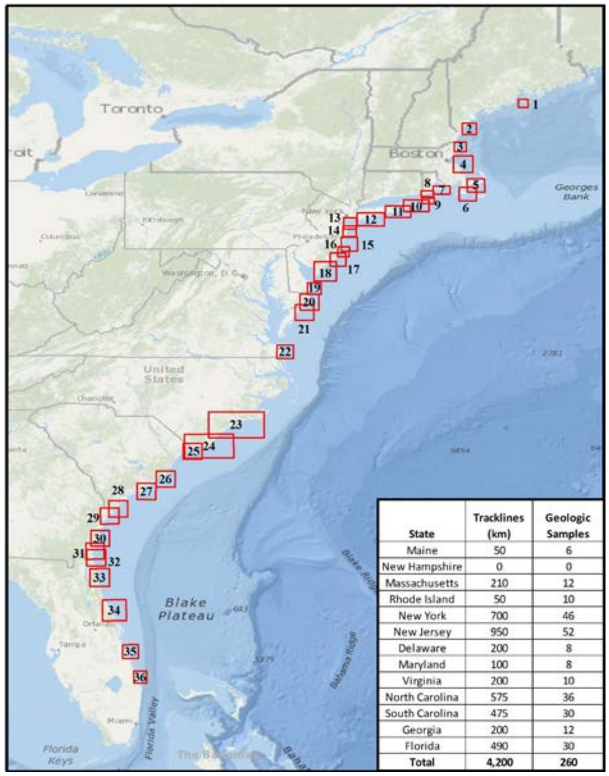
Sweden. No report.

United Kingdom. No report.

United States

In 2015/2016, the Federal Bureau of Ocean Energy Management (BOEM, formerly the Mineral Management Agency) completed reconnaissance geophysical track lines and geologic sample locations along the Atlantic Outer Continental Shelf (OCS) as part of an Inventory of Potential Beach Nourishment and Coastal Restoration Sand Sources on the Atlantic Outer Continent Shelf of the United States. Relevant existing databases were reviewed including those of the U.S. Geological Survey, National Oceanic and Atmospheric Administration, the U.S. Army Corps of Engineers as well as those held by state agencies and academic institutions.

The study area began 5.6 km offshore within water depths less than 30 m or to 14.8 km offshore whichever is closer to shore. The limitation of 30-m water depth is the maximum practical dredging capability of U.S. dredges. Thirty-six survey areas were identified (Figure 1); survey areas 1 to 19 are considered as being in the ICES territory



State	Tracklines (km)	Geologic Samples
Maine	50	6
New Hampshire	0	0
Massachusetts	210	12
Rhode Island	50	10
New York	700	46
New Jersey	950	52
Delaware	200	8
Maryland	100	8
Virginia	200	10
North Carolina	575	36
South Carolina	475	30
Georgia	200	12
Florida	490	30
Total	**4,200**	**260**

Overall, 5600 km of geophysical (seismic, sidescan, interferometric, bathymetry magnetometer) survey lines, 250 vibrocores and 100 grab samples were collected. In total, 75% (4200 km of geophysical data collection and 260 geologic samples) was at a reconnaissance level; 25% (1400 km of geophysical data collection and 90 geologic samples) at a design level. 40% of the data was offshore New York and New Jersey. Vibrocores were to be described by layer thickness, colour, texture (grain size), composition and presence of clay, silt, gravel, or shell.

13. ToR G (G1, G2): Harmonization

Belgium

What kind of system (e.g. black box, EMS,…) is used to monitor aggregate extraction in your country?	Closed and sealed system: Electronic Monitoring System (EMS) - black-box - automatic recording system
How long since this system is in operation and how long are the records kept?	Complete records since 2003 available for interpretation of intensity. Historical data storage on hard disk OD Nature Ostend and Continental Shelf Service Brussels
Who is the owner of the data?	FPS Economy - Continental Shelf Service Brussels
List the raw data fields that are recorded e.g. coordinates, navigation speed, time, status, vessel ID/drag head, type of material,… Please provide some example data for each field.	Identification of vessel, code of concessionary, date, time (UTC), geographical position, speed, status of dredging pump(s), dredging activity, (loaded volume). All necessary sensors are installed to enable the recordings of the parameters above-mentioned. The acquisition rate depends on the ships' activity with additional records during anomalies of the EMS.

How is the raw data processed e.g. block/grid analysis and what units are used e.g. h/km²/yr, m³/km²/yr, …?	Extracted volume of trailing suction hopper dredger per timeframe is based on the known fixed loading capacity (or declared load). The final table can be used to evaluate the extracted volume on any surface and for any time interval and statistics as function of time and space are easily calculated. Grids of extracted volume per year are available at different resolution (from m^3 /y/100m ^{2} to m^3/y/10000m ^{2}) to map at different scales the evolution of extraction.
Who is doing the data processing?	OD Nature Ostend and Continental Shelf Service Brussels
What do you consider the advantages and disadvantages of your system?	* Advantages: low cost, easy to install, easy maintenance, reliable performance, data falsification almost impossible. * Disadvantages: extracted volume is an estimation but practice shows this approach amply satisfies
Is data freely accessible?	yes, on request for scientific purposes (basic data except vessel identification data)
Is onboard screening going on?	yes, physical control of the EMS and the inaccessibility for third parties is carried out on regular basis
What data is used for e.g. legislation, scientific research,…?	all the above mentioned data
Are there issues of confidentiality?	yes, identification data
Are there national limits set for dredging intensity?	Yes, the total extraction depth is limited to 5 m below a reference level defined by the authorities. If this depth is exceeded, the involved area can be closed for extraction. In the control zones all concessionaires can extract a maximum volume of 15 million m^3 during a period of 5 years.
Are there any reports/papers available in which intensity is mentioned. Please provide the paper or the reference.	* Degrendele, K., Roche, M. and Schotte, P., 2002, Synthèse des données acquises de novembre 1999 à avril 2001 quant à l'incidence des extractions sur le Kwintebank, Rapport Fonds pour l'extraction de sable, Ministère des affaires économiques de Belgique. * Degrendele, K., Roche, M., Schotte, P., Van Lancker, V.R.M. & Bellec, V., 2010. Morphological evolution of the Kwinte Bank central depression before and after the cessation of aggregate extraction. Journal of coastal research, SI, 51: 77–86. * Van Lancker, V.R.M., Bonne, W., Garel, E., Degrendele, K., Roche, M., Van den Eynde, D., Bellec, V., Brière, C., Collins, M.B. & Velegrakis, A.F., 2010. Recommendations for the sustainable exploitation of tidal sandbanks. SI, 51: 151–164. * Roche, M.; Degrendele, K.; De Mol, L.; Schotte, P.; Vandenreyken, H.; Van den Branden, R.; De Schepper, G. (2011). Synthesis of the monitoring of the impact from the aggregate extraction on the Belgian Continental Shelf, in: (2011). Study day: Marine aggregate extraction: needs, guidelines and future prospects, 17 oktober 2011, Bredene. pp. 3–45 * Roche, M., Degrendele, K., De Mol, L., Milano, R. ,Van den Branden, R., & De Schepper, G., 2013. Essential facts of the monitoring of the sand extraction and its impact on the Flemish banks on the Belgian continental shelf from 2003 to 2012. MARID IV Marine and River Dune Dynamics, Bruges, 15 - 17 April 2013, conference proceedings 223–230.

Would it be possible to make the raw/processed data available to WGEXT? (Y/N)	Yes
Any ideas on where else data can be harmonised with regards to aggregate extraction to allow data to be used across member countries	OSPAR (EIHA - QSR); EMSAGG; CIRIA; MSFD; EMODNET

Canada. No report.

Denmark

What kind of system (e.g. black box, EMS,…) is used to monitor aggregate extraction in your country?	AIS data and quarterly reports from the permit holders.
How long since this system is in operation and how long are the records kept?	Quarterly reports since before 1990, but since then, they have been electronically saved in a database. AIS data since approx 1997, also saved in a database.
Who is the owner of the data?	The Agency for Water and Nature Management, The Ministry of Environment and Food
List the raw data fields that are recorded e.g. coordinates, navigation speed, time, status, vessel ID/drag head, type of material,… Please provide some example data for each field.	Vessel name, date and time, speed, volume, type of extracted material, extraction site, port of unloading, pumping time, method, water depth.
How is the raw data processed e.g. block/grid analysis and what units are used e.g. $h/km^2/yr$, $m^3/km^2/yr$, …?	visual control in GIS
Who is doing the data processing?	The Agency for Water and Nature Management
What do you consider the advantages and disadvantages of your system?	Advantage: low cost. Disadvantage: time consuming, not accurate and not sure if the vessel is actually pumping
Is data freely accessible?	No
Is onboard screening going on?	No
What data is used for e.g. legislation, scientific research,…?	All data is used for legislation. Sometimes the quarterly reports are used scientifically
Are there issues of confidentiality?	Yes
Are there national limits set for dredging intensity?	Only in by the permitted volumes, where most licenses have a yearly maximum as well as a total maximum.
Are there any reports/papers available in which intensity is mentioned. Please provide the paper or the reference.	In the EIA, both the yearly and total maximum has to be considered.

Would it be possible to make the raw/processed data available to WGEXT? (Y/N)	The AIS data: Yes. The quarterly reports: only processed, and only for the common extraction sites
Any ideas on where else data can be harmonised with regards to aggregate extraction to allow data to be used across member countries	No

Estonia. No report.

France. No report.

Germany. No report.

Greenland and the Faeroes. No report.

Iceland. No report.

Ireland. No report.

Latvia. No report.

Lithuania. No report.

The Netherlands

What kind of system (e.g. black box, EMS,…) is used to monitor aggregate extraction in your country?	Closed and sealed system: Electronic Monitoring System (EMS) - black-box - automatic recording system
How long since this system is in operation and how long are the records kept?	Since approx. 2000 black-boxes are running on board of vessels. Records are stored in databases and kept there 'forever'.
Who is the owner of the data?	Rijkswaterstaat
List the raw data fields that are recorded e.g. coordinates, navigation speed, time, status, vessel ID/drag head, type of material,… Please provide some example data for each field.	Identification of vessel, code of concessionary, date, time (UTC), geographical position, speed, status of dredging pump(s), dredging activity, (loaded volume).
How is the raw data processed e.g. block/grid analysis and what units are used e.g. $h/km^2/yr$, $m^3/km^2/yr$, …?	Data is processed in GIS to see where dredgers have been dredging in order to be able to enforce the permits. The permit states that the dredging areas should be dredged evenly. The tracks can be plotted in GIS maps to determine that. In combination with the dredged volumes this is an indicator for intensity.
Who is doing the data processing?	GIS for Permitting and Enforcement
What do you consider the advantages and disadvantages of your system?	* Advantages: low cost, easy to install, easy maintenance, reliable performance, data falsification almost impossible.

	* Disadvantages: extracted volume is an estimation but practice shows this approach amply satisfies
Is data freely accessible?	After consultation a tailor-made data export can be produced
Is onboard screening going on?	yes, physical control of the EMS and the inaccessibility for third parties is carried out on regular basis
What data is used for e.g. legislation, scientific research,…?	all the above mentioned data
Are there issues of confidentiality?	yes, identification data
Are there national limits set for dredging intensity?	Yes, the total extraction depth is limited in the permit (to 2 m up to 20 m) below initial seabed depth (found prior to dredging). If this depth is exceeded, the involved area can be closed for extraction.
Are there any reports/papers available in which intensity is mentioned. Please provide the paper or the reference.	Several EIA's
Would it be possible to make the raw/processed data available to WGEXT? (Y/N)	• Raw data – No • Processed/amalgamated data – More detailed discussion would be required for digital data to be issued.
Any ideas on where else data can be harmonised with regards to aggregate extraction to allow data to be used across member countries	OSPAR (EIHA)

Norway. No report.

Poland. No report.

Sweden.

What kind of system (e.g. black box, EMS,…) is used to monitor aggregate extraction in your country?	No system in operation

United Kingdom.

What kind of system (e.g. black box, EMS,…) is used to monitor aggregate extraction in your country?	• The Crown Estate Electronic Monitoring System is used to monitor aggregate extraction on all licensed dredging areas in the UK. • The Electronic Monitoring System comprises a standard PC which is linked to a GPS navigation system, and up to 4 dredging status indicators in addition to a pumps running trigger switch. The dredging status indicators identify whether the vessel is pumping water or loading aggregates. • The EMS has 2 modes: standby and operational. In standby mode the system logs a record every 30 minutes to show that it is switched on and functioning correctly. In operational mode, when pumps are switched on, it logs a record every 30 seconds detailing the vessel's position and the output of the dredging status indicators.

How long since this system is in operation and how long are the records kept?	The EMS has been in operation since 1993. A second upgraded version of the system was launched in 2005. A complete archive is maintained since 1993.
Who is the owner of the data?	The Crown Estate (the main seabed mineral owner) is the owner of the EMS system and therefore also of the data it generates. The EMS enables The Crown Estate to manage its commercial dredging licences.
List the raw data fields that are recorded e.g. coordinates, navigation speed, time, status, vessel ID/drag head, type of material,… Please provide some example data for each field.	* When dredging, date, time, coordinates, and the status of up to four dredging indicator channels are recorded in the following format: *02/02/2014,07:26:13,5232.3289,N,00153.3788,E,0000,9999,9999,9999* • When not dredging, only time and date are recorded: *02/02/2014,07:11:41,*
How is the raw data processed e.g. block/grid analysis and what units are used e.g. h/km²/yr, m³/km²/yr, …?	• Data is processed via GIS grid analysis. Dredging intensity is calculated based on 50m² grid cells. • Standard categories for each grid cell are used as follows o Low : less than 15 minutes of dredging o Medium: Between 15 minutes and 1 hour 15 minutes of dredging o High: More than 1 hour 15 minutes of dredging • The system is also customisable to produce user defined categories or cell sizes.
Who is doing the data processing?	Data processing is carried out by Royal HaskoningDHV, the Minerals and Infrastructure Managing Agent for The Crown Estate.
What do you consider the advantages and disadvantages of your system?	* The main advantage of the EMS is it is a relative simple solution, and is robust enough to operate in the harsh conditions on-board dredging vessels. It requires a minimum of input from crew. * It was developed as a 'one system fits all' solution so it is suitable for a wide variety of dredging vessels, with a different level of equipment and technical capabilities and is therefore suitable on any type of dredger which may operate in UK Waters. * A disadvantage of the system could be that it does not record vessel position in standby mode, however this was a deliberate decision by The Crown Estate when the system was developed.
Is data freely accessible?	Raw GIS data (vessel track) is not issued to any parties. Processed GIS (intensity) data can be requested by dredging companies for licence management and for regulatory monitoring purposes at no charge. Processed GIS data can be requested by parties undertaking scientific studies, but they may charged, based on the amount of time needed by the Crown Estate's managing agent to assemble the information. Graphical (non GIS, eg jpeg) versions of the processed data are published in the annual Crown Estate Area of Seabed Dredged brochure on a regional basis, and these are therefore freely available in the public domain.
Is onboard screening going on?	If this question refers to screening of material during dredging, then it is permitted on certain licences.

What data is used for e.g. legislation, scientific research,…?	• EMS data play an important role in research and assisting in annual monitoring studies and substantive reviews (required by the regulator) undertaken by dredging area licensees. • It also assists in shaping policy for future dredging initiatives and activities. • EMS data are now used for the enforcement of Marine Licence Conditions by the Marine Management Organisation and Welsh Government.
Are there issues of confidentiality?	Exact vessel dredging locations and patterns have always been considered commercially sensitive and hence raw tracks are not made available via data requests. However vessel track is now increasingly available in the public domain (AIS) so we recognise that this type of information may now be available in other forms.
Are there national limits set for dredging intensity?	Dredging intensity data is only calculated for seabed inside the UK Continental Shelf Median Line.
Are there any reports/papers available in which intensity is mentioned. Please provide the paper or the reference.	Publications by the Crown Estate: Annual Area of Seabed Dredged Reports, 10 Year Review, upcoming 15 Year Review.
Would it be possible to make the raw/processed data available to WGEXT? (Y/N)	• Raw data – No • Processed/amalgamated data – More detailed discussion would be required for digital data to be issued.
Any ideas on where else data can be harmonised with regards to aggregate extraction to allow data to be used across member countries	Greater provision of publically available data regarding location and status of extraction sites across Europe would be beneficial.

United States. No report.

14. ToR H: Archaeological, cultural and geomorphological values

Belgium

Legislation	Ratification of the UNESCO Convention for protection of UCH (2013)
	Integration of UCH protection into Belgian Marine Spatial Planning (2014)
Included in EIA	Yes
Statutory advisor	Flanders Heritage Agency
Consultancy	MUMM
Type of antiquities	Archaeological structures
	Paleontological remains
Geomorphological features	Buried landscapes and coastlines
Methodology	Geophysical & Remote sensing technology
Guidance note	Under development (SeArch)
Reporting protocol	No
Research & Management projects	SeArch:
	1) Development of an efficient assessment methodology towards sustainable management policy and legal framework
	2) Development of a practical guidance towards stakeholders
	Renard Centre, Univ. Gent: Mapping the archaeological potential of the Belgian Continental Shelf
	1) 3D geo-archaelogical preservation models
	2) 2D archaeological potential maps
	3) Identification of key archaeological zones
Contact person	Dr. Marnix Pieters: marnix.pieters@rwo.vlaanderen.be
Web sites	https://www.abc.se/~pa/mar/authmain.htm

Canada

Legislation	The Parks Canada Agency Act (1998)
	Archaeological Heritage Policy Framework (1990)
	Provincial and territorial governments
Included in EIA	N/d

Statutory advisor	Parks Canada
	Canadian Environmental Assessment Agency (for development plans)
Consultancy	N/d
Type of antiquities	N/d
Geomorphological features	N/d
Methodology	N/d
Guidance note	N/d
Reporting protocol	Yes: to Parks Canada
Research & Management projects	N/d
Contact person	information@pc.gc.ca

Denmark

Legislation	The Danish Act on Museums
Included in EIA	Yes
Statutory advisor	Agency for Culture and Palaces
Consultancy	Administered locally by museums: Vikingeskibsmuseet, Moesgaard Museum, Nordjyllands Kystmuseum, Strandingsmuseum St. Geoge and Langelands Museum
Type of antiquities	Any manmade objects older than 100 years are preserved to some extent. Stone Age settlements and wrecks older than 100 years automatically preserved
Geomorphological features	Buried landscapes
	Palaeolandscapes
	Drowned sites
Methodology	Geophysical & Remote sensing technology (side scan sonar, magnetometer)
Guidance note	Under development
Reporting protocol	Yes: through Agency for Culture and Palaces
Research & Management projects	Various projects, partly funded by the building project owners, which will result in scientific publications. Also a project involving 3D documentation with photos, and a SASMAP-project has recently been carried out, in cooperation with other countries.
Contact person	Torben Malm: tor@slks.dk

Estonia

Legislation	European Convention on the Protection of Archaeological Heritage (199
Included in EIA	Yes
Statutory advisor	National Heritage Board
Consultancy	University of Tartu
	Tallinn University of Technology
	Estonian Maritime Museum
Type of antiquities	Archaeological sites, wrecks (incl warships from WWI, WWII)
Geomorphological features	UCH within 12M and on EEZ
Methodology	Geophysical & Remote sensing technology
Guidance note	N/d
Reporting protocol	Yes: National Heritage Board
Research & Management projects	Present: USHer
	Past: CODEUCH, SHIPWHER
Contact person	Maili Roio: maili.roio@muinas.ee
Web site	https://www.riigiteataja.ee/en/eli/ee/Riigikogu/act/517062015012/consolide
	https://www.riigiteataja.ee/en/eli/ee/Riigikogu/act/530112015004/consolide

Finland

Legislation	Antiquities Act
Included in EIA	*Yes*
Statutory advisor	Finnish Board of Antiquities' Cultural Environment Protection
Consultancy	Finnish Board of Antiquities' Archaeological Field Services unit
Type of antiquities	Jetties, bridges
	Wrecks > 100 years
Geomorphological features	Eskers
	Ice marginal deposits
Methodology	Geophysical & Remote sensing technology
Guidance note	No

Reporting protocol	No
Research & Management projects	Vrouw Maria Project
Contact person	Stefan Wessman: stefan.wessman@nba.fi

France

Legislation	Law on Preventive Archaeology (2001)
	Ratification of the UNESCO Convention for protection of UCH (2013)
Included in EIA	Yes
Statutory advisor	Department of Submarine Archaeological Research (DRASSM)
Consultancy	No
Type of antiquities	
	Gold torques (Late bronze Age), lead (Celtic tribes of Roman Britain)
	Shipwrecks, canonballs, aircraft remains
Geomorphological features	Palaeo-environments (landscapes)
Methodology	Geophysical & Remote sensing technology (side scan sonar, magnetometer)
Guidance note	No
Reporting protocol	No
Research & Management projects	The Atlas of the Two Seas : from the Channel to the North Sea (Interreg IV)
	(Collaboration between DRASSM/English Heritage/Flemish Heritage Institute)
	The Archaeological Atlas of Martime Cultural Remains of the Atlantic Arc
	National Archaeological Map of the Littoral Zone: Managing Cultural Remains
Contact person	Michel L'Hour: le-drassm@culture.gouv.fr

Germany

Legislation	Legislation per Bundesland, also concering North Sea and Baltic
Included in EIA	Yes

Statutory advisor	Each of the 16 Bundesländer coordinate this individually (legislation)
	Kommission für Unterwasserarchäologie
Consultancy	Deutsches Schiffahrtsmuseum, Bremerhaven
	University of Wilhelmshaven
	University of Wilhelmshaven
	DEGUWA (German Society for Underwater Archaeology)
	Schiffahrtsmuseum Rostock
Type of antiquities	Archaeological structures
	Prehistoric remains
	Fluvial sites
Geomorphological features	Buried landscapes
	Palaeo-landscapes
	Wooden piles from housing
Methodology	Geophysical & Remote sensing technology
Guidance note	N/d
Reporting protocol	N/d
Research & Management projects	Past: MoSS; MACHU
Contact person	Martin Mainberger: martin.mainberger@uwarc.de

Greenland and the Faeroes. No report.

