CSA OCEANS 2
JPI Oceans support action

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Support to the JPIO action Munitions in the Sea
Report from Oslo and Rome workshops
The way forward

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- PU = Public

CONTENTS

RATIONALE AND OBJECTIVES

Ammunition dumped at sea during or after wars constitutes an environmental and safety issue in many European countries. Chemical and conventional ammunition from World War I and II are corroding, and the risks of spontaneous detonations, or leakage of toxic compounds, are increasing. The whereabouts and condition of the dumped munition is still unknown. At the same time, there is increasing pressure to use coastal areas for recreational, residential and industrial purposes. This leads to increasing challenges with societal and environmental risks.

In 2015, JPI Oceans has initiated a joint action on "Munition in the sea" to facilitate research coordination and exchange of knowledge across European countries. Twelve EU countries joined the action.

The action mainly addresses the scientific and technological aspects that can contribute to provide solutions at EU level, including sharing experiences and the involvement of the relevant stakeholders in the process.

The end-users priorities and national offers have first been reviewed in order to estimate the feasibility and impact of joint activities. In October 2017, an implementation plan for the 2018 activities was agreed. This plan included the development of **two workshops**.

The first workshop, held in Oslo in June 2018 and organized by RCN and FFI, was designed as a simulated scenario, in order to identify the practices and gaps to be filled. Despite that workshop was framed within the scenario of tackling the challenges of unexploded ordnances in areas where pipelines and cables are planned to be installed, the outputs can be considered more general for the aspects of risk assessments, remediation options and spatial planning.

The second workshop, held in Rome in December 2018 and organized by CNR, was based on the outputs of the Oslo workshop and addressed some major aspects where research can bring substantial contributions for solutions or advances in knowledge.

In such a way, the two workshops were closely linked and the outputs of the last can be considered as the joint results of the process towards the identification of future activities where JPI Oceans can add value.

Both workshops received a financial contribution from CSA Oceans 2, and brought together researchers, regulators/authorities, industry, and EOD-operators.

ROME WORKSHOP STRUCTURE AND OUTPUTS

The workshop has addressed four main aspects:

- A - Knowledge-based support to decisions
- B - Large scale identification of objects
- C - Chemicals sensing and remediation
- D - Cost efficient explosions' remediation

The first day four keynote speeches and four parallel sessions have been developed for debating how available scientific results or advances in knowledge can impact on solutions. A session in the second day analysed and elaborated on future steps to be proposed to the JPI Oceans Management Board for evaluation and adoption.

In the following, very brief summaries of the outputs from the parallel sessions. In italic the outputs addressed as "more feasible" activities in a short-term timescale.

A- KNOWLEDGE-BASED SUPPORT TO DECISIONS/PLANNING INTERVENTIONS

A1) The use of info maps is crucial for supporting decisions. Often, data are difficult to access and their acquisition and release are a national responsibility. *A joint protocol and standards should be agreed and proposed.*

A2) A categorization of risks is proposed (as for humans, environment, industrial activities). This can result in addressing the priorities, timescales and risk perceptions. A map designed for easy interpretation is appropriate.

A3) The risk assessment has to be supported by an option assessment, identifying what interventions can be adopted, their consequences, with the aid of services/tools aimed at facilitating simulation and decisions.

A4) *A light document/position paper for increasing the decision-makers' attention* is needed.

A5) *Annual meetings* for sharing non-public information and practices are needed.

B- LARGE SCALE IDENTIFICATION OF OBJECTS

B1) Despite technologies exist, false positives increase costs. Algorithms need to be improved by feeding with data. A bridge between governmental authorities and industry and research, can be provided by a neutral "third party" that can provide a 1-stop/platform for info-data and algorithms is needed. *Possible candidates for this neutral party should be scouted* (EMSA? DG MARE? Other?).

B2) *Specifications and format for useful data* coming from different instruments and environments is the first step to identify the owners of the data and a win-win framework for data sharing. Neutralization of sensitive data can be supported and local aspects to be evaluated.

B3) Experiments can be performed in *some infrastructures that can be provided for open access.*

C- CHEMICAL SENSING AND REMEDIATION/IMPACTS

C1) Detection, degradation, transportation/diffusion of chemicals in the water system, are all aspects that need drastic improvement in sensing, simulation and reporting.

C2) The effects on the environment and humans (mainly via the food web) are poorly investigated at large scales, resulting in a lack of robust risk assessments.

C3) The risk assessments have to be provided not only in a situation at rest but also predicted in case of interventions, in order to allow evaluation of impacts within the option assessments.

D- COST EFFICIENT EXPLOSIONS'REMEDIATION

D1) *A toolbox for options for explosions' remediation* is useful and can be built on experiences to be shared. A first step would be *listing and evaluating options, including pros/cons, situations and sources.*

D2) Theoretical work is needed to investigate different options (including those addressing other mitigation measures than bubble curtains), with experimental validations that should monitor noise/shock waves and also the chemical impacts. *Some infrastructures can be provided for open access to experiments*.