Iceland

Legislation	European Convention on the Protection of the Archaeological Heritage (1969)
	World Heritage Convention (1972)
	United Nations Convention on the Law of the Sea (1985)
	European Convention on the Protection of Archaeological Heritage (Valleta 1992)
	The International Convention on Salvage (2002)
	Cultural heritage law of Iceland (2012)
Included in EIA	Yes

Statutory advisor	The Cultural Heritage Agency of Iceland
Consultancy	N/d
Type of antiquities	Archaeological structures
	Shipwrecks, aircraft remains
Geomorphological features	Buried landscapes and coastlines
Methodology	Geophysical & Remote sensing technology
Guidance note	No
Reporting protocol	No
Research & Management projects	**Research Projects (past and present):**
	The Melckmeyt. Dutch wreck in Flatey (1993)
	Kolkuós, medieval harbour (2006)
	The Postship Phønix (2008-?)
	The Vestfirðir surveying (2009–2010)
	A Phd project on submerged archaeological record on the W/NW region, current

Ireland

Legislation	Amendment to the National Monuments Act (1987)
	National Monuments (Amendment) Acts 1987 and 1994
Included in EIA	N/d
Statutory advisor	National Monuments Service: Underwater Archaeology Unit
Consultancy	N/d
Type of antiquities	Wrecks and sites (license required if older than 100yrs)
	Wrecks over 100yrs: protected
Geomorphological features	Ancient Coastlines and buried landscapes
Methodology	Geophysical & Remote sensing technology
Guidance note	N/d
Reporting protocol	N/d
Research & Management projects	N/d
Contact person	Karl Brady: nationalmonuments@ahg.gov.ie

Latvia

Legislation	N/d
Included in EIA	N/d
Statutory advisor	Centre of Archaeology
Consultancy	N/d
Type of antiquities	N/d
Geomorphological features	N/d
Methodology	Geophysical & Remote sensing technology
Guidance note	N/d
Reporting protocol	N/d
Research & Management projects	N/d
Contact person	Dr. Juris Urtans: jurtan@parks.lv

Lithuania

Legislation	Ratification of the UNESCO Convention for protection of UCH (2006)
Included in EIA	N/d
Statutory advisor	Dept. Of Cultural Heritage
Consultancy	Dept. Of Navigation History
	Society of the Lithuanian Archaeology
	Klaipeda University: Underwater archaeology
Type of antiquities	Buried landscapes
	Wrecks
Geomorphological features	Ancient Coastlines
Methodology	Geophysical & Remote sensing technology
Guidance note	N/d
Reporting protocol	N/d
Research & Management projects	N/d

Contact person	centras@heritage.lt

The Netherlands

Legislation	MONUMENTENWET 2007
	New Monumentenwet: 2016
Included in EIA	Yes
Statutory advisor	Rijksdienst voor het Cultureel Erfgoed (RCE)/Cultural Heritage Service
Consultancy	Rijkswaterstaat
	NIOS
	Companies: ADC, RAAP, City of Amsterdam
Type of antiquities	Historical wreck (ships and aircrafts)
	Archeological sites
	Fluvial sites
Geomorphological features	Prehistoric landscapes
	Drowned sites
Methodology	Multibeam; Side scan sonar; Coring
Guidance note	Yes
Reporting protocol	Yes, available on internet
Research & Management projects	Present: Maritiem Programma
	Past: MoSS; MACHU project
Contact person	Martijn Manders: m.manders@cultureelerfgoed.nl

Norway

Legislation	N/d
Included in EIA	N/d
Statutory advisor	Directorate for Cultural Heritage (Riksantikvaren)
Consultancy	National Maritime Museum (Oslo)
	NTNU (Trondheim)
	Maritime Museum in Stavanger
	Maritime Museum in Bergen
	Tromso Museum
	These museums have an own wreck register for each region
Type of antiquities	N/d
Geomorphological features	N/d

Methodology	Geophysical & Remote sensing technology
Guidance note	N/d
Reporting protocol	Yes: to the museums stated above or the local police
Research & Management projects	N/d
Contact person	N/d

14.15 Poland

Legislation	Act of Protection of Monuments (J.L, 03, No162,1568)
	European Convention on the Protection of Arcaheological Heritage (Valleta 1992)
	Act of Polish sea areas and maritime administration (Journal of Law, 2003, No 6, pos.41)
Included in EIA	Yes
Statutory advisor	State Service for the Protection of Monuments
Consultancy	National Maritime Museum in Gdansk
Type of antiquities	Archaeological structures
	Shipwrecks, aircraft remains
Geomorphological features	Palaeo-environments (landscapes)
Methodology	Geophysical & Remote sensing technology
Guidance note	No
Reporting protocol	N/d
Research & Management projects	Past: MACHU (2006–2009)
	Inventorying of archaeological sites of the Gdańsk Gulf (AZP)
	Development of methods of research and photogrammetric documentation of wrecks F53.14 and F 53.31 as part of a project funded by the Ministry of Culture "Inventory wrecks F 53.14 and F 53.31 of the Gulf of Gdansk".
Contact person	Jerzy Litwin & Iwona Pomian - National Maritime Museum Gdansk

Portugal

Legislation	Ratification of the UNESCO Convention for protection of UCH (2006)
	European Convention on the Protection of Arcaheological Heritage (1997)
	Decreto-Lei nº 164/97 (Rules on the underwater cultural heritage)
	Decreto-Lei nº 107/2001 (Policy for the protection and enhancement of the cultural heritage)
	Decreto Legislativo Regional nº 27/2004/A (Legal policy of the archaeological heritage management in the Azores archipelago)
Included in EIA	Yes (for volumes > 150,000t.year$^{-1)}$
Statutory advisor	Direção-Geral do Património Cultural (mainland)
Consultancy	Direção Regional da Cultura (Azores archipelago)
Type of antiquities	Archaeological structures
	Prehistoric human artefacts
	Shipwrecks
Geomorphological features	There are no references to this item in the Portuguese legistlation
Methodology	Geophysical & Remote sensing technology
	Diving
Guidance note	No
Reporting protocol	No
Research & Management projects	**Projects of archeological maps ongoing:**
	Carta Arqueológica Subaquática dos Açores
	Carta Arqueológica Subaquática de Cascais
	Carta Arqueológica Subaquática - Baía de Lagos
	Arqueologia Marítima da Ria de Aveiro
	Carta Arqueológica Subaquática do Concelho de Peniche

Spain

Legislation	Spanish Historical Heritage Act (Law 16/1985)
	Green Paper: Spanish National Plan for the Protection of Underwater Cultural Heritage
	Different Regional Heritage Laws (the competence is attributed to the regions,

	which legislate accordingly)
	Law 14/2014 on Navigation (excludes UCH from salvage and regulates some other UCH questions)
	State party to: Ratification of the 2001 UNESCO Convention for protection of UCH (2005); 1954 The Hague Convention;1972 World Heritage Convention; 1992 Valetta Convention
Included in EIA	Yes
Statutory advisor	Authorities on Cultural Heritage
Included in EIA	The National Centre for Underwater Archaeology (ARQUA)
Type of antiquities	Archaeological sites
	Prehistoric artefacts (animal & human remains)
	Shipwrecks
Consultancy	Historical Heritage Council
	The National Museum for Underwater Archaeology (ARQUA), Cartagena
Geomorphological features Methodology	Buried landscapes and coastlines
Methodology	Geophysical & Remote sensing technology
	Diving
Guidance note	N/d
Reporting protocol	N/d
Research & Management projects	Different projects through the different regional administrations Now visit also http://www.campusdelmar.es
Contact person	Elisa de Cabo; Secretariat of State for Culture: elisa.decabo@mecd.es

Sweden

Legislation	Cultural Environmental Act (1988:950)
	the Swedish Environmental Code
Included in EIA	Yes
Statutory advisor	National Maritime Museums in Sweden
Consultancy	The Swedish National Heritage Board
Type of antiquities	Archaeological structures
	Prehistoric artefacts (animal & human remains)
	Shipwrecks, cannonballs, aircraft remains
Geomorphological features	Eskers
	Ice marginal deposits
Methodology	Geophysical & Remote sensing technology
	Diving
Guidance note	No
Reporting protocol	National Maritime Museum (Bert Westenberg)
Research & Management projects	Wooden ships in the Baltic: Ghostwreck, Mars, Lion wreck etc N/d
Contact person	Reporting finds: Bert Westenberg: bert.westenberg@sshm.se

United Kingdom

Legislation	Protection of Wrecks Act (1973)
	Ancient Monument and Archaeological Areas Act (1979)
	Protection of Military Remains Act (1986)
	European Convention on the Protection of Archaeological Heritage (Valleta 1992)
	Merchant Shipping Act (1995)
	Marine Policy Statement (2011)
	Annex to the UNESCO Convention for protection of UCH (2013)
Included in EIA	Yes

Statutory advisor	English Heritage
Consultancy	Wessex Archaeology Ltd (BMAPA-Crown Estate)
	Cotswold Archaeology Ltd.
	Maritime Archaeology Ltd.
	Sea Change Heritage Consultants Ltd.
	Fjordr Ltd.
Type of antiquities	Prehistoric artefacts (animal remains, humanly worked flints)
	Shipwrecks, aircraft remains
	Palaeo-environments (landscapes)
Geomorphological features	Geophysical & Remote sensing technology
Methodology	2003 (BMAPA-English Heritage)
Guidance note	2005 (BMAPA-English Heritage)
Reporting protocol	Seabed Prehistory (ALSF)
Research & Management projects	Englands Shipping (ALSF)
	Historic Seascapes Character (EH)
	Regional Environmental Assessments
	Regional Environmental Characterisations
	Palaeo-Yare Catchment Assessment (BMAPA)

United States

Legislation	National Environmental Policy Act
Included in EIA	Yes
Statutory advisor	State Historic Preservation Office
Consultancy	BOEM
Type of antiquities	Archaeological sites
	Shipwrecks
Geomorphological features	Former shorelines
Methodology	Geophysical & Remote sensing technology
	Diving
Guidance note	N/d

Reporting protocol	N/d
Research & Management projects	Federal Permit/US Army Corp of Engineers (permitting agency)
	Underwater Cultural Heritage Law Study (BOEM, 2014)?
Contact Person	Ole Varmer: Ole.Varmer@noaa.gov

15. ToR I (I1): Cumulative assessment

Cumulative assessment guidance (draft)

Jan van Dalfsen

Introduction

Human activities in the marine environment have the potential to impact both coastal and offshore environments through a wide range of effects. The large number of sectors that use and exploit the ecosystem and its components generates a great variety of pressures and through a complex network of interactions results in a wide range of impacts (Knights *et al.*, 2013). The response of an environmental system to a human induced impact is the product of often complex ecological interactions that give rise to either direct linear but more often to non-linear responses including synergistic effects, threshold effects and compounding effects. The final impact will be the end product of the impacts from all individual activities and will be governed by a combination of direct and indirect impacts, cumulative impacts and impact interactions (Walker 1999).

With growing intensity of marine activities, there is an increasing demand to develop policy and management to cope with their impacts. Existing maritime activities have expanded and coastal and offshore waters around the world are being used in new ways (Anderson *et al.* 2013). This together with inland developments introducing new substances and materials has caused all kinds of mostly unintentional effects such as regime shifts, altered food web structures and other adverse effects which have been observed especially in coastal environments and in marginal seas (Korpinen *et al.* 2012). Even before the publication of the work of Halpern *et al.* (2008) which brought the combined effect of different stressors to the marine environment clearly to attention to the wider public, attempts were made to address cumulative impacts in marine management. This with the aim of developing widely accepted and harmonized processes and methodologies to assess these impacts.

In order to protect the environment it is a common use to conduct an environmental assessment by which the anticipated effects and implications on the environment of a proposed development, project or plan are described, prior to their approval or authorisation. In the European Union guidance is provided by the Directive 2011/92/EU (known as 'Environmental Impact Assessment' – EIA Directive) or, for public plans or programmes, by the Directive 2001/42/EC (known as 'Strategic Environmental Assessment' – SEA Directive). Soon however, it was recognised that many of the environmental effects may not result from direct impacts from individual projects or developments only but also from an interaction between effects, generated by a number of activities in time and space. In response to this shortcoming of EIA the assessment of indirect and cumulative impacts and impact interactions has emerged (Spaling 1993, Parr 1999). In Europe cumulative impacts are considered since the implementation of the EC Directive (85/337/EEC) in 1988. With the amendment (11/97/EC) tot the Directive 85/337/EEC it is now required that an EIA should also cover the direct effects and any indirect, secondary, cumulative, short, medium and long term, permanent and temporary, positive and negative effects of the project as well as that the "inter-relationships" and "interactions" between specified environmental effects must be considered.

In June 2008 the European member states adopted the Marine Strategy Framework Directive 2008/56/EC (MFSD). This MSFD aims to protect the marine environment across Europe. The Directive requires Member States to prepare national strategies to manage their seas to achieve or maintain Good Environmental Status (GES) by 2020 and to protect the resource base upon which marine related economic and social activities depend. These marine strategies shall be put in place with the aim of protecting and preserving the marine environment, preventing its deterioration or restoring marine ecosystems in areas where they have been adversely affected. These measures should also prevent and reduce inputs in the marine environment so as to ensure that there are not significant impacts on or risks to marine biodiversity, marine ecosystems, human health or legitimate uses of the European seas. In order to achieve or maintain a good environmental status in the marine environment it was decided to apply an ecosystem-based approach as the core concept in the management of human activities under the EU Marine Strategy Framework Directive (Anderson *et al.* 2015).

Dredging activities such as for aggregate extraction, dredging for navigational purposes, dumping of dredged material, offshore construction works and coastal development create direct pressures on seabed habitats including, such as loss of habitat, habitat change and physical damage to the habitat and with that to the species that depend upon it (Tillin & Tyler-Walters 2013). Although extraction activities often occurs in discrete locations, dictated by the spatial extent of the resource and conducted in single operations, there is a potential for cumulative effects from multiple dredging activities in close proximity to one another, or for effects of aggregate dredging in conjunction with other activities, for example commercial fishing, capital dredging activities or offshore renewable energy (OSPAR 2009b).

So from the ICES WGEXT it is a logical step to have a look at the consequences of the aforementioned initiatives and EU Directives for the aggregate extraction industry, research and policy and management developments. The development of a more holistic (ecosystem level) approach to marine environmental management, including evaluations of cumulative effects of extraction activities was addressed by the ICES WGEXT (2009).

The overall aim of this chapter is to provide information and guidance on the assessment of cumulative impacts with regard to the goals of the Marine Strategy Framework Directive due to potential impacts of aggregate extraction on marine and coastal habitats and species listed in Annexes I and II of the Habitats Directive.

In particular, this chapter will:

- review and summarise activities undertaken on cumulative impacts assessment in the ICES Area and beyond;
- investigate the methods used for cumulative impact assessment with a focus of relevance to aggregate extraction;
- make recommendations on how cumulative impacts assessment can be incorporated in aggregate extraction policy making and (licence) procedures.

Cumulative effects in marine legislation

Environmental regulations, are more and more incorporating cumulative effects because there is consensus among scientists and managers that a single activity, single stressor – impact effect approach is not sufficient to assess the implications of multiple stressors on the diversity of ecosystem components and ecosystems. This has resulted in the need for an integrated approach to science and management in which the assessment of cumulative effects considers both the exposure to multiple stressors and the consequence of these stressors for multiple components within and across ecosystems (Murray *et al.* 2014).

The following regulations are relevant to the development and implementation of CEAs.

The UN Convention on Biological Diversity which objective is to combine human desires and needs with the conservation of a healthy environment. To reach this goal, it is necessary to manage coasts and seas in a comprehensive and integrated way, accounting for the diversity of these ecosystems and the combined effects of multiple stressors. Ecosystem-based Marine Spatial Planning is a well-recognized approach to such integrated management (Foley *et al.* 2010).

The EU Marine Strategy Framework Directive (2008/56/EC) as it states that coastal waters, including their seabed and subsoil, are an integral part of the marine environment.

The Water Framework Directive (WFD) as, apart from the extensive geographical overlap with MSFD, many of the proposed measures in riverine and coastal waters to meet the objectives of the WFD may also have significant (positive) consequences for the MSFD targets and descriptors (CEDA NAVI 2015).

The EU Directive (85/337/EEC) implemented in 1988 and the European Environmental Impact Assessment Directive (Directive 2011/92/EU). Both address the need to include an analysis of cumulative effects within an EIA.

The EU Habitats Directive (92/43/EEC) adopted in 1992 states that "Any plan or project not directly connected with or necessary to the management of the site but likely to have a significant effect thereon, either individually or in combination with other plans or projects, shall be subject to appropriate assessment of its implications for the site in view of the site's conservation objectives."

OSPAR has adopted ICES guidance on environmental impacts of aggregate extraction (OSPAR Agreement 2003–15). It promotes the management of marine aggregate operations in such way that the footprint and potential resource conflict with other marine users is minimised. In the OSPAR maritime area CEAs are required for new projects, plans and programmes through the Espoo Convention (incl. Kiev Protocol), the afore mentioned EU EIA Directive (Directive 85/337/EEC, as amended by Directives 97/11/EC and 2003/35/EC), the SEA Directives (Directive 2001/42/EC) and the EU-Habitats Directive (Council Directive 92/43/EEC) (OSPAR 2009).

Under the Marine Strategy Framework Directive eleven so called elements where identified to describe the Good Environmental Status (GES) elements of the ecosystem. Several of these GES elements are of importance to dredging activities (CEDA ref). Relevant descriptors to extraction as an activity are the MSFD GES descriptors: biological diversity (D1), marine food webs (D4), sea-floor integrity (D6), hydrographical conditions (D7) and underwater noise (D11). See chapter XX (M. Desprez).

Definitions

Although a single formal definition of cumulative effects does not exist and there is also no consensus on how to undertake a cumulative effects assessment, several definitions for cumulative effects and cumulative effects assessment can be found that vary slightly:

Cumulation: outcome of effects to the environment from a single activity or multiple activities overlapping in space and or time.

OSPAR (2008) defined *cumulative effects* as: "all effects on the environment which result from the impacts of a plan or project in combination with those overlapping effects from other past, existing and (reasonably foreseeable) future projects and activities".

"*Cumulative effects assessment* is a systematic procedure for identifying and evaluating the significance of effects from multiple pressures and/or activities. The analysis of the causes, pathways and consequences of these effects is an essential part of the process"

Cumulative effects assessment is "the process of evaluating the potential consequences of activities or development relative to existing environmental quality to predict changes to the environment due to the project combined with the effects of other past, present and reasonably foreseeable future activities" (Dubé, 2003).

Basic principles of cumulative effect assessment

The international community is presently active in addressing cumulative environmental impact assessment and in developing methodologies to do so. Even when there is a direct effect between a single human activity which produces a single stressor it is still not always easy to predict its impact on an ecological component or an ecosystem. The reason for this is that stressors interact with each other and can be additive or non-additive, and can multiply (synergistic) or reduce effects (antagonistic) predicted from single stressors (Crain *et al.*, 2008). Because of all these potential interactions it is even more difficult to describe and predict the response of ecological components to multiple stressors.

Although there is to date no common methodology or understanding of CEA, the general approach is that of an "impact chain" in which source → pressure → effect → ecosystem component exposure pathways are identified. Describing the different pathways makes it possible to construct an activity–pressure–ecological component linkage matrix (see Knights *et al.* 2013). The pressure is the mechanism through which an impact occurs. Such a matrix describes the potential for an impact on an ecological component from an activity or sector.

The results are presented in score tables and visualised in distribution maps. To do this the intensity of each stressor is mapped as well as the location of each habitat type or presence of an ecological component sensitive to the stressor. After this a vulnerability weight is applied that translates the intensity of a stressor into its predicted impact on the ecological component habitat, creating a single 'currency' of stressor impact (Halpern *et al.* 2007, Halpern *et al.* 2008b, Teck *et al.* 2010, Kappel *et al.* 2012). The expected impacts are finally summed up into a total cumulative impact score. Each of those steps, however, requires many assumptions (Halpern & Fujita 2013).

The first step for understanding and mapping cumulative impacts starts with mapping the spatial distribution of human activities and determining which pressures and stressors must be included in the assessment. This needs ways to link impacts on ecosystem components to human activities. The OSPAR Intercessional Correspondence Group on Cumulative Effects (ICGC) has produced a list of pressures which is presented in the report of HBDSEG 2013. This step also highlight the need to determine how much to lump versus split groups of stressors (Halpern & Fujita 2013). These decisions have important implications for how much of a potential impact any given stressor or group of stressors can contribute to overall cumulative impact. Should in the case of aggregate extraction or dredging all types of dredging methods be treated equally? Is there a difference between sand and gravel extraction, shallow and deep extraction or single site use versus repetitive extraction in the same area? And if so, to which detail should there be made a distinction? Some of the decisions will be simply driven by data limitations, but in general they require assumptions or expert judgment about how important particular types and groups of stressors are in determining ecosystem condition (Halpern & Fujita 2013).

Next steps involve making distinctions between point source and dispersive pressures and to consider and determine if and how the 'effects' within the exposure pathways interact, taking into account the different types of indirect and direct impact, impact interactions and cumulation over time and in space (see figures Walker 1999, Judd and Murray *et al.* 2014).

'Point-Source' pressures are those where there is effectively a one-to-one relationship between the activity and the pressure (and effect), e.g. the pressure 'habitat structure changes' from aggregate extraction will only be exhibited where the minerals are actively extracted; 'extraction of target species' from fishing will only be exhibited where fishing vessels operate (OSPAR 2016). 'Dispersive' pressures are those where the pressure (and effect) cover a larger spatial area than the causal activity, e.g. noise will propagate away from its source (e.g. pile driving); nutrients and hazardous chemicals entering the marine environment from rivers will disperse. An example of the extent of such a dispersive pressure is given in the EIA for the development of the Rotterdam harbour extension Maasvlakte 2 (PMR 2007b). Different modelled scenarios indicated a potential increase in turbidity due to introduction of silt (fraction < 63 μm) as a result of the sand extraction. This increase could develop in the whole Dutch coastal area ranging from the Voordelta south of the extraction site to the Wadden Sea in the north and up to a maximum of 20 km out of the coast. As a result of the increased turbidity a maximum reduction of 10 -25 % in the year averaged chlorophyll-a concentration (as a measure for primary production) was predicted for the coastline between Walcheren and Egmond. The effect could even last for a number of years after the extraction activities have ended, partly due to resuspension. Light reduction due to increase turbidity could result in a delay of one to two weeks in coastal spring algal bloom against the normal spring bloom period.

Next to mapping the distribution of activities, the spatial distribution of ecosystem components (key species and habitats) as well as their vulnerability and sensitivity to the pressures need to be defined. In the last years there has been an enormous progress in mapping the distribution of species and communities in the European marine waters. However, assessing the impact of biological communities to specific anthropic pressures in marine systems is far from easy due to lack of knowledge and data on species vulnerability and sensitivity which prevent the development and use of proper models that predict how the different pressures exerted at the individual level can be progressively integrated and quantified from individual to species and community level (Certain *et al.* 2015). In the case of (aggregate) dredging the sensitivity of an individual, species or community to the activity can defendable be score this as 1 (maximum impact) as dredging initially will result in the complete removal of animals from the dredging area, with the exception of some deep burrowing animals or a few very mobile surface animals. Transfer to and survival of animals placed with the sand at another site will be almost zero as not many benthic animals will survive the destructive process of being pumped up, transported and dumped. Few examples exist of benthic animals surviving the dredging process (Van Dalfsen & Lewis 2001).

After all these steps are made the effects can be cumulated using the most appropriate method.

Currently cumulative effects in Europe are related to the MSFD and the realisation of GES. Biodiversity indicators are mostly used as way to assess the cumulative effects. However, this implies that these biodiversity indicators are the way of describing the ecosystem and its functioning. Support for using biodiversity indicators as a measure of overall ecosystem condition comes from statistically significant (negative) correlations found between biodiversity status and cumulative pressures (Anderson 2015).

(Inter)national actions taken on the issue

Spatial analyses of anthropogenic stressors and their cumulative impacts on the marine ecosystems have been conducted globally and regionally (Halpern *et al.* 2008, 2009; Selkoe *et al.* 2009; Ban *et al.* 2010; Korpinen *et al.* 2012, Korpinen 2015), in order to provide much-needed information for ecosystem-based management.

In the recent past cumulative assessment approaches were developed looking e.g. at multiple-activity assessments (Cooper and Sheate 2002); Eastwood *et al.* 2007; Stelzenmüller *et al.* 2008; de Vries *et al.* 2012 and 2010; Halpern *et al.* 2008 and 2012; Judd; Van der Wal & Tamis 2014, Andersen *et al.* 2013; Anderson *et al.* 2015; HBDSEG 2013; Korpinen A. 2015; Tillin & Tyler-Walters 2013; Knights *et al.*, 2015)

To help the EU Commission in the process of implementing the MSFD a number of actions with respect to the assessment of cumulative have been carried out recently.

The OSPAR Intersessional Correspondence Group – Cumulative Effects (ICG-C), part of OSPAR commission Environmental Impact of Human Activities (EIHA), studied common approaches on (cross-border) cumulative effects. In 2012 the OSPAR ICG-C discussed three cumulative effects assessment (CEA) methods after which cases studies were conducted to find best approaches and tools: CUMULEO (Van der Wal e& Tamis 2014; ODEMM ((Knights *et al.* 2015); and HARMONY (Andersen *et al.* 2013). In 2015 the work of the ICG-C focussed on reviewing methodologies for generating cumulative ‘pressure’ / ‘impact’ maps (HARMONY, CUMULEO and ODEMM) (OSPAR 2016). The review indicated that the approaches are broadly similar and that there was nothing to suggest that any approach was better than another. It was therefore decided not to proceed by adopting one single approach. The work will continue with actions on a targeted CEA of pressures and impacts aligned with the content of the Intermediate Assessment 2017 and Quality Status Report 2021 and further development on a CEA that is aligned and makes best use of OSPAR common indicators and their associated data.

The CEDA MSFD NAVI group (a ‘thematic cluster’ of nine navigation sector bodies in the marine and inland, commercial and recreational navigation and dredging sector) looked into the measures that could be taken under the MSFD on a national, European or international level that have the potential to affect navigation or dredging related activities. This group want to draw attention to some aspects because there may be unwarranted implications for the activities of the sector in some or all Member States in a marine region or sub-region (CEDA 2015). Amongst these is the geographic scale. It is NAVI’s view that the measures imposed by the Member States should be relevant at the geographical scale at which the MSFD operates and be directly linked to achieving or maintaining GES. The appropriate scale at which measures are taken is likely to be a key issue for various descriptors and not least for the assessment of cumulative and in-combination effects.

OSPAR's Intersessional Correspondence Group (ICG) on Coordination of Biodiversity Assessment and Monitoring (ICG-COBAM) conducted a case study looking into the multiple causes of physical damage to benthic habitats (ICG-C 2016). The study evaluated the extent to which the seafloor and the associated benthic communities are being damaged or disturbed by current pressures caused by human activities. The study collected information on the distribution and intensity of pressures, the distribution and extent of habitats and an assessment of the sensitivity of those habitats to pressures. The case study has, however, only considered fisheries activity data for vessels >12m to quantify ‘damage’. The ICGC case study is expected to extend this initial work by incorporating additional pressures.

In the UK, the Marine Management Organisation (MMO) has an obligation to ensure potential cumulative effects are taken into account in its decision making under the UK Marine Policy Statement (MMO 2014). The MMO developed a framework for scoping cumulative effects at the strategic level (MMO 2014). The framework considers the scoping stage only. It provides a step by-step approach to the identification of potential cumulative effects. This framework process was tested using a number of offshore wind developments in the Greater Wash as well as by a hypothetical CEA case in which both a large and a small scale activity was analysed in a hypothetical area. In order to apply the framework an evidence database was which identifies activities taking place in the marine environment, the pressures that they exert, and the receptors which may potentially be sensitive to those pressures (MMO 14). It provides summary matrices, highlighting where there may be potential for cumulative effects between activities based on overlapping pressures with potential to affect a common receptor, to support an initial assessment.

The European Topic Centre on Inland, Coastal and Marine Waters (ETC-ICM) is working to propose a cumulative effects assessment (CEA) method for the European Environment Agency's (EEA) of the state of the European seas (OSPAR 2016). A task team reviewed the existing CEA methods in 2015, focusing on spatial assessments of cumulative anthropogenic pressures and impacts on marine environments, and recommended a method for further testing (Korpinen *et al.* 2015). The purpose of the review was to recommend a method for assessing the cumulative degree and spatial distribution of human activities, pressures and their impacts in the European marine environment (OSPAR 2016). The review concluded that the current approaches used to assess cumulative pressures and cumulative effects in the marine environment are all relatively similar. All of them rely on three factors: spatial extent of pressures, spatial extent of ecosystem components and an impact weight score transforming the pressures to impacts on the ecosystem components. In 2016, the objective of the work is to further develop the recommended method to better serve European-wide assessments and to find out spatial data layers on human activities and pressures. In 2017, the method will be tested and more practical preparations for the European CEA assessment will be initiated.

In the Netherlands the ministries of Economic Affairs and of Infrastructure and Environment set up a framework for assessing ecological and cumulative effects of offshore wind farms (Ministry of Economic Affairs and Ministry of Infrastructure and Environment 2015). Extensions have been developed for the effects on population development of birds and one marine mammal, the harbour porpoise.

Anderson *et al.*, 2015 analysed the linkages between human activities, pressures and impacts and the status of the marine biodiversity in the Baltic Sea. Describing the biodiversity status for the period 2001–2007 using a multi-metric indicator-based assessment tool and combining this with detailed mapping data on the human pressures in the Baltic area. They were able to provide scientific evidence on the linkage between cumulative impacts and biodiversity status on a wider scale. Moreover, by ranking the pressures and impacts for each of the studied sub-regions in the Baltic Sea this study provided a prioritisation of area specific measures targeting relevant human activities and the subsequent development of ecosystem-based management strategies (Anderson *et al.*, 2015).

Knight *et al.* (2015) illustrated how the exposure-effect approach can be used to assess the risk to ecosystems from human activities at considerably larger spatial scales being the Europe's regional sea ecosystems. This was done considering a range of sectors, pressures, and ecological components. This study included up to 17 sectors, 23 pressure types, and broad ecological components. They used an "impact chain" approach by constructing a sector–pressure–ecological component linkage matrix (see Knights *et al.* 2013) in which each cell in the matrix describes the potential for an impact on an ecological component from a sector, wherein a pressure is the mechanism through which an impact occurs. After this the threat from each chain was assessed by way of a pressure assessment (sensu exposure-effect) approach (see Robinson *et al.*, 2013, for full details of the methodology). This pressure assessment methodology was designed with the concept of risk assessment in mind, such that the assessment criteria developed could be used to evaluate the likelihood and consequences of a specific or combination of impact chains. The assessment was based on expert judgement for which they approached a good number of participants from a range of institutions and countries from around the EU and more broadly.

Rijkswaterstaat, Ministry of Infrastructure and Environment, the Netherlands prepared a discussion paper on the need for a common cumulative effect assessment (CEA) approach in assessing the ecological effects of offshore wind farms (OWFs) in the southern North Sea (Boon & Prins 2016 prep).

Brief review of EIA and CEA studies addressing cumulative impacts in relation to extraction

EIA Maasvlakte 2, the Netherlands

For the Rotterdam Harbour extension Maasvlakte-2 an EIA was made (PMR 2007). Because of the very large quantity of material needed to build this second extension, the Basic Alternative estimated 324 Mm3 of sand needed to be extracted from the North Sea, the EIA addressed the design, the location of the dredging areas and the way the extraction was executed (timing and equipment). Extraction depth looked upon varied between depth of 10 to even 20 meters below the seabed surface, the latter doubling the water depth. Next to this attention was also given to nature, recreational use, nautical aspects and archaeology. Different environmental aspects were assessed among which seabed disturbance, loss of habitat and biota, turbidity, emissions, noise (both air and under water), and disturbance (visual, light, noise). When looking at cumulative effects of the Maasvlakte-2 development, attention was given to other developments such as offshore wind energy and especially to the combined effects with activities as bottom trawling, other extraction activities and maritime transport. For the latter the additional annual extraction of 35 Mm3 in the Netherlands was taking into account. Notwithstanding the large amount of sand needed for the development of the Maasvlakte-2, the EIA concluded that for most of the aspects accounted for, no serious effects were to be expected. The cumulative assessment for most of the aspect was done either quantitative or qualitative and represented in scoring tables. No integrated methodology, however, was applied to assess the cumulative effects of the sand extraction with all other activities including other sand extraction in the coastal zone of the Netherlands.

Extraction & Fisheries (United Kingdom)

To contribute to an informed debate and sustainable use of resources Cooper (2005) reported the views of the fishing industry on the perceived impacts of aggregate dredging on their activities in an area to the east of the Isle of Wight. The study was based on information from interviews with local fishermen working in the vicinity of areas of aggregate extraction, a review of published information, information from fisheries authorities and fisheries scientists combined with information on extent of dredging operations obtained from Electronic Monitoring System (EMS) data. Charts were made to map the cumulative extent of different activities.

Results indicate a general avoidance of licensed areas by static gear fishermen and by trawlers. The latter due to perceived changes in the nature of the seabed (e.g. dredged tracks and depressions) that may persist for several years. This could have a subsequent effect of increasing fishing pressure in alternative grounds with already heavily exploited stocks remote from dredging areas. Concerns were found on vessel safety of small vessels in relation to the increased distances offshore. Furthermore the study concluded that dredging operations affected the abundance and distribution of some commercially targeted species e.g. the brown crab (*Cancer pagurus*) and of smooth hound (*Mustelus mustelus*) targeted by recreational fisherman.

However, the assessment was complicated by absence of quantitative data on localised spatial and temporal scales and no simple cause-effect attributions can be made due to the interaction of anthropogenic and natural influences.

Extraction & Fisheries (France)

The effect of extraction activity on the benthic community and with that on the distribution of fishing effort of French and English demersal fleets was studied at a number of French and English extraction sites in the eastern Channel (Desprez *et al.*, 2014, Marchal *et al.*, 2014). The most prominent result of the study was that most types of fishing near the extraction sites were not deterred by the dredging activity. The fishing effort of scallop dredging and potters were even found to have increased adjacent to aggregates sites. Where the distribution of French netters remained consistent over the study period, the effort of this fishing type increased substantially for sole in the impacted area of the Dieppe site. This increase of fishing was found to be correlated with the extraction intensity. The attraction of the different types of fishing is likely due to a local temporary concentration of their main target species as a result of changes in the seabed habitat.

Although the finding of the study seem logical and explicable, the study shows how complex it is to integrate and quantify the cumulative effects of different pressures affecting the seabed from species to community level as there is also a sequence in cause and effect between the different pressures. Moreover, can changes to the seabed leading to different benthic communities be foreseen as positive outcomes and if so, how could this be incorporated into the assessment?

Discussion

Worldwide initiatives are undertaken to understand and develop methods to assess the potential for cumulative effects in the marine and coastal waters. In relation to dredging activities such actions are also taken to address cumulative effects looking beyond the site specific effects of single operations (OSPAR 2009).

A number of issues that go along with cumulative impacts are still under discussion.

Spatial scale

Looking at a single human activity such as aggregate extraction, there is a need to inform and have information on its extend in time and space and its contribution to an impact on a certain ecosystem component in terms of policy making and management. OSPAR (2009) suggest to assess the potential cumulative effects of multiple dredging operations in close proximity to one another on a temporal and spatial scale by means of a regional environmental assessment. Such cumulative impacts may also occur when aggregate extraction occurs close to another seabed activity, for example an offshore wind farm. For reasons of marine spatial planning, designation of marine protected areas and ecosystem-based management this certainly makes sense.

However, from a practical day to day point of view from a single project, there is an obligation to have information on the cumulative impacts, because of licensing. For the latter, the level of detail of information needed is much larger to make any sense in terms of a time and spatial adequate assessment. The activity is often taking place in a relative confined space, a small area and often only for a limited amount of time.

On a project base spatial impacts will be most likely on the relative small local scale as dredging amount are rarely large. Even when taking into account the side effects of increased turbidity which could impact a much larger area due to hydrographic conditions (PMR 2007), the effect is expected to be relative limited. Even for the very large extractions such as the Rotterdam harbour extension only the worst case model scenario predicted a substantial increase in turbidity leading to a possible delay of maximum 2 weeks in the annual spring algal bloom (PMR 2007b). Choice of scenario and mitigation measures taken will help to reduce the spatial extend of the effects. Cumulative effect assessment will then be focussed only on that project area, either by looking into multiple dredging activities over time and potential impacts of other activities in that area, e.g. fishing.

The Ecosystem Approach is the main tool of the OSPAR Commission for the management of human activities. A key feature of the ecosystem approach is the conservation of ecosystem structure and functioning, whereas under the Malawi principles ecosystems must be managed within the limits to their functioning. It is therefore important to consider where the boundaries for management and related measures lie when looking at aggregate extraction and moreover, to what extend is management feasible and practical?

This is also brought forward in CEDA NAVI's (2015) view that it is important to realize that the measures imposed by the Member States should be relevant (i.e. capable of making a difference) at the geographical scale at which the MSFD operates and be directly linked to achieving or maintaining GES (CEDA Navi 2015). The appropriate scale at which measures are taken is likely to be a key issue for various descriptors and not least for the assessment of cumulative and in-combination effects.

In terms of single project assessments, the spatial component of the activity and related pressures and impact is limited whereas in more policy and management driven assessments spatial distribution in general is much larger. In Annex I of the OSPAR Guidelines for the Management of Dredged Material (OSPAR 2009) the spatial coverage is preferably given in percentage of the respective OSPAR Region or classified in seven classes ranging from less than 10 km2 to more than 1.000.000 km2. In the CEA case study on offshore windfarms and fisheries using the CUMULEO approach (Van der Wal & Tamis 2014) the footprint of five pressures where calculated in terms of habitat loss i.e. area no longer suitable as habitat for the different ecosystem components taken into account in the study. For instance, the fisheries pressure was expressed in term of relative area trawled (RAT) in ICES-rectangles or geographic areas which are approximately 30 x 30 nautical miles and the offshore wind. This spatial size is far beyond the regular dredging activity.

Time scale

The time scale on which a specific activity and pressure and impact should be assessed is an issue that needs to be looked into. Nature itself is continuously changing and trends, whether or not human induced, are not easy to include. In the Halpern 2008 methodology an activity with its pressure stays "forever" on the map. It could be discussed how long the impact of trenching a cable into the seabed on the biodiversity of the benthic community remains detectable. So the question remains on how far into the future and how far into the past one should look to in addressing and assessing "past, present and reasonably foreseeable" effects? Certainly with the experience that dredging impacts on the seabed community is relative short

Furthermore, the appreciation of changes in nature expressed in some sort of value is a human concept and therefore susceptible to changing policy over time (see Valuation of changes).

Indicators

In many studies and methodologies developed cumulative effects were analysed using biodiversity as an indicator to calculate impact. Approaches using other GES elements as basic indicator are not under study. For a biodiversity assessment many indictors exist amongst which are those for benthic and pelagic habitats, population indicators of zooplankton, benthic communities, demersal and pelagic fish communities, seabirds and marine mammals. Additional to these also indicators on more physio-chemical properties as and water transparency, sediment characteristics and nutrient concentrations could be added. It is, however to be discussed which of these indicators should be included while assessing the cumulative impacts of dredging.

In addition to the above, there is the issue of different receptor groups that are relevant in different countries, due to the variability in species distribution but also due to different protection levels of species in the different countries (Boon & Prins in prep).

Impacts could be looked upon as function of habitats or systems while in some cases, like in the relative localized impacts of dredging, it might be more appropriate to look at population level of certain species or at a community level.

CEDA NAVI (2015) advised to pay attention to how the potential unintended consequences of introducing a measure for improvement of one GES descriptor of the MSFD could affect measures proposed to improve other descriptors. Introducing speed restrictions in order to reduce underwater noise has the potential to impact on the descriptor relating to levels of contaminants because ship's engines are designed to run at a particular speed to be at their most efficient and reducing the speed could potentially result in an increase of unburnt fuel entering the marine environment.

Valuation of changing habitats

During the life span of an activity such as dredging and after the activity has stopped, habitat changes are frequently observed. These changes in the seabed may provide a new habitat, potentially susceptible to settlement to other species than originally occurring in the area before the activity started. The work of Desprez *et al.* (2000, 2012) and Marchal *et al.* (2014) on dredging sites along the French coast illustrated the economic consequences for fisherman as fish species with a higher market value showed up as a result of dredging activities. In the Netherlands an experiment was done to deliberately change the topography within a dredging site with the aim of creating another habitat type which potentially could result in a different species composition (Van Dalfsen *et al.* 2004, Van Dalfsen & Aarninkhof 2009, De Jong *et al.* 2014, 2015a, 2015b, 2016).

Depending the magnitude of changes the impacts for a community may be limited to the proportion of the different species groups in that community. The element of valuation of habitat change, being negative or positive, in the calculations of impact, either in a straightforward EIA or a CEA is yet not included. How to deal with the valuation of changing habitats structures and associative communities in cumulative impact assessment and what indices should be used to deal with this remain questions for further investigation.

Other mining activities

When looking into assessing the cumulative effects of human activities in the marine environment with a focus onto extraction, a decision should be made on the activities addressed. Should it be limited to aggregates extraction (sand and gravel) only or should it include all dredging activities as well as mining for marine minerals (being a relative new industry but in the near future expected to grow and having potentially other impacts)?

Conclusion

Cumulative impacts are considered essential in the implementation of an ecosystem based approach to the management of human activities. Substantial effort is currently undertaken to address the assessment of cumulative impact to the environment in order to help marine management and policy.

The above mentioned issues of geographical and time scale are yet under study but solutions are likely not to be provided in short time. Next to the issue of how to valuation change in the assessment a discussion should also be started on how to include changing circumstances like trends over time and space. Although these phenomena are widely known, incorporating these in cumulative assessments of human activities is challenging. Potentially some of these issues could be included in a CEA by introducing something as a “life cycle assessment”.

With a focus on the marine minerals extraction it will be important to come up with a common CEA approach that is feasible and practical in terms of measures proposed to be taken and information to be provided as well as appropriate to the scale at which the industry is active.

With all the activities presently undertaken to develop tools and methodologies to address the issue of cumulative effects of all human activities, including for example aggregate extraction, it seems to be not relevant to start developing a separate tool for cumulative assessment focussing on marine minerals extraction. The WGEXT activities could better assist in these developments by focussing on providing relevant information on this topic within OSPAR and ICES.

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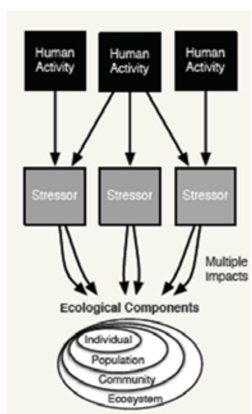

Figure 1. Theoretical framework of pathways by which independent and cumulative effects to ecological components are accounted for. A human activity produces a single or multiple stressors that impact a single or multiple ecological components over space or time and multiple activities produce multiple stressors that have multiple impacts on a suite of ecological components. Stressors from activities can accumulate across space (local, regional and global stressors) and time (past, present and predicted future activities). Adjusted from Murray *et al.* 2014.

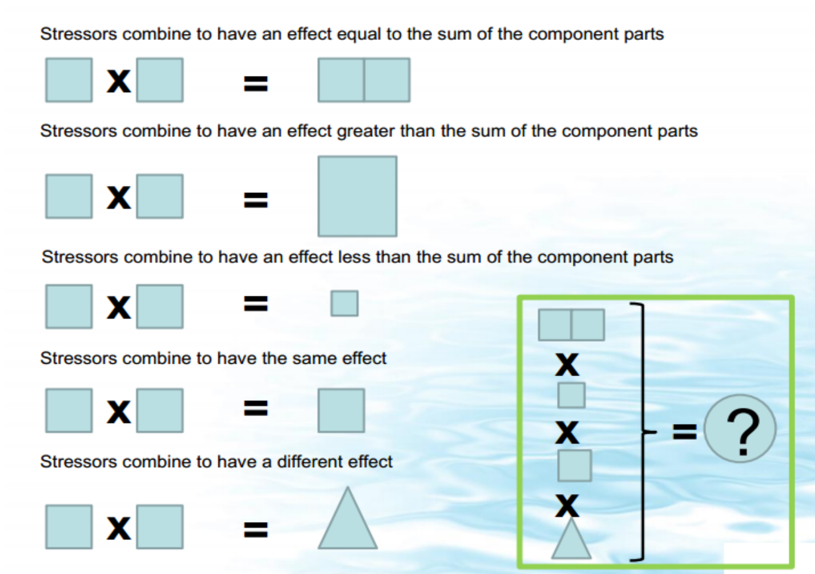

Figure 2. From Judd, presentation for OSPAR.

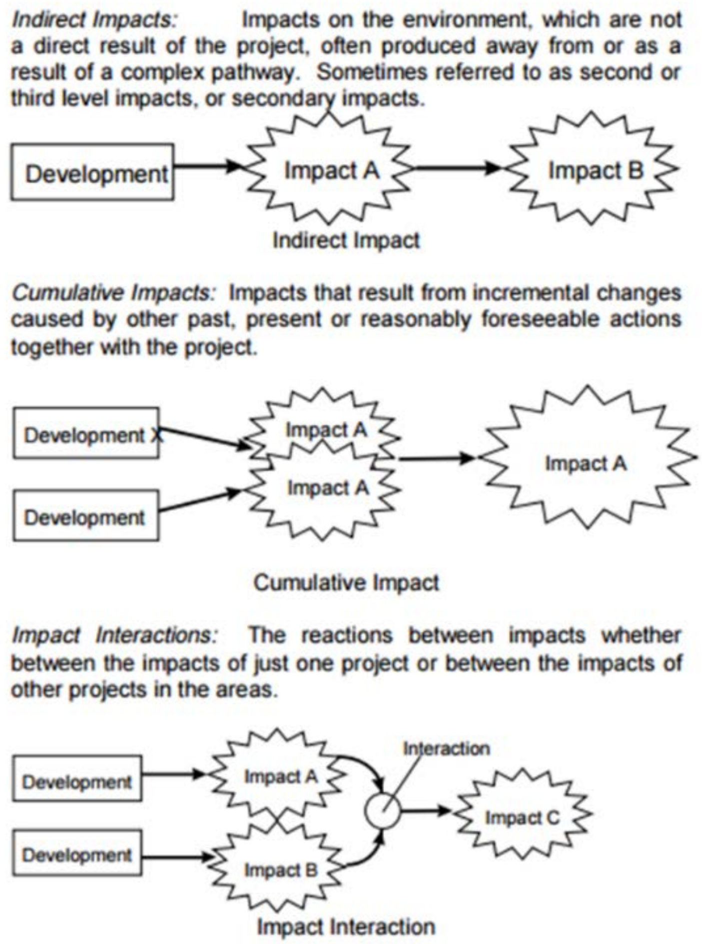

Figure 3. Flow diagrams illustrating indirect and cumulative impact interactions (Walker, 1999).

16. ToR J: Review of Decision Criteria for Requiring Environmental Impact Assessments

Belgium

In Belgium, sand and gravel exploitation at sea started in 1976 (29 000m³). Over the past few years, the exploitation increased and now the total amount fluctuates around 3 000 000m³ a year. It is mostly sand that is exploited. This sand is used in the construction sector as draining and stabilization sand or in the concrete industry where it is mixed with other aggregates. For huge infrastructure works, as the construction of a gas pipe line (Zeepipe 1991; Interconnector 1997), there is need for large quantities of sand in a short time. The Flemish Community also increasingly uses the sand for beach supplements and coastal protection.

The law of 13 June 1969 ('Continental Shelf Law') amended by the law of 20 January 1999 ('Protection of the Marine Environment Law') and the law of 22 April 1999 regulates the exploration and exploitation of sand and gravel in certain areas on the Belgian Continental Shelf. Two implementing decrees were published (BS 07.10.04):

Royal Decree (RD) of 1 September 2004 (Belgian Official Journal of 10 October 2004, PDF, 14pp, 118KB) as regards conditions, geographic limits and procedures for granting licences, “Procedure decree”.

RD Decree (RD) of 1 September 2004 (Belgian Official Journal of 10 October 2004, PDF, 4pp, 46KB) as regards rules for environmental impact assessment.

There are 4 control zones defined, divided in sectors for which a concession can be issued. These were confirmed in the RD of March 20th 2014 which defines and demarcates the maritime spatial plan.

Exceptionally concessions can be issued outside these zones.

The permits for exploiting sand and gravel can be obtained, according to the law, by submitting a concession demand which includes an Environmental Impact Study (EIS). This EIS will be evaluated: MUMM evaluates the acceptability of the activity for the marine environment in an Environmental Impact Assessment (EIA). This EIA forms part of an official advice to the Minister responsible for the marine environment, who will give his advice to the federal Minister of Economy. The advice of the Minister responsible for the marine environment is binding: when the advice is negative, no concession can be issued.

As such, in principle every project has to submit an individual EIA….but the Minister can allow that several (all) permit applications can use the same combined EIS when sand and gravel extraction takes place in the same areas (which it does since we only have 4 zones). Thus every project uses the same two EIS (one for zone 1–3, one for zone 4). These are updated every three years and will be renewed every 10 years.

Canada. No report.

Denmark: Always required

Estonia

In Estonia such decision is made by the Ministry of Environment. Environmental impact is assessed upon applying for development consent or for amending development consent whereby the proposed activity which is the reason for applying for or amending the development consent potentially results in significant environmental impact; if an activity is proposed, which alone or in conjunction with other activities may potentially significantly affect a *Natura* 2000 site. The decision is made on a case-by-case basis exercising professional judgment, but commonly marine extractions exceeding a of volume of 10 000 cubic meters is considered an activity with significant environmental impact as are areas of open-cast mining where the surface of the site exceeds 25 hectares,

Finland

EIA procedure is required practically for all marine aggregate extraction in Finland. According to the EIA act extraction exceeding 25 hectares in area or 200 000 m3 in volume /year automatically requires an EIA. Smaller scale extraction may also require an EIA, if there are “presumable negative impacts on environment”.

France

EIAs are required for all extractions of marine aggregate whatever the volume, area or depth of dredging. Marine aggregate extraction comes under the Mining Code and may require three joint permits (Decree of 6 July 2006). These are:

- A mining permit (exclusive research license or concession) is issued by the Ministry in charge of Mines (i.e. Ministry of Economy) giving the exclusive research license allowing a deposit and its natural and human environment to be identified. It is granted for a maximum period of 5 years and is renewable twice. The concession is for industrial extraction with a maximum duration of 50 years; this procedure is subject to a public inquiry.
- For sites located in territorial waters, a temporary authorization to occupy the maritime public domain or domain authorization must be granted by the Prefet of the Department only;
- An authorization to open mining works is granted by the Prefet of the Department

The last requires the completion of a pre-licensing impact study assessing the initial state of the environment, the expected environmental impact of extraction and its compatibility with other activities carried out at sea. (Decree n ° 2006–798 of 6 July 2006, as amended on prospecting, research and exploitation of minerals or fossils contained in the seabed in the public domain and metropolitan continental shelf) A Natura 2000 impact study may be required. Exploitation licensing requires environ-mental monitoring with bathymetric, morphological, sedimentary and biological controls during operation. Government services control the movements and activity of the extraction vessel (duration, depth, navigation, etc.) and the volume of material removed.

The content of the Impact Study is described in the Environmental Code (Article R. 122–5) modified by the Decree n° 2011–2019 of 29th December 2011 reforming impact studies. An Impact study must contain:

- A description of the project design and dimensions, including a description of the physical characteristics of the project, the technical requirements of land use during phases of construction and operation and, if appropriate, a description of storage, production and manufacturing operations, such as the nature and quantity of the materials used, as well as estimate the types and amounts of expected residues and emissions and resulting from the operation.
- An analysis of the initial state (baseline survey) zone and environments likely to be affected by the project, including on population, flora and fauna, natural habitats , sites and landscapes, property, ecological continuity as defined by Article L. 371–1 , biological balance, climatic factors, cultural and archaeological heritage, soil, water, air, noise, natural, agricultural, forestry, marine and leisure, as well as the interrelationships between these elements.
- An analysis of the positive and negative effects, direct and indirect, temporary (including during the construction phase) and any permanent environmental impacts as well as short-term, medium-term and long-term impacts. These include the project impacts on and energy consumption, the convenience of

the neighbourhood (noise, vibration, odor, and light emissions), hygiene, health, safety, and public health.

- An analysis of cumulative effects project with any other projects that have been the subject of an impact document under Article R. 214–6 and a public inquiry, or have been the subject of an impact assessment under this code and for which a notice of the authority administrative jurisdiction of the environmental state has been made public. Excluded are projects subject to an order under section A. 214–6 to R. 214–31 mentioning a time lapsed and those whose authorization decision, approval or implementation lapsed, including the public inquiry is no longer valid as well as those which have been officially abandoned by the petitioner or the client.
- An outline of alternatives to the project that were considered in terms of its impact on the environment or human health.
- The criteria for assessing the compatibility of the project with land use. It may be necessary to provide drawings, diagrams and programs (Article R. 122–17) and to take into account the regional pattern of ecological coherence in the cases mentioned in Article L. 371–3.
- Measures to be taken to avoid or mitigate significant adverse effects of the project on the environment or human health and reduce the effects could not be avoided.
- A description of the methods used to establish the initial state described in 2 and evaluate the project's effects on the environment and, when several methods are available, an explanation of the reasons for the choice made.
- A description of the possible difficulties of a technical or scientific nature, faced by the client for this study.
- The names and precise and comprehensive qualities of the author of the study and impact studies that have contributed to its realization.

Germany. No report.

Greenland and the Faeroes. No report.

Iceland. No report.

Ireland. No report.

Latvia

An EIA is always required, but if the mining area is less than 20 hectares, the EIA may be carried out by ranking. Decisions are made by Environmental Protection Department.

Lithuania. No report.

The Netherlands

EIA's are relatively brief statements of potential risks. However, a distinction is made between a regular extraction (< 10 million m^3) and a large scale extraction (>10 million m³) or deep extraction (> 2 m below sea bed). EIA's, covering the whole range of impacts is required for any project proposing extractions over over10 million cubic meters or covering 500 hectare (5 km²). This was established in the "Besluit Milieueffectrapportage (Besluit m.e.r.)" decision on the EIA as part of the Law on the Environment, and the updated in the Tweede Regionale Ontgrondingenplan Noordzee (RON2), which was the second regional plan for extraction in the North Sea. Furthermore, the same applies to situations in which several smaller ones that are in each other's vicinity together exceed the 500 hectares. (The website for the EIA commission is http://www.commissiemer.nl/english). The EIA process includes setting boundaries in the Terms of Reference, providing the complete EIA to the EIA commission (M.E.R.) followed by a public notice.

Volume	Area	Depth	Research
<10 million m3	<500 ha	Up to 2 m	Not required
<10 million m3	<500 ha	> 2m	Quantity
> 10 million m3	<500 ha	> 2m	MER (full EIA)
> 10 million m3	> 500 ha	Up to 2 m	MER (full EIA)
> 10 million m3	> 500 ha	> 2m	MER (full EIA)

Norway. No report.

Poland

Environmental assessments are always required.

Portugal

Until now the only places where marine aggregates have been dredged annually are in the Madeira and Azores archipelago. In Madeira the local authorities have not yet provided information about EIA requirements. In the Azores, given that extraction quantities are very small and localized, until now, no EIA was prior to ex-traction activities.

Spain

An EIA is compulsory if the volumes are in excess of 20 000 cubic meters or if the extraction area is included within the Natura 2000 network or other Marine Protected Areas. For extractions over 100 000 cubic meters in estuaries, and any other dredging activity different to navigational proposes.

Sweden

There has been only one active license at the moment; the first granted in some 15 or 20 years. An EIA was required and all future applications will require an EIA.

Requirements are established in the Continental Shelf Ordinance (1966:315), section 5. A permit to extract sand, gravel or cobbles in an area which in its entirety is situated within public waters of the sea shall be granted by the Geological Survey of Sweden, unless otherwise provided by the last paragraph. An application for such a permit shall contain the particulars needed to assess how the general rules of consideration of Chapter 2 of the Environmental Code will be observed. As provided in Section 3a of the Continental

Shelf Act (1966:314), the application shall include an environmental impact assessment. The application documents shall be submitted in at least six copies. When considering an application for a permit, the Survey shall obtain opinions from the Swedish Environmental Protection Agency, the local authority and other authorities concerned. A permit shall be granted for a fixed period, at most ten years, and shall relate to a specific area. The permit shall state to what extent sand, gravel or cobbles may be taken and shall set out such stipulations as are necessary to safeguard to a reasonable extent other interests, such as navigation, fisheries and nature conservation, or as are otherwise called for by the provisions of the United Nations Convention on the Law of the Sea. Attention shall be drawn in the permit to any consideration of the activity that may be required under other legislation. Fees as referred to in Section 4 b, second paragraph, of the Continental Shelf Act shall be payable for the permit, unless the limited extent of the enterprise or some other special reason gives cause to waive them. Such fees shall be determined by the Geological Survey of Sweden. If the extraction to which the application relates is substantial in scale or could give rise to significant detrimental effects, or in other cases if the Swedish Environmental Protection Agency so requests, the Geological Survey of Sweden shall refer the application to the Government, attaching to it its own opinion. (Ordinance 2007:952)

United Kingdom

There are few MMG.1 criteria although a new Marine Policy statement is pending. All projects (more than 10 000 tonnes) require an EIA, but the value is a guideline. There is a screening tool (short risk assessment) that can be sent to the regulatory authority in each county but usually any proposals for commercial extraction just go right to the EIA, an EIA being routinely required. In some regional areas, the industry has voluntarily done a non-statutory EA to facilitate the process of project-specific EIAs.

United States

For proposed projects, an initial screening is required as an environmental impact assessment (EA) by the permitting agency (usually the US Army Corps of Engineers for dredging permits. This may result in a “Finding of No Significant Impact” (FON-SI). A finding of significant impact is a professional judgment. There is not a quantitative matrix, but general policies for evaluating permit applications are to include consideration of the extent of probable impacts, including cumulative impacts, the public benefits of the project. The judgment is to be based on the relevant issues of conservation, economics, aesthetics, general environmental concerns, impacts on wet-lands, historic values, fish and wildlife values, flood hazards, floodplain values, land use, navigation, shore erosion and accretion, recreation, water supply and conservation, water quality, energy needs, safety, food and fiber production, mineral needs, considerations of property ownership and, in general, the needs and welfare of the people.

17. Presentations to WGEXT

Laura Addington, Nature Agency of the Ministry of Environment and Food.

Danish policy on marine extraction and developments in extraction practice in Denmark

The Act on Raw Materials regulates the exploitation of stone, gravel, sand, clay, lime, chalk, peat, topsoil and others such as shells, on both land based and marine extraction. The Act focuses on a balance between:

1) securing the Danish society sufficient amounts of raw materials for the ongoing development and construction works

2) minimizing the impact of the exploitation activities on the nature and the environment

Until 1997 the were no defined extraction sites, and no area specific regulation of volumes. In 1997 extraction sites were defined and there was an aim for doing EIA's on the extraction sites within the following 10 years. In 2007 the extraction sites were reduces in size and maximum volumes for the specific sites were introduced, and also doing an EIA and a geological mapping of all new extraction sites was now necessary.

The geological mapping is done by seismic surveys including side scan sonar, single/multibeam and sometimes vibrocores, grab-samples and grain size analysis, and it has two phases. Phase 1A is a large scale mapping / screening for potential resources, and it is the minimum level of mapping that must be done, when an exploration permit is obtained. If potential resources are found, a Phase IB detailed mapping of the potential resources for describing the volume and the quality of the resource, must be done, before an extraction permit can be granted.

In the EIA the biological value of the area and the surrounding 500 meters is reported by identifying the nature types, and the environmental impact on these, by the dredging activities applied for. The method used includes side scan sonar, visual verification (diving, camera, ROV) combined with a literature study. In case stone reefs are mapped within the area applied for, then they are excluded from the final extraction site.

There are 3 types of extraction sites, each with different m3 prices:

- Common areas (87 in DK) have fixed prices, and are the most expensive. In these areas anyone can apply for a license, and it can be obtained within a few days. When the licensed volume has been extracted by the license holders, the site is closed. Applications for new common areas, or new volumes i¬¬n former common areas, must be made by a company, on the basis of the necessary mapping and EIA, and this company will therefore be able to extract from these areas at a reduces price.
- Auctioned areas (8 in DK) which are exclusive, and the price varies depending on the bid on the auction.
- Project owner's areas (5 in DK) which are also exclusive, and they can vary in price, but are often free.

Compliance monitoring of the extraction activities is done by controlling the AIS data from the dredging vessels, and also by comparing these data with the quarterly reports from the license holders, with information about the volumes extracted from the sites, and which location they were shipped to.

The reported volumes are also the basis for the quarterly and yearly statistics on extracted volumes in the Danish extraction sites.

Every year the State does a geological mapping project in the Danish waters, to get more knowledge about potential resources, for future extraction sites. The data and results from all geological mapping activities in Denmark, that hold information about potential resources in the Danish waters, are gathered in The Database of Marine Raw Materials, which can be accessed on the internet.

In the near future, a marine spatial plan is to be made for the Danish waters, and according to the coming law on marine planning, Marine extraction should be included in the plan.

Johan Nyberg, Geological Survey of Sweden

Resource mapping in Sweden

The Geological Survey of Sweden has been commissioned by the Department of Enterprise, in cooperation with the Agency for Marine and Water Management, to look at the prerequisites and costs for marine extraction as replacement to land extraction. The purpose is to get a sustainable extraction that is part of the national and regional raw material supply. Glacio-fluvial deposits including eskers on land and similar formations in the landscape are important sources of groundwater and consequently drinking water. These natural sand and gravel deposits are also of significance for energy supply, the natural and cultural landscape, and recreation. Therefore it is of importance to housekeep glacio-fluvial material including eskers on land for e.g., future water supply. Here, potential areas within the Swedish EEZ to be used for marine sand and gravel extraction are presented. These areas are chosen from a suitable geological and sediment dynamic perspective where a "continuous" accumulation of sand and gravel occurs. The sand and/or gravel deposits are wave washed accumulated material from glacio-fluvial material (eskers) and till as well as the accumulated end in sediment transportation systems.

17.3 Brigitte Lauwaert, Management Unit of the North Sea Mathematical Models (MUMM)

JPI-Oceans pilot action: Ecological aspects of deep-sea mining

This pilot action is one of the 4 pilot actions under JPI (The Joint Programming Initiative Healthy and Productive Seas and Oceans) from the EC. The other pilot actions are on multi-use of infrastructures for monitoring, ecological aspects of micro-plastics in the marine environment and intercalibration of the EU Water Framework Directive). JPIO (2011) represents 21 countries which represent ca 88% of the research funding in Europe.

The goal of this action is to assess the impact of potential mining activities on deep sea ecosystems: environmental status of polymetallic nodule habitats in the DISCOL Experimental Area, SE Pacific, and implications for future nodule mining activities in the Clarion Clipperton Zone, NE Pacific. The co-ordinator is Matthias Haeckel, GEOMAR

Helmholtz Centre for Ocean Research Kiel. The project runs from 1 January 2015 till 31 December 2017. The main objectives are:

- Spatial (footprint of impact) + temporal scales of abyssal response to anthropogenic disturbances;
- Proof of concept for (rapid assessment) monitoring technology capable of defining the ecosystem status;
- Comparative ecological, genetic, geochemical, hydrodynamic investigation between different areas in the CCZ and DISCOL;
- Communicate results to stakeholders, policy makers (ISA: initiate revision of regulations), industry.

Preliminary conclusions e.g. on the "benthic diversity and recolonization potential" work package are the following:

- Nematode community inhabiting the 37 years old mining tracks still differs from the reference site: its density and diversity is lower;
- There are no strong evidence of some progress in recovery process in the 37 years old mining track (as compared with 2004 data);
- It seems that the recovery rate may be determined by the sedimentation and bioturbation rates (very low) in the studied area and may last hundreds or thousands of years until characteristics of sediment inside the track become equal to ones in the reference area.

Michel Deprez, Independent Consultant

Biological perturbations linked to marine aggregate extraction in two French sites in the eastern Channel

An experimental program (SIEGMA) was developed from 2004 to 2012 on two sites of the eastern Channel after the creation of a stakeholder consortium including end users (fishermen, mining companies), scientists, authorities and policymakers. Fundamental objectives of this program were to improve the international knowledge on the impacts of dredging and on the restoration process of extraction areas, and to get original data on demersal fish communities and trophic relationships between fish and benthos, as per several ICES recommendations (1992, 2001).

Moreover, an applied objective was to test different extraction strategies (intensity, duration) to select the most sustainable one in the perspective of a close increase of licences in this area. Investigation of the mechanisms by which the pressures may change the marine ecosystem enabled to propose a limited extraction intensity and/or duration of extraction. These are management options for achieving locally a Good Ecological Status by fulfilling requirements of several descriptors of the Marine Strategy Framework Directive.

Szymoni Uścinowicz, Polish Geological Institute

Morphological and sedimentological effects of sand and gravel extraction in the Polish maritime.

18. OSPAR National Contact Points for Sand and Gravel Extraction

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19. Marine Aggregate Extraction and Marine Strategy Framework Directive: A review of existing research

(5th draft of the WGEXT Collaborative Paper)

This review is the result of a collaborative contribution of the WGEXT members, coordinated by Michel Desprez.

Introduction

Global biodiversity is threatened by human activities which are increasingly impacting marine ecosystem (Halpern *et al.*, 2008). These impacts are usually cumulative and can lead to degrading habitats and ecosystem functionality (Ban *et al.*, 2010).

Understanding relationships between human pressures and ecosystems is the second major challenge identified by Borja (2014) for future research within the field of marine ecosystem ecology.

This review is providing information on research aspects related to various effects of marine aggregate extraction on the seafloor and the water column, and the connection with criteria for good environmental status which is relevant to several descriptors of the MSFD: biological diversity (D1), commercial fishes (D3), marine food webs (D4), sea-floor integrity (D6), hydrographical conditions (D7) and underwater noise (D11):

The following table is summarizing the impacts on the marine ecosystem, developed in different chapters, and the links between these impacts and the descriptors:

Effects of aggregate extraction:	**Impact on:**	**Potentially influenced MSFD descriptors:**
Seabed removal	Topography/Bathymetry	(D1), D6, D7
	Sediment composition	D1, (D3), D6
	Habitat & biological communities	D1, (D3), D4, D6
Sediment plumes	Turbidity	D3, D4
	Deposition	D1, D3, D4, D6
Ship activities	Underwater noise	D11

This review also aims to highlight gaps to expand on the current knowledge to fulfill MSFD requirements.

Descriptor 1: Biological diversity is maintained. The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climate conditions. Assessment is required at several ecological levels: ecosystems, habitats and species.

Approaches to support the conservation of marine biodiversity include measures of rarity, diversity, identification of the number and abundances of species and habitats in different locations, but also the identification of biological indicators (Hiscock and Tyler-Walters, 2006).

According to a decreasing gradient of impact Browning (2002) identified three main classes of anthropogenic pressures on biodiversity in the English Channel-North Sea area:

- a class of maximal impact is including fishing activity (threatened species, destruction of protected biotopes) ;
- a class of higher medium impact is including many types of pollution ;
- a class of lower medium impact is including marine aggregate extraction and deposition of harbour maintenance sediments.

The marine sediments -searched by the extraction industry- correspond to sand and gravel bottoms which represent only a fraction of the high diversity of habitats and marine life (variety of bottom types, habitats of common interest, rare and endangered species). In general, the biodiversity of the seabed tends to increase with the size and heterogeneity of the sediment (microhabitat) and with the stability of the substrate.

- Sandy bottoms, with low diversity in microhabitats, particularly mobile banks of coarse sand searched for extraction, are typically poor in species and biomass.
- Gravelly bottoms are the most diversified among the marine habitats, the larger size of gravel allowing settling and providing shelter for many sessile and mobile organisms.. This knowledge resulted in many studies related to the commercial extraction of marine aggregates (Newell *et al.*, 1998; Desprez, 2000; Cooper *et al.*, 2007). The deep gravel habitats are more diverse than those closer to the coast, with a diverse and abundant epifauna with sponges, tunicates, bryozoans, hydroids and polychaetes. Biogenic reefs under threat and of high heritage value are associated with these gravels.

Potential impacts of marine aggregate extraction on key habitats and species of the European Directive Natura 2000 were summarized in the following table (Posford Duvivier Environment, 2001), where gravelly areas are surprisingly absent whereas identified as a more sensitive habitat than sand (Foden *et al.*, 2010)!

Table 1. Potential impacts of marine aggregate extraction on key habitats and species of the European Directive Natura 2000 (S = Short Term, M = Mean term L = Long term; in Posford Duvivier Environment, 2001).

Potential Impact	Habitats (Ann. I)	Species (Ann. II)	
	Sand and Gravel Banks	Fish	Mammals
Benthos and substrate loss	M	M	M
Turbidity	S	S	S
Sediment	ML	ML	

Effects

A loss of 60 % for the number of species is generally observed within dredging sites (Newell *et al.*, 1998; Desprez, 2000; Boyd *et al.*, 2002; Boyd and Rees, 2003; Newell *et al.*, 2004; ICES, 2009, 2016; Krause *et al.* 2010; Desprez *et al.*, 2014) but this local and temporary loss of biodiversity is counterbalanced by the increase in diversity of benthic communities (Hewitt *et al.*, 2008; de Backer *et al.*, 2014) because of the strong link between habitat and species diversity; at a local scale, such an increase in the number of EUNIS habitats and associated communities was observed in a site of extensive dredging in the eastern Channel (Desprez *et al.*, 2014) with three new habitats in a geographical context of coarse shelly sands with *Amphioxus* (EUNIS Habitat A5.135).

Cusson *et al.* (2014) observed that changes within community assemblages in terms of structure are generally independent of biodiversity.

Recovery

For benthos, the loss of biodiversity associated with the extraction is local and important but sustainable in coarse bottoms. In the case of intense deposit of fine sediments due to screening, the damage by dredging to functional diversity and to the capacity of the macrofaunal assemblage to recover is immediate and not so dependant on dredging intensity (Barrio-Frojan *et al.*, 2008).

Moreover, the return to the initial biodiversity can be artificially accelerated by creating a heterogeneous substrate with the seeding of shells or gravel (Collins and Mallinson, 2007; Cooper *et al.*, 2010a) but the cost of these works is questioning (Cooper *et al.*, 2010b).

Habitat engineering can exert facilitating and inhibiting effects on biodiversity (Bouma *et al.*, 2009).

Biodiversity and ecosystems functionality

It is now fully recognised that understanding the entire ecosystem requires the study of all biodiversity components (Borja, 2014), from species to habitats, including food-webs (descriptor 4) and complex bio-physical interrelationships within the system.

The study of the ecological function of biodiversity is very recent but has been recognised to have fundamental implications for predicting the consequences of biodiversity loss.

This missing of the functional aspects of biodiversity was highlighted by the WG GES (EC, 2010).

Biodiversity indicators

Biodiversity can be seen as an overarching descriptor and a too broad topic to list all possible indicators and in any case not all indicators can be applied everywhere. There is therefore a need for more guidance on which habitats and species to consider (EC, 2010).

Whilst their population equivalents do not always reflect biodiversity changes, the sample Simpson, Shannon and Richness indices are useful indicators of change in biodiversity (Barry *et al.*, 2013).

Demersal fish communities consisting mainly of mobile species, neither the habitat-level indicators nor the single species distribution indicator, explicitly directed at sessile/benthic species, are pertinent; appropriate fish biodiversity metrics cannot be derived to support this D1 indicator (Greenstreet *et al.*, 2012).

Conclusion

With respect to descriptor (1) WGEXT recognises that extraction of marine aggregates can potentially be a serious threat to biodiversity when exploitation projects affect gravelly areas either of small size or under-representated in the geographical area (loss of habitat).

The ICES Guidelines for the Management of Marine Sediment Extraction (2003), as adopted by OSPAR, provide for the adoption of appropriate extraction site locations, with the aim to prevent any harmful effect on habitats of prime importance.

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Descriptor 3: Commercial fish

The proposed indicators mortality and biomass are the base for this descriptor, while the third one (size) should be linked to the ones on food webs (D 4).

Stelzenmüller *et al.* (2010) investigated the vulnerability of 11 species of **fish and shellfish** to aggregate extraction. The authors calculated a Sensitivity Index (SI) for each species and modelled their distribution around the UK. These species were likely to be affected by aggregate extraction and had either commercial or conservational importance; target fish communities include the flatfish sole, thornback ray and plaice, the gadoids cod and whiting, and the bivalve mollusc queen scallop.

Turbid plumes can cause avoidance behaviour in visual predatory fish, such as mackerel and turbot; for herring and cod, critical levels were demonstrated at very low silt concentrations (3 mg/l). They can also cause mortality of larvae of herring and cod at slightly higher levels (20 mg/l), while eggs can tolerate concentrations >100 mg/l (Westerberg *et al.*, 1996).

WGEXT recognises that extraction of marine aggregates can potentially be a serious threat to commercial fish species when functional impacts can affect sensible and threatened species (e.g. through loss of spawning areas)

The ICES Guidelines for the Management of Marine Sediment Extraction (2003), as adopted by OSPAR, provide for the adoption of appropriate extraction site locations, with the aim to prevent any harmful effect on habitats of prime importance.

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Descriptor 4: All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity.

This descriptor concerns important functional aspects such as energy flows and the structure of food webs (size and abundance).

Effects of substrate loss

Functionally, the qualitative and quantitative depletion of benthic communities may affect the higher trophic levels (e.g. fish & birds), as the increase in extraction surface in a given geographical area leads to the loss of habitat and potential food web (Birklund & Wijsman, 2005). Several fish species are more or less closely related to the bottom by their way of feeding ; plaice, sole, dab, gurnard, red mullet, haddock, whiting and cod, feed primarily on benthic organisms, like bivalves, worms, crustaceans and sea urchins. Coastal bottoms actually are important feeding areas for diving birds (ducks, terns, penguins, northern gannet…), due to their high productivity (Michel *et al.* 2013).

Top predators, such as seabirds and mammals, can be highly sensitive to changes in the abundance and diversity of their primary prey; nevertheless, many bird species are able to switch to alternative prey (Rombouts *et al.*, 2013).

More than 48 species of fish in the north-east Atlantic area are associated with sandy gravel bottoms for spawning (herring, black bream, sole...); about forty others are associated with these habitats (rays, dogfish, plaice, sand eels, sharks...). On the other side, most flatfish species of commercial interest develop and reproduce in fine and silt sand without interest for extraction.

Shellfish make up an important component of the coastal food web, for example for shellfish-eating birds such the common scoter as well as demersal fish (Kaiser *et al.*, 2006; Tulp *et al.*, 2010). As such, the impacts of aggregate extraction on shellfish species are being investigated in the Netherlands; the American clam (*Ensis directus*) was taken as a model organism because of its high dominance in biomass in the Dutch coastal zone.

Predicting the disturbance of mobile **fish** species is particularly difficult as there are few studies that have directly investigated disturbance in relation to marine aggregate extraction, or suggested that significant impact will occur (Stelzenmüller *et al.*, 2010).

A study by Boyd *et al.* (2001) compared the commercial fish landings for fish caught in an aggregate zone, to those obtained from ports distant to dredging. A localised decline in catches in Dover sole was observed, and the study considered that this may be a result of the reduced abundance of prey items within the extraction area as Dover'sole derive much of their food from benthic species.

In a French experimental site (Desprez *et al.*, 2014), fish monitoring between 2007 and 2011 showed a strong negative impact of aggregate extraction on fish presence, either in the number of species (-50%), or in abundance and biomass (- 92%). Such a strong impact was not observed in the commercial site of Dieppe (respectively + 50%, - 35% and + 5%) and could be explained by the difference in extraction strategy (zoning), with a low intensity in Dieppe (<1h/ha/year), whereas medium to high (4 to 10 h/ha/year) in the Baie de Seine.

In a Dutch deep sand extraction site (de Jong *et al.*, 2014), significant differences in demersal fish species assemblages were associated with variables such as water depth, median grain size, fraction of very fine sand, biomass of shells and time after the cessation of sand extraction. One and two years after cessation, a significant 20-fold increase in demersal fish biomass, dominated by plaice, was observed in deeper muddy parts of the extraction site colonised by high densities of white furrow shell (*Abra alba*).

Trophic structure is an important driver of community functioning and biological traits, in particular body size, in turn determine which species interact (Nordström *et al.*, 2015).

A study by Pearce (2008) investigated in UK sites the importance of benthic communities within marine aggregate areas as a food resource for higher trophic levels. The study noted that the alterations to the benthos due to dredging were likely to cause alterations to the diet of demersal fish, which may be unfavourable. However, given the natural levels of trophic adaptability observed, a change in dietary composition may not be damaging to the fish population as the majority of species studied are likely to switch prey sources, providing sufficient biomass is available to support them.

Evidence of this trophic adaptability was also observed in French sites of the eastern Channel with a strong increase in the abundance of sole and the best example of switching prey sources in the case of the red mullet (Desprez *et al.*, 2014).

Mobile species are also more likely to be influenced by other impacts or anthropogenic activities outside of a licence area, again making direct predictions between marine aggregate extraction and mobile species difficult. A study by Kenny *et al.* (2010) looked at the long term trends of the ecological status of the east coast aggregate producing region, which included consideration of fish stocks. This study noted that long term trends appear to be dominated by wider factors that govern trends at the North Sea scale, as declining fish stocks were observed in both the North Sea and east coast aggregate producing region.

Effects of turbid plume

Only a large scale continuous extraction activity may cause an indirect impact through a persistent turbidity plume which can:

- reduce the primary production of phytoplankton;
- disrupt the feeding and respiration of zooplankton;
- cause avoidance behaviour in visual predatory fish, such as mackerel and turbot. For herring and cod, critical levels were demonstrated at very low silt concentrations (3 mg/l);
- cause mortality of larvae of herring and cod at slightly higher levels (20 mg/l), while eggs can tolerate concentrations >100 mg/l (Westerberg *et al.* 1996).

A direct consequence of increased turbidity from aggregate extraction is the reduction of light penetration into the water column, which can negatively affect **phytoplankton** growth. Phytoplankton constitutes the basis of the food web, thus a decreased availability can affect higher trophic levels. In addition to a reduced phytoplankton abundance in the water column, elevated silt concentrations may impede the intake of phytoplankton by shellfish, and potentially cause additional stress (i.e. higher energetic costs) to these organisms as they need to excrete silt in the form of pseudo-faeces (Michel *et al.*, 2013).

Cook and Burton (2010) reviewed the potential impacts of aggregate extraction on **seabirds**. One direct effect was the issue of increased turbidity, and to what extent this affects a bird's ability to see prey. Vision for foraging is important for a number of species of seabirds, including terns, the common guillemot and the northern gannet. However, for the most part, material falls out of suspension relatively quickly (mostly within 500 m), meaning this increased turbidity is short term and within a limited area.

In a review of impacts of marine dredging activities on **marine mammals**, Todd *et al.*, (2014) conclude that sediment plumes are generally localized, and marine mammals reside often in turbid waters, so significant impacts from turbidity are improbable. However, entrainment, habitat degradation, noise, suspended sediments, and sedimentation can affect benthic, epibenthic, and infaunal communities, which may impact marine mammals indirectly through changes to prey.

Food web indicators

Many food web indicators are also relevant to other MSFD descriptors 1, 3 (groups/species targeted by human activities) and 6 (early warning indicators)

The existing suite of indicators gives variable focus to the three important food web properties: structure, functioning and dynamics, and more emphasis should be given to the latter two. Indicators based on the structure and processes of benthic groups can help to describe trophic functioning. Whereas the currently proposed indicator 4.1.3 is suggested to a single group/species, biomass can be considered over several trophic levels simultaneously and can therefore become an ecosystem-based indicator (Rombouts *et al.*, 2013).

The proposed indicators, in particular those based on abundance and biomass, can inform on the structural properties of food webs but they may provide only partial information about its functioning. Hence, the development of criteria for D4 should be directed towards more integrative and functional indicators that consider (1) multiple trophic levels or whole-system approach (i.e. ecosystem-based indicators), (2) processes and linkages (e.g. trophic transfer efficiencies) and (3) the dynamics of food webs in relation to specific anthropogenic pressures.

Conclusion

Thompson *et al.* (2012) emphasize that food-web ecology will act as an underlying conceptual and analytical framework for studying biodiversity and ecosystem function, if some challenges are addressed such as relating food-web structure to ecosystem function, or understanding the effects of biodiversity loss on ecosystem function.

With respect to descriptor 4, direct and indirect effects of m.a.e. are proportional to the size of dredging areas, with "limiting" factors like the trophic adaptability of fish and bird species and their mobility to avoid disturbed areas, or the tolerance of marine mammals for turbidity.

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Descriptor 6: Sea-floor integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected

D 6.1. Physical damage, having regard to substrate characteristics

The physical impact of the extraction is site-specific and linked to many factors such as the hydrodynamics, the sediment grain size, the dredging method and intensity.

- The action of extracting aggregate alters the **topography** with creation of isolated furrows (dredge tracks) in extensive sites (Cooper *et al.*, 2005; Le Bot *et al.*, 2010) up to durable depressions of several meters deep after several years of localised extractions (Degrendele *et al.*, 2010).
- Removal of aggregate can lead to a **change in the seabed substrate**, by removing surficial layers of sediment to leave a new substrate exposure of coarser sediments (Cooper *et al.*, 2007; Le Bot *et al.*, 2010) or by altering the particle size distribution as a result of intensive deposition from overflow (Boyd *et al.*, 2005; Cooper *et al.*, 2007; Krause *et al.*, 2010; Barrio- Frojan *et al.*, 2011; Wan Hussin *et al.*, 2012).
- Extraction generally results in an **increased variability** in terms of particle size composition within both high and low dredging intensity sites (Cooper *et al.*, 2007).

As the distribution of marine organisms and communities is strongly related to hydrodynamic, morphological and sediment parameters (McLusky and EIliott, 2004; Baptist *et al.*, 2006; Degraer *et al.*, 2008; Pesch *et al.*, 2008), any physical changes in the sea bed will lead to a response in the composition of its natural benthic assemblages. This will affect the habitat quality in a wider area, the transport of fish larvae and the abundance of food for fish, birds and mammals.

The direct removal of surface aggregate sediments and associated fauna results in an immediate and local loss of the benthic fauna in the order of 60% for the number of species and 80–90% for the abundance and biomass (Newell *et al.*, 1998; Desprez, 2000; Newell *et al.*, 2004; Boyd and Rees, 2003; ICES, 2009; Krause *et al.* 2010; Desprez *et al.*, 2014). This may range from almost total defaunation (Simonini *et al.*, 2007) to a more subtle and less significant change (e.g. van Dalfsen *et al.*, 2000; Robinson *et al.*, 2005).

Extensive dredging will have the less pronounced impact without functional consequences (e.g. no reduction in biomass) on the higher trophic levels (Bonvicini *et al.* 1985; Desprez *et al.*, 2014). In sandy areas of the North Sea and the Baltic Sea, the effects of sand extraction only became evident when the annual extractions affected 50 % of the licensed area, causing a drop in biomass values (Birklund and Wijsman, 2005).

The cumulative impact, in time and/or space, of multiple extractions results in a continuous disruption of benthic communities, which are reduced to their simplest form (few tolerant species, reduced abundance and minimal biomass due to the elimination of long living bivalves and echinoderms) (Newell *et al.,* 2004a; Boyd and Rees, 2003; Robinson *et al.*, 2005; Cooper *et al.,* 2007; Barrio-Frojan *et al.*, 2008).

Differences in impact and subsequent recovery also depend on **local hydrodynamics** (Mestre *et al.*, 2013)**, sediment characteristics**, as well as on the nature and type of stress to which the community is adapted in its natural environment (ICES, 2009). In the sandy bottoms of the North Sea, small-scale disturbances in seabed morphology and sediment composition result in limited effects on the benthic community (van Dalfsen *et al.*, 2000), but large scale and deep sand extractions (de Jong *et al.*, 2014) result in a net increase of the fraction of very fines in the sediment and of the biomass of the white furrow shell (*Abra alba*) biomass.

In gravelly areas, the impact is higher as a consequence of the heterogeneity and the stability of the sediment which favour more diversified and abundant communities (Seiderer and Newell, 1999; Newell *et al.*, 2001; Cooper *et al.*, 2007).

The main **indirect impact** of dredging is linked to the deposition of sediment from the overflow or screening plume, which can cause smothering / damage to sensitive benthic receptors. Extensions of deposits have been calculated for spring tides conditions in the English Channel: 800m for sand and 6.5km for silt (Duclos *et al.*, 2013).

The majority of studies (Desprez, 2000; Newell *et al.*, 2004b; Boyd and Rees, 2003; Cooper *et al.*, 2007; Desprez *et al.*, 2010) suggest that adverse biological change is constrained to the 100m–200m from the dredge area, even where sedimentary change has been detected at greater distances up to 2 km from the dredge site in the direction of and after remobilisation by strong local tidal currents (Robinson *et al.*, 2005; Cooper *et al.*, 2007; Desprez *et al.*, 2010).

Several types of effects have been observed depending on the **intensity of the oversanding and the nature of the bottom**:

- On gravelly bottoms, the elimination of the benthic fauna can be almost complete, identical to that observed in the dredged area (ICES, 2009; Desprez *et al.*, 2010), the original communities being unable to withstand a big deposition of fine sands. Due to the permanent extraction activities and remobilization in areas under strong hydrodynamic conditions, the original stable bottom is replaced by a continuously remobilized substrate (Newell *et al.*, 2004b; Robinson *et al.*, 2005; Desprez *et al.*, 2010). Beyond a few hundred meters from the extraction site, there is a rapid increase in the number of species and abundance consistent with the low dispersion of overflowing sediments. Boyd and Rees (2003) also showed that the faunal composition changed gradually with the distance from the extraction site. This is mainly due to the fact that the distribution of species is correlated with the sedimentary characteristics of the deposition area (medium to fine sand);
- A transition from a sandy-gravelly bottom with a diverse epifauna to a sandy bottom with a less diverse infauna can occur as a result of overflow (Boyd *et al.*, 2005; ICES, 2009; Desprez *et al.*, 2010).
- On sandy bottoms, the benthic fauna is less affected in the deposition area than in the extraction site (Newell *et al.*, 2004b). The benthic species which are less sensitive to overflow deposits are those able to move rapidly through the sediment and free-swimming epifaunal species (crabs, shrimps…);
- The species richness, abundance and biomass can increase in overflow areas, when sediment deposition is limited and the available food is increased through organic enrichment (Newell *et al.*, 1999; Desprez *et al.*, 2010).

Generally, the creation of sediment plume has the potential to adversely impact benthic organisms through an increase in sediment induced scour, smothering and through damage and blockage to respiratory and feeding organs (Tillin *et al.*, 2011). Effects of suspended sediments and sedimentation are species-specific, but invertebrates, eggs, and larvae are most vulnerable.

Studies such as Last *et al.* (2011) investigated the impacts of increased SPM and smothering on a number of benthic species of commercial or conservational importance under a range of environmental and depositional conditions. Two test conditions of SPM were tested (high SPM, equivalent of near dredge conditions and low SPM, equivalent of wider secondary impact conditions). All species survived the higher SPM conditions. The ross worm (*Sabellaria spinulosa*) was highly tolerant to short term burial (< 32 days) and its growth rate showed significantly higher tube growth under high SPM conditions.

Szostek *et al.*, (2014) showed that elevated SPM had no short-term effects on survival of the king scallop (*Pecten maximus*), but observed a reduction in growth rate; this species appeared more tolerant of burial and elevated levels of SPM than the queen scallop (*Aequipecten opercularis*).

D 6.2. European Commission selected as indicators for the sea-floor integrity (Rice *et al.*, 2012):

(i) type, abundance, biomass and aeral extent of relevant biogenic substrates:

Sabellaria reefs & *Mytilus* beds (Cooper *et al.*, 2007; Gibb *et al.*, 2014; Pearce *et al.*, 2014), *Chaetopterus* beds (Rees *et al.*, 2005), *Lanice* meadows (Braeckman *et al.*, 2014) and other biogenic reefs (Farinas-Franco *et al.*, 2014) are examples of the coastal ecosystems dominated by epibenthic engineers which belong to the most valuable ecosystems among the world, but remain threatened and declining.

An example of reversibility of the reduction process of biodiversity has been observed on extraction sites (Cooper *et al.*, 2007; Gibb *et al.*, 2014; Desprez *et al.*, 2014) with the return of the tubeworm *Sabellaria spinulosa* (key species of the Habitats Directive and the OSPAR list of endangered species), observed from the early stages of recolonization, encouraged by the deposit of sand overflow.

(ii) extent of the seabed significantly affected by human activities for the different substrate types:

Halpern *et al.* (2008) estimated that 41 % of marina areas are already strongly affected by multiple anthropogenic perturbations. In the six direct physical pressure types affecting the seabed of England and Wales, Eastwood *et al.* (2007) estimated that selective extraction caused by demersal trawling affected between 5 % to 21 % of the total area, while the pressure arising from aggregate dredging affected only 0.1 % for the direct removal, plus 1.2 % for the siltation caused by screening plumes. Disturbance of the seabed by demersal fishing gear shows a footprint reaching over 99 % of the known footprint of all human pressures on the UK seabed (Foden *et al.*, 2010).

(iii) presence of particularly sensitive and/or tolerant species:

The sensitivity measures the degree of the response to stress using indicators (species, communities, habitats). Identifying the sensitivity of species and biotopes relies on accessing and interpreting available scientific data in a structured way (sensitivity information can be overlaid with the distribution of protected or threatened species and habitats, designated areas, and the location and intensity of specific activities considered damaging to the marine environment) to disseminate suitably presented information to decision makers (Hiscock and Tyler-Walters, 2006).

Presence of particularly sensitive or tolerant species should inform on the condition of the benthic community (D 6.2) However, Zettler *et al.* (2013) recently demonstrated that the use of static **indicator species**, in which species are expected to have a similar sensitivity or tolerance to either natural or human-induced stressors, does not account for possible shifts in tolerance along natural environmental gradients and between biogeographic regions. Their indicative value may therefore be considered at least questionable.

The identification of sensitive habitats implies ambitious mapping programmes of biological characteristics of marine habitats at regional scales, much bigger than research permits and extraction areas. Because of the high biodiversity of gravel habitats, it would be desirable to add some of these habitats to the list of the European Directive.

Table3. Risk analysis of marine aggregate extractions for the main types of seabeds exploited on the French littoral (Poseidon matrix); (In Desprez, 2011).

Risk Analysis		Habitats Sensitivity		
Impact Indicator			NATURA 1110.2	NATURA 1110.3
Dredging Intensity	Recovery rate	Sandy gravels with epifauna	Gravelly sands with *Amphioxus*	Medium sands with *Ophelia*
High	> 10 years	High	High	Medium
Medium	1–10 years	High	Medium	Low
Low	< 1 year	Medium	Low	Negligible

The ICES Guidelines for the Management of Marine Sediment Extraction (2003) and the Working Group for Marine Habitat Mapping (ICES, 2008) point out the importance of this objective in the selection process of extraction areas to protect benthic threatened communities and to allow a good resources management. The most sensitive species/habitats are maërl beds (high structural diversity), spawning areas (fundamental functional diversity) and biogenic reefs (both structural and functional diversity) which have specific protection measures (OSPAR, Natura 2000).

The level of pressure on habitats and species will be different depending on the nature of the impact related to extraction. The following table details the impact level observed in Dieppe (Desprez , 2011) on the different habitats and species identified in the major international conventions that regulate the management of the activities and the protection of the marine ecosystem.

Table 2. Sensitivity of key-species and habitats (identified by international conventions) to various levels of impact of marine aggregate extraction (E=Extraction; T=Turbidity; D=Deposition) in Dieppe. (in Desprez, 2011).

Sensitivity to extraction		*Pressure Levels*				
Indicators of impact		High	Mean	Low	Negligible	Positive
OSPAR species	Cod	T	D			E (zoning)
	Rays			E / T	D	
OSPAR habitats	Sabellaria reefs	E			T	D
	Maerl banks	E / T / D				
	Hard substrates with Modiolus	E / D		T		
ICES habitats	Spawning areas	E / T / D				
	Nurseries	E / D			T	
	Shell beds	E	D		T	
NATURA 2000	1110.2 (gravelly sands)		E / T / D			
	1110.3 (medium sands)			E / T	D	

(iv) Multi-metric indices assessing benthic community condition and functionality, such as species diversity and richness, proportion of opportunistic to sensitive species

Ware *et al.* (2009) provided options for aggregate indicators based on impacts to the physical and biological environment, including the percentage of silt/sand and gravel and benthic indices such as diversity and biomass (van Hoey *et al.*, 2007, 2010).The ability of both the Infaunal Quality Index and M-AMBI cannot be supported in inshore gravel currently (Fitch *et al.*, 2014)

Other indicators such as biological traits of benthic community (Bremner *et al.*, 2006ab, 2008), habitat heterogeneity (Hewitt *et al.*, 2008) and functional diversity (Törnroos *et al.*, 2014) have also been proposed. Functional indices may provide a more detailed assessment of the benthic communities than structural ones, but the overall outcome is broadly similar for both types of indices; this suggests measurement of functional indices may be unnecessary for routine monitoring purposes (Culhane *et al.*, 2014; Strong *et al.*, 2015), although they may have value in revealing more specific aspects of change in a system.

Metrics which are closely associated with species number and density of individuals scored highest in terms of sensitivity in relation to aggregate extraction impacts and such observations largely support similar findings in the literature relating to a variety of activities that typically result in physical impacts on the seafloor and its associated fauna (Ware *et al.*, 2009, 2010). A Benthic Ecosystem Quality Index (BEQI) was developed by Van Hoey *et al.* (2007) for the monitoring of windfarms, maintenance dredging deposits and aggregate extraction on the Belgian Continental Shelf (De Backer *et al.*, 2014). However, while some indicators are used to a certain extent already, there is further work to be done for indicators to be used as method to assess the physical impacts of aggregate extraction (Schleuter *et al.*, 2010; Fitch *et al.*, 2014).

The relative lack of sensitivity of traditional indices (AMBI, M-AMBI, ITI and BENTIX) may be attributed to their dependence on species responses to organic enrichment (Ware *et al.*, 2009; Targusi *et al.*, 2014), an impact not routinely associated with aggregate extraction activities, rather than physical perturbation (Salas *et al.*, 2006). The ability of both the Infaunal Quality Index and M-AMBI cannot be supported in inshore gravel currently; the IQI has not been tested as often as other indices but it has the potential to be a reliable predictive tool across a wide range of pressures and habitats (Fitch *et al.*, 2014).

Impact indicators for major drivers of marine biodiversity loss are currently lacking (Woods *et al.*, 2016).With increased knowledge and understanding about the strengths and weaknesses of competing index approaches, the field needs to unify approaches that provide managers with the simple answers they need to use ecological condition information effectively and efficiently (Borja *et al.*, 2009, 2010a).

For Green (2011), indices are appealing because they can be used to reduce complex data to single numbers, which seem easy to understand. But that is not biological or environmental reality, which is rarely 1- dimensional. At best reduction to an index means loss of information. In summary, avoid using indices because of information loss and the likelihood that their use will lead to misleading conclusions. He concludes that if you absolutely must use indices for some non-scientific reason, it is better to use them together with other statistical methods that retain more of the information in the biological data set.

Structure & Function

Understanding the role of biodiversity in maintaining ecosystems functionality is the main challenge in marine ecosystem ecology identified by Borja (2014). Theoretically, a higher number of functional group types will provide higher functional biodiversity organization to the system and contribute to more stable and resilient ecosystems (Tomimatsu *et al.*, 2013).

The study of the ecological function of biodiversity (Loreau *et al.*, 2001; Bremner *et al.*, 2003, 2006ab, 2008; Duffy *et al.*, 2007; Cooper *et al.*, 2008; Mouillot *et al.*, 2013) is very recent but has been recognized to have fundamental implications for predicting the consequences of biodiversity loss on ecosystem function, i.e. translate structural biodiversity measures into functional diversity to generate better Biodiversity–Ecosystem Functioning relationships (Strong *et al.*, 2015).

Habitat variation as a driver of functional composition and diversity suggests that habitat heterogeneity should be explicitely included within studies trying to predict the effects of species loss on ecosystem function. Between-habitat differences in functional traits are driven by differences in organisms densities rather than presence/absence of individual traits, emphasising the importance of density shifts in driving function (Hewitt *et al.*, 2008).

Theoretically, a higher number of functional group types will provide higher functional biodiversity organization to the system, and thus, contribute to more stable and resilient ecosystems (Borja *et al.*, 2009; Cusson *et al.*, 2014). However, Törnroos *et al.* (2014) observed that a decrease in taxon richness was leading to an overall reduction in function, but functional richness was remaining comparatively high even at the lowest level of taxon richness. It was confirming that a potential for species substitutions was existing to maintain ecological functioning in marine benthic systems (Frid, 2011). Frid and Caswell (2014) showed evidence, during some periods, for changes in functioning linked to changes in several (key or rivet) taxa, whereas during other periods, resilience maintained functioning in the face of taxonomic change. Clare *et al.* (2015) confirmed that ecological functioning (trait composition) was statistically indistinguishable across periods that differed significantly in taxonomic composition.

(v) & (vi) are not considered during monitoring programmes

Impact & natural variability

Ecological and environmental variability in natural ecosystems precludes the widespread use of simplistic design and analysis tools to detect the effects of human activities on natural ecosystems (Frid, 2011; Frid and Caswell, 2014; Clare *et al.*, 2015). Scale is one of the most important concepts in impact assessment (Hewitt *et al.*, 2001). As spatial or temporal scale increases, both the number of processes and their importance in influencing local populations and communities will change, increasing the variability encompassed by the study.

Recovery

The recovery time is strongly related to environmental characteristics (Woods *et al.*, 2016).

The prime role of <u>hydrodynamics</u> was observed around UK (Foden *et al.*, 2009, 2010) where 96% of extraction activity occur in sand or coarse sediment; the mean period of biological recovery is 8.7 years in deeper target coarse sediments with moderate tidal stress while shallow coarse sediments with weak tidal stress have a longer period (10.75 years).

Clean sand communities, adapted to high energy environments, have the most rapid recovery rate following disturbance (Dernie *et al.*, 2003; Foden *et al.*, 2009; Coates *et al.*, 2014); Simonini *et al.* (2007) observed the end of the recovery phase (structure and community composition) after 30 months in sand bottoms where dredging operations did not change the physical characteristics of the sediment, although complete defaunation at the dredged site.

To minimise recovery times following the cessation of dredging, it may be preferential to grant new aggregate extraction licences in sites of high natural disturbance where the macrofaunal communities present are less sensitive to the physical impacts caused by dredging (Cooper *et al.*, 2011a).

Extraction intensity may also influence the rate of recovery (Boyd *et al.*, 2003, 2004; Thrush *et al.*, 2008; Wan Hussin *et al.*, 2012; Waye-Barker *et al.*, 2015) with times of 7 years at low dredging intensity (< 1h/ha) and up to 15 years after cessation of high dredging intensity (> 10h/ha).

Unless the physical conditions can first be restored, impacted sites may not fully recover the pristine biological community (Cooper *et al.*, 2010). Fifteen years after cessation of extraction in Dieppe, pebble crests and their associated benthic and fish communities are still present in a natural environment of coarse sands (Desprez *et al.*, 2014); this situation is similar to that of wind farms introducing artificial hard substrates in sandy sediments of the North Sea (De Troch *et al.*, 2013; Wehkamp and Fischer, 2013; Vandendriessche *et al.*, 2014; Stenberg *et al.*, 2015), with a highly species-specific attraction effect of fish (adequate refuge in combination with additional food resources).

The attainment of a functioning ecosystem is more important and more relevant to the definitions of recovery than merely achieving the presence of structural features (e.g. species presence) (Verdonschot *et al.*, 2012). The rate of stabilisation and recovery of ecological functioning appears to depend on environmental context, but can be of the order of 5–10 years in marine benthos (Coates *et al.*, 2014).

Physical disturbances of the seabed by fishing gears (trawling and dredging) can result in permanent community changes when the frequency and extent of disturbance outstrips the recovery potential (Thrush *et al.*, 2008). For marine aggregate extraction, if exact values of acceptable limits for disturbance have yet to be developed (Cooper *et al.*, 2010), different functional metrics, used to investigate the rate of recovery in ecosystem function after dredging, indicated that the disturbed area was capable of full recovery given enough time: one or two years at a low dredging intensity site, 2–4 years after short intensive dredging events (Kenny *et al.*, 1998; Sarda *et al.*, 2000; Van Dalfsen *et al.*, 2000; Van Dalfsen and Essink, 2001), 7 years at a low intensity site; these time-scales, observed with traditional measures of abundance and biomass (Cooper *et al.*, 2005), reach up to 15 years after a long period of commercial extraction (Wan Hussin *et al.*, 2012; Waye-Barker *et al.*, 2015). But are there limits beyond which the capacity of impacted habitats to recover is compromised?

After many years of sustained dredging in North Sea, it was seen that even when one of the measured variables departed significantly from an equitable state, the effect did not persist from one year to the next; the potential for short-term partial recovery of the assemblage had not been compromised, at least in terms of abundance and species richness (Barrio-Frojan *et al.*, 2008).

Complete recovery is the return of an ecosystem to its original, pre-disturbance state, whereby the abundance, diversity, structure and functioning of the biological community are the same as prior to the disturbance (Woods *et al.*, 2016). However, system recovery may not require similar biomass, biodiversity or community composition.

Wan Hussin *et al.* (2012) stated that for measuring the recovery of macrofaunal communities after marine aggregate dredging, functional metrics are considered to be complementary to traditional environmental assessments metrics. Analyses suggest that ecological functioning can be sustained in communities undergoing long-term compositional change, as characteristically similar (redundant) taxa exhibit compensatory changes in population densities (Clare *et al.*, 2015).

Good Environmental Status cannot be defined exclusively as “pristine” status, but rather status when impacts of uses are sustainable; therefore, two conditions need to be met (Rice *et al.*, 2012):

- pressure does not hinder the ecosystem components to retain their natural diversity, productivity and dynamic ecological processes;
- recovery from perturbation, such that attributes lie within their range of historical natural variation, must be rapid and secure.

For Borja (2014), recovering ecosystem structure and functioning is a grand challenge; therefore, studies are needed for a deeper knowledge of recovery processes (Borja *et al.*, 2010), and for promoting ecological restoration to repair damaged ecosystems.

Restoration

Few studies provide evidence of how ecological knowledge might enhance restoration success (Cooper, 2011b, 2012), as well as any possible modes of intervention to remedy any critical damage caused (Collins and Mallinson, 2007; de Jong *et al.*, 2014, 2016).

Effects mostly occur only in short-term and at local scale, the organism group(s) selected to assess recovery does not always provide the most appropriate response, the time lags of recovery are highly variable, and most restoration projects incorporate restoration of abiotic conditions and do not include abiotic extremes and biological processes. Restoration ecology is just emerging as a field in aquatic ecology and is a site, time and organism group-specific activity. It is therefore difficult to generalise. Despite the many studies only few provide evidence of how ecological knowledge might enhance restoration success (Verdonschot *et al.*, 2012).

Conclusion

With respect to descriptor (6) WGEXT recognises that direct changes to the function and structure of ecosystems, particularly physical parameters, will occur as a result of the extraction of marine sediments. The exploitation of marine aggregates should preferably take place in naturally unstable bottoms (coarse sand dunes), where benthic communities are poor (<5 g/m^2), adapted to regular bottom disturbance, and able to rapidly recolonize exploited sites (Cooper *et al.*, 2005).

However, the group are content that in the context of appropriate consent regimes which provide for rigorous environmental assessment and evaluation of each proposal to extract sediment, these impacts may be considered to be within environmentally acceptable limits and therefore not adverse (Cooper *et al.*, 2011a).

WGEXT suggest that in defining “adverse” it should be accepted that direct changes to the physical structure of the seabed will result from the extraction of marine sediments. Defining “adverse” as being no environmental change from existing (pre-dredge) conditions would, in the opinion of the group, be inappropriate and detrimental to the continued ability of member countries to extract marine sediments from their seabed.

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Descriptor 7: Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems.

Changes in seabed morphology and associated hydrodynamic effects have the potential to **affect adjacent coastlines** (Kortekaas *et al.,* 2010). If dredging is undertaken within the area of sediment movement known as the 'active beach profile' then material can become trapped within depressions caused by dredging, preventing it from moving back onshore during calmer conditions (Brampton and Evans, 1998).

In the North Sea, **below the 25 m depth contour, no impacts were observed** on wave regime, sediment transport or stability of the coastline. Further onshore, the removal of sediment during marine aggregate extraction may impact sediment transport pathways that replenish the coastline.

In southern Portugal, sand was dredged on the continental shelf for beach nourishment and a research project (SANDEX) accompanied its physical effect on the seabed and coastline. Around 370 000 m^3 of sand were extracted leaving a sandpit with approximately a rectangular shape with 900 m length and 150 m width, located 4000 m away from the shore at depths between 15–20 m, with average depth of the excavation around 5 m (Gonçalves *et al.*, 2014). Numerical modelling showed that the tidal flow and the orbital wave velocities within the pit and neighbouring areas were modified by the presence of the pit. The excavation influenced the tidal flow in an area of approximately 3000 * 3000 m^2 around it. In that area the maximum velocity increase was 2%, occurring in the nearby surroundings of the pit, and the maximum decrease was 16%, in the pit deepest zone. The orbital velocities for the storm wave conditions showed a decrease of 15% within the pit and its influence extended up to the 4 m contour, not reaching the shore (Lopes *et al.*, 2009). Bathymetric analysis between May 2006 and November 2008 showed an accretion of sediments of around 60,000m^3 which would put the recovery time of excavation to a value about 24 years, very similar to modelling results. Phillips (2008) investigated South Wales areas where critical beach loss has been associated with dredging activities; five years of beach monitoring did not find a qualitative or quantitative link between marine aggregate dredging and beach erosion; natural changes, such as changing wind direction and increased easterly storms were most significant in affecting beach formation processes.

The removal of a significant thickness of sediment results in a localised drop in current strength associated with the increase in water depth. This reduced strength of the bottom current can cause the **deposition of fine sediments** within the dredged depressions from overflow discharges (Duclos *et al.*, 2013; Krause *et al.*, 2010) or from natural sediment transport (Desprez, 2000; Cooper *et al.*, 2007 and Le Bot *et al.*, 2010). For the seaward harbour extension of the Port of Rotterdam, large-scale sand extractions down to 20m below the seabed, generated a strong increase of the fraction of fine muddy sands in the troughs and deepest areas of the extraction site (de Jong *et al.*, 2014)... no information on effects on current pattern.

No infilling neither biological recovery of the deepest part of the experimental CNEXO site due to a strong increase of current velocities.

Conclusion

In general and in relative terms, the dimensions of dredged pits are so small that the deepened area has little influence on the macroscale current pattern. Furthermore, it was concluded that, in most cases, the current pattern would only be changed in the direct vicinity of the dredged area.

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Descriptor 11: Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment

The attention to underwater sound in relation to dredging and sediment extraction is increasing during the last years, as sound is utilized by many marine organisms to sense the environment around them and find prey. Consequently, an increase in anthropogenic low-frequency noise, such as that produced by dredging (Dreschler *et al.*, 2009; Robinson *et al.*, 2011), has the potential to cause adverse effects.

The value of 200 kHz for sonar sources is an accepted threshold (D 11.2).

The extent to which effects disseminate through the foodweb to marine mammals is unknown, but speculated effects are given, based on available data.

Extensive variability exists between hearing sensitivity of **fish** species, but in general, they are sensitive to low frequencies (Popper and Fay, 2011), which puts them at risk from dredging noise. No study has looked at dredging noise specifically, but avoidance of low-frequency vessel noise by some fish species has been reported (de Robertis and Handegard, 2013) and Handegard *et al.*, (2003) noted vertical and horizontal avoidance by cod (*Gadus morhua*) of a bottom-trawling vessel. Dredging noise is unlikely to result in direct mortality, or permanent hearing damage of fish, but long-term exposure could theoretically affect fitness of some individuals.

Responses to particle motion of low-frequency sound have also been recorded in **cephalopods** (Mooney *et al.*, 2010), which can form an important part of the diet of some marine mammals. Low-frequency noise in the 1 Hz–10 kHz band altered cephalopod breathing rhythms and movement.

Dredging has the potential to impact marine **mammals**, but effects are species and location-specific, varying also with dredging equipment type. In general, evidence suggests that if management procedures are implemented, effects are most likely to be masking and short-term behavioural alterations and changes to prey availability (Todd *et al.*, 2015). Exclusion of prey from foraging areas has potential to impact marine mammals negatively, but extent to which this occurs depends on the significance of the feeding ground, ability to switch prey species, and availability of alternative foraging areas. The level of effect is therefore species- and context-dependent.

The **sound level** radiated by a dredger undertaking full dredging activities is in line with the one expected for a cargo shipping travelling at moderate speed (de Robertis and Handegard, 2013; Robinson *et al.*, 2011).

However, extracting gravel does cause additional noise impact (Dreschler *et al.*, 2009; Robinson *et al.*, 2011). In the UK, underwater noise from aggregate extraction has been largely discounted as a significant impact. Similarly, in the Netherlands, the noise levels from dredgers were not in the top seven major underwater sound sources (Ainslie *et al.*, 2009).

During the reclamation works for the enlargement of the harbour of Rotterdam, a monitoring program on underwater sound measured the noise from a large range of trailer suction hopper dredgers (in power and in volume, 2000 to 22000 m^3); for all frequencies, the noise of dredging and dumping was less than the noise of transit (Heinis, 2013).

Conclusion

With respect to this descriptor, WGEXT recognises that extraction of marine sediment does generate underwater noise; however, aggregate extraction is only contributing to the noise of shipping and introduces no negative effects from the extraction itself.

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GENERAL CONCLUSION (personal suggestions to discuss within WGEXT members)

A method for assessing the vulnerability of marine ecosystems to various anthropogenic threats by impact categories has been proposed by Halpern *et al.*, (2008); by decreasing order of perturbation, invasive species, pollution, management, toxic blooms, demersal fisheries and the phenomena of hypoxia have a higher impact than extraction of marine aggregates (both in terms of spatial and temporal scales ?).

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Assessments should take account of the 2003 "ICES Guidelines for the Management of Marine Sediment Extraction", as adopted by OSPAR, which provide for the adoption of appropriate extraction site locations, and implementation of mitigation and monitoring programmes:

- encouraging an ecosystem approach to the management of extraction activities and the identification of areas suitable for extraction.
- protecting sensitive areas and important habitats (such as marine conservation areas) and industries (including fisheries), and the interests of other legitimate uses of the sea.
- ensuring that methods of extraction minimize the adverse effects on the environment and preserve the overall quality of the environment once extraction has ceased.

Concluding questions :

- what kind of monitoring to detect impacts (parameters, indicators…) ?

Monitoring programs (effort and quality) have to provide sufficient information to allow a confident assessment of GES (van Hoey *et al.*, 2010).

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- what type of extraction strategy for a sustainable use minimizing impacts and promoting recovery (including Building with nature ?) ?

To enable sustainable use of marine resources (Birchenough *et al.*, 2010), there is a clear need for enforcing management measures such as:

- seasonal closures for specific areas (i.e. during recruitment seasons),
- rotation of dredging intensity to allow recolonisation and recovery of macrobenthos,
- prevention of screening
- exploratory restoration techniques in areas where the seabed has been impoverished as a result of extraction activities.

In a local context, controlling the area and intensity of dredging and allowing undisturbed deposits to act as refuges between dredged furrows may be an effective measure for enhancing the rehabilitation of the seabed. There may also be environmental benefits from rotating dredging operations across different zones and leaving "fallow" areas to rehabilitate for several years before reworking. Future case studies are needed on the consequences of marine aggregate extraction on marine biota over sufficiently long time-scales to underpin the derivation of reliable and scientifically credible models (Barry *et al.*, 2010).

Barry, J., Boyd, S., and Fryer, R 2010. Modelling the effects of marine aggregate extraction on benthic assemblages. Journal of the Marine Biological Association of U.K., 90: 15–114.

Studies are needed for a deeper knowledge of recovery processes in structure and function through time and for promoting ecological restoration to repair damaged ecosystems (Borja *et al.*, 2010).

Restoration or Building with Nature (de Jong *et al.*, 2015).

- what else ?

The European Marine Strategy Framework Directive aims at good environmental status (GES) in marine waters, following an ecosystem-based approach, focused on 11 descriptors related to ecosystem features, human drivers and pressures. Furthermore, 29 subordinate criteria and 56 attributes are detailed in an EU Commission Decision. The analysis of the Decision and the associated operational indicators revealed ambiguity in the use of terms, such as indicator, impact and habitat and considerable overlap of indicators assigned to various descriptors and criteria. We suggest re-arrangement and elimination of redundant criteria and attributes avoiding double counting in the subsequent indicator synthesis, a clear distinction between pressure and state descriptors and addition of criteria on ecosystem services and functioning (Berg *et al.*, 2015).

Berg, T., Furhaupter, K., Teixeira, H, Laura Uusitalo, L., and Zampoukas, N. 2015. The Marine Strategy Framework Directive and the ecosystem-based approach – pitfalls and solutions. Marine Pollution Bulletin, 96 : 18–28.

But also consider that the geographical scale at which the MSFD operates is much larger than single project assessments. As extraction activity is often taking place in a relative small area and often only for a limited amount of time, the spatial and temporal components of the activity and related pressures and impact are limited = Conclusion générale

Concluding suggestion:

Table summarizing WGEXT results in the 3d column.

Effects of aggregate extraction:	**Impact on:**	**Level of contribution of WGEXT ??? to MSFD descriptors:**
Seabed removal	Topography/Bathymetry	(D1), D6, D7
	Sediment composition	D1, (D3), D6
	Habitat & biological communities	D1, (D3), D4, D6
Sediment plumes	Turbidity Deposition	D3, D4 D1, D3, D4, D6
Ship activities	Underwater noise	D11

gaps in knowledge

D 1: requirement of high-resolution maps of habitat types (Woods *et al.*, 2016)

Limitation of taxonomic coverage (Woods *et al.*, 2016)

D 3: mapping of spawning areas

D 4.2: proportion of selected species at the top of food webs

D 431: abundance/distribution of groups with fast turnover

Lack of primary production indicators.

D 6.2: size composition of a community reflected by the proportion of small and large individuals

D 6.2.3: proportion of biomass or number of individuals in the macrobenthos above some specified length/size

D 6.2.4: parameters describing the characteristics of the size spectrum of the benthic community

D 7: "Permanent" alterations of hydrographical conditions

Monitoring & compliance with MSFD (cf Shepard *et al.*, 2015)

20. Synthesis and future course of monitoring marine sand extraction in The Netherlands

Proceedings EMSAGG 2015 Conference: Marine sand and gravel – finding common grounds, 4–5 June, Delft, The Netherlands.

Synthesis and future course of monitoring marine sand extraction in the Netherlands

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Abstract

During the last decade very thorough monitoring is carried out on the effects of marine sand extraction in the Netherlands. Both on a regular scale as on large-scale extractions. Now is the time to synthesize the results of these monitorings and to set the course to the future.

The monitoring of regular (ca. 25 million cubic meters per year) and larger scale extraction (till 200 million cubic meters for a project) is focused on ecological and morphological effects and the effects on other uses of the sea area.

Several issues are monitored during the last decade, both by field measurements and by additional modelling. The most pronouncing are: effect on the distribution of suspended matter in the water column, including the effect on the benthic fauna, the recolonization of benthic fauna, the effect of underwater sound of dredgers on marine mammals, the effects of changes of morphology of a sand extraction pit.

Although the monitoring programs are different in their aim and approach there is a remarkable similarity in the results. The main overall conclusion is that marine sand extraction, at least in this environment, is less harmful for the ecosystem than expected in our worst case approach.

Sand extraction in the Netherlands

Since the 1970s marine sand is used in the Netherlands for coastal nourishment and for use on land, mostly as landfill. In the 70s and 80s the amounts were still small, about 3 million m3 per year, but from the late 80s onward the amounts were increasing, due to policy decisions. By lowering the price for marine sand compared to sand from land based sources, the government stimulate the use of marine sand in the western provinces. Also new policy on coastal protection was formulated in which the safeguarding of the coastline of 1990 was secured. This leads to an increase in coastal nourishment. Both decisions lead to a gradually increase in the regular extraction of marine sand till about 25 million m3 per year in the years around 2000 (Figure1).

The policy on extraction of marine sand was formulated in the Regional Extraction Plan for the North Sea, first in 1993 and updated in 2004. The most striking decision was the exclusion of the coastal zone shallower than 20 meter from sand extraction. This was decided to prevent negative effects on the coastal ecology and on the coastal defense against erosion.

Initial the maximum extraction depth was fixed on 2 meter below sea bed, but as the volumes increase the allowed maximum depth was increased to prevent the disturbance of a large area. The maximum depth for extractions must be derived from EIA studies. In extreme cases the maximum depth can be rather deep. For the enlargement of the harbor off Rotterdam (Maasvlakte 2) a maximum depth of 20 m below sea bed was allowed in a water depth of 23 meter.

In the National Water Plan the area between the established -20 m NAP depth contour and the 12 miles boundary is designated as the zone where sand extraction has priority above other uses of the sea (Anonymous, 2009).

In recent years the extracted amount of sand was very much increased by large projects like the Sand Engine (21,5 million m^3), the Hondsbossche- and Pettemer Sea Defense (35 million m^3) and Maasvlakte 2 (213 million m^3).

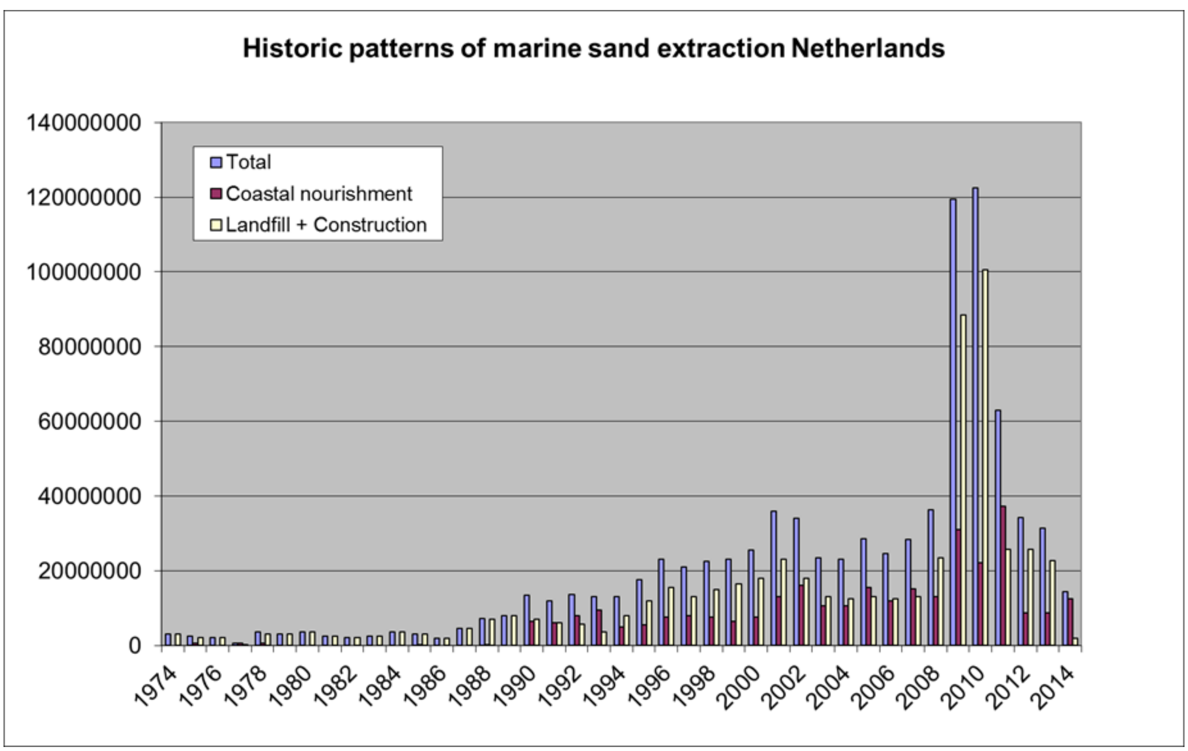

Figure1. Marine sand extraction in the Netherlands.

Resource monitoring

Through the years resource mapping is executed by Rijkswaterstaat and the Geological Survey of the Netherlands. In the years that extraction was restricted to 2 meter below the sea bed the whole area was mapped for the first 2 meters. Recently a marine sand information model has been developed by the Geological Survey and TNO to be able to calculate the amounts of sand available in the area designated for sand extraction. In this model several qualities of the sand are incorporated, like grainsize, silt content, shell content. Also it is possible to define a lower limit by a maximum silt content or a clay layer of a certain thickness (Maljers *et al.*, 2014). The whole area is divided in grids of 250 by 250 m and 0.5 m thick. This is a very useful method for resource managing (Figure2).

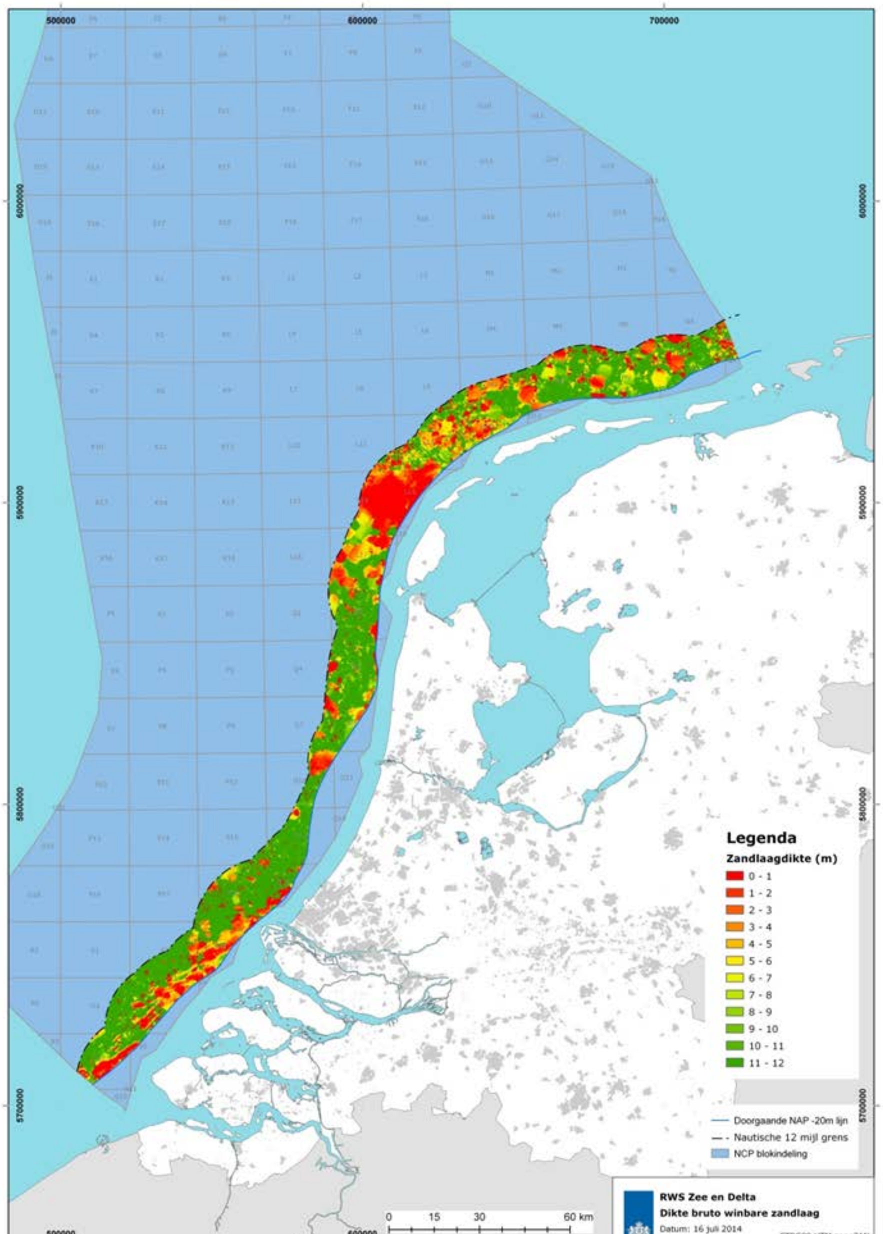

Figure 2. Sand extraction zone and thickness available sand layers (Maljers *et al.* 2014).

Compliance monitoring

Before the extraction a bathymetric survey must be executed to define the start situation of the area to be extracted. This is mostly combined with a side scan sonar study for the report on cultural and archeological values that has to be made before extraction can take place.

After the planned volume is taken out and the area is closed for extraction again bathymetric survey is done.

For large or special projects additional compliance monitoring can be obliged. For the large scale and deep extraction for Maasvlakte 2 is was prescribed in the license that the slopes must be between 1:10 and 1:7 and that no coarse sand should be used for fill. During the extraction the grainsize was measured for every shipload. During the extraction mostly every month the bathymetry of the pit was measured. After the extraction the slopes of the pit were calculated (Figure 3).

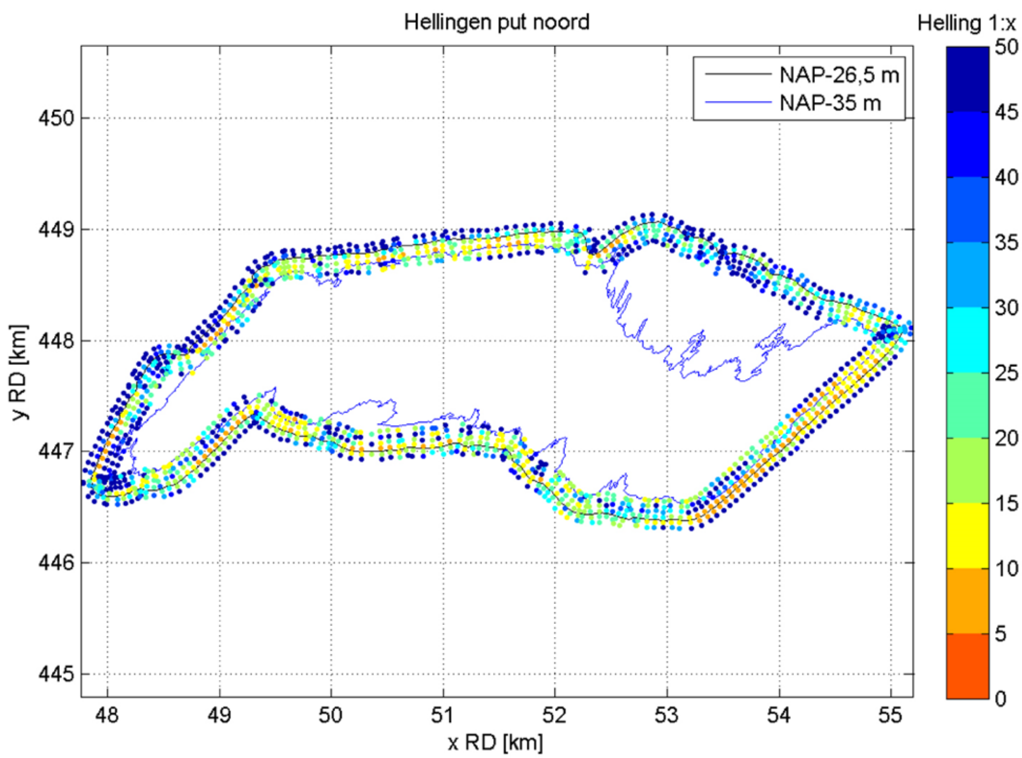

Figure 3. Slopes of sand extraction pit Maasvlakte 2 (Klein and Van den Boomgaard, 2013).

Effect monitoring

When the amounts of extraction increased and the need for large scale and deep extraction became serious, the concern about the effects on the environment increased as well.

The main concerns were on the effects of increased amount of suspended matter, on the coastal erosion, on recolonization of the benthic fauna and on under water noise .

Both for the regular extraction for coastal nourishment and landfill/construction as for the large scale and deep extraction for Maasvlakte 2 extensive monitoring programs were executed on the base of the license and EIA.

This monitoring programs were focused on morphological and ecological effects of the extraction.

For the regular extraction research was done on the effects of suspended matter on the benthos and fish catching birds, on recolonization of the benthos and on the impact of physical disturbance on seals. The general conclusion is that on these aspects there are no negative effects with the present day amounts and way of sand extraction (Rozemeijer *et al.*, 2013).

For Maasvlakte 2 there was, among other items, monitoring and research on:

morphological behavior of the pit and it influence on currents and waves; the increase of suspended matter and the influence on benthic fauna outside the pit; the recolonization of benthic fauna within the pit; under water noise and the effect on marine mammals.

A main point of concern was the increase of suspended matter in the Nature2000 area 'Voordelta' southeast of the sand extraction pit. Measurements, both satellite- and shipborn, are used to model the suspended matter in the Dutch coastal area. The increase in the N2000 area was far beyond the worst case scenario in the EIA (Blaas *et al.*, 2014).

The recolonization monitoring is just started after the ending of the extraction. Results are expected in the coming years.

The effect of the pit on waves and currents is minimal, as expected. The modelling of the morphological behavior show a larger effect of enlarging by levelling of slopes than expected (Klein and Van den Boomgaard, 2013). The bathymetry will be measured in the future on a regular basis.

An interesting result was from the monitoring of the underwater sound. Monitoring the noise from a large range of trailer suction hopper dredgers (in volume and power) showed that for all frequencies the noise of dredging and dumping was less than the noise of transit (Figure 4). The conclusion is that, at least in these area and circumstances, sand extraction is contributing to the noise of shipping , but introduces no negative effects from the extraction itself.

Both monitoring programs have led to an important improvement of the models on the transport and behavior of suspended matter.

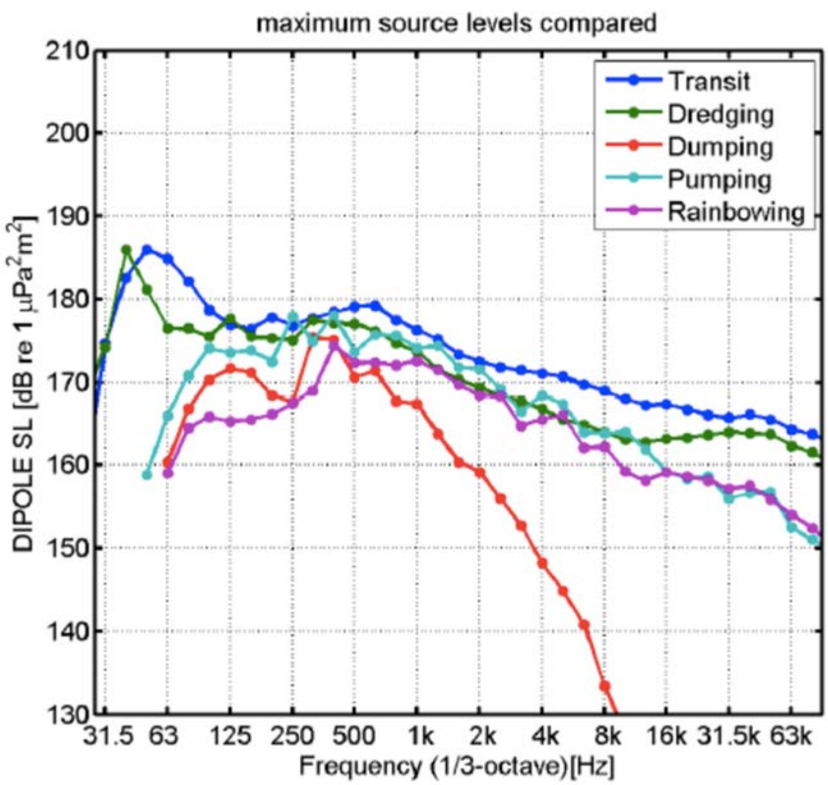

Figure 4. Underwater sound sand extraction Maasvlakte 2 (Heinis, 2013).

Future monitoring

From the results of both monitoring programs it is clear that some aspects do not need further monitoring when the extraction continues on the present scale. It has to be decided if a much larger scale of extraction, both in locations and intensity, will give the need for monitoring these aspects again. Cumulative effects of sand extraction and other use is still an item that needs further research. Close to N2000 areas it is important to extract in areas that have a low content of mud.

Although the monitoring programs are originate from the EIA and the license and were executed on behalf of the organization who ordered the extraction, a tendency towards a more combined monitoring is already is started. The extractors for commercial landfill or construction sand are united in an organization named LaMER. The governmental Rijkswaterstaat is responsible for the sand extraction for coastal nourishment. Both organizations together finance and execute the monitoring for the regular sand extraction. New initiatives like the Sand Engine (21,5 million m³) and the Hondsbossche and Pettemer Sea Defense (35 million m³) are welcomed to join this monitoring program by financial support instead of execute their own monitoring. The reason for this is that the exiting monitoring programs in the Dutch sand extraction area can be improved and that duplicates can be avoided.

Initiatives are taken for a change in the regulation of the monitoring of the ecological and morphological effects of marine sand extraction. The monitoring of the future will be focused on the (few) general questions that are not answered yet, on specific local conditions, on the possibility of a large increase in sand extraction due to sea level rise and on requirements from the Marine Strategy Framework Directive.

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