REFLECTIONS

When in 2015 the Munition in the Sea action was launched, it aimed at supporting solutions to the challenge with contributions from a joint effort at EU level in research and technology. It was mainly focused at addressing the ultimate goal of safety of citizen and operators, and the process first attracted the competencies involved in those territories who are facing directly the possible impacts of Munitions in the Sea.

Despite this "perceived" limited territorial challenge, such a challenge has involved the **scientific community, industry, authorities and civil society** in a very complex process addressing a diversity of aspects also in terms of **legislation, planning, knowledge-based support to decisions and much wider environmental aspects**.

Munitions in the Sea involves diverse and interconnected aspects: awareness of huge amount of polluting chemical compounds (their impacts on environment and human health, their propagation through such a diffusive medium as the sea), social perception of the alarm, management of risk and related interventions, identification of options (e.g. remediation and mitigation), increased human activities at sea. In few words, what was initiated in past decades as the short-term response to an **emergency** to be concentrated in some areas is now facing one of the most **complex long-term challenges at EU level**, where risk/option assessments, in its meaning of knowledge-based support to decisions, is advocating as an example **MSFD and MSP** too.

The outputs of the workshops have therefore to be interpreted as a truly request for urgent intervention at EU level, where the aspects of Munitions in the Sea can be considered as one of the most comprehensive examples of multi-agent interventions.

In this context, a proposal to **frame the future activities** in a structure that can enable the emergence of an effective support to tackle this challenges has been proposed. **This proposal can be considered a starting frame to structure the thematic lines of activity and their links, which should also include the main conclusions of the workshops.** In order to be efficient and allow many countries to participate with their own capacity, the **appropriate instruments** (sharing data and/or infrastructures, experts' time for preparatory documents or specific services, call, workshops, knowledge hubs, web interfaces etc.) have to be identified within each thematic line (which in the annex are refereed as work package), addressing the **EU added value, the estimate of the needed and offered efforts, the risks for the implementation and the foreseen timescales** for the products to be delivered.

THE WAY FORWARD

The outputs of the two workshops have been presented to the JPIO Seminar and Management Board (MB) meeting held in Brussels respectively on 17 and 18 January 2019.

MB asked experts to prepare a final "operational" proposal of join activities, specifying which funding instruments are considered appropriate, in order to evaluate the commitments.

LIST OF ANNEXES

1 - Programme of the Rome workshop

2 - List and pic of participants to the Rome workshop

3 - Extract of the Oslo workshop's report

ANNEX 1 – PROGRAMME OF THE ROME WORKSHOP

The scientific support to Munition in the Sea
December 6-7, 2018
National Research Council of Italy, Institute of Marine Engineering (CNR-INM)
Via di Vallerano 139, 00128 Rome, Italy

FIRST DAY 9:30 – 17:00

09:00 – 09:30	Registration of the participants

09:30 – 10:30	**Opening**

Welcome (Daniele Ranocchia, CNR-INM Acting Director)
Munition in the Sea in a nutshell
Emilio F. Campana, JPI Oceans MB, CNR, Italy
Rationale and aims of the workshop
Pier Francesco Moretti, JPI Oceans Secretariat, CNR, Italy

10:30 – 10:45 Coffee break

10:45 – 13:00	**Keynotes**

Support to decisions: the agent-based modeling
Amedeo Cesta, CNR-ISTC, Rome, Italy
Chemicals sensing and remediation: the state of the art
Claus Böttcher, Ministry of Energy, Agriculture, the Environment, Nature, Digitisation, Kiel, Germany
Explosions' remediation: accounting for cost efficiency and nature conservation needs
Sven Koschinski, Meereszoologie, Nehmten, Germany
Classification of objects: algorithms from other sectors and relevant information for artificial intelligence
Kristine Bauer, Fraunhofer IGD, Rostock, Germany

13:00 – 14:00 Light Lunch

14:00 – 17:00	**Parallel sessions:** planning of interventions, chemical remediation, explosions' remediation, classification via autonomous vehicles

Discussion between experts and draft proposals for action

SECOND DAY 9:30 – 13:00

09:30 – 13:00	**Support to policy and knowledge-based solutions**

Report from the four parallel sessions (presented by the Rapporteur of each parallel session)
The cross-cutting issues with MSP and MSFD
Maurizio Ribera d'Alcalà, Stazione Zoologica Anton Dohrn, Naples, Italy

11:00 – 11:30 Coffee break

Feedbacks from the Management Board
Open Discussion (Moderator: Pier Francesco Moretti)
Workshop wrap-up (Pier Francesco Moretti)

13:00 – 14:00 Light Lunch

OPTIONAL

14:00 – 15:30	**Tour to INM Facilities and Labs**

ANNEX 2 – LIST AND PIC OF PARTICIPANTS TO THE ROME WORKSHOP

Name	Institution
Eric Achterberg	GEOMAR Helmholtz Centre For Ocean Research, Kiel, Germany
Kristine Bauer	Fraunhofer Institute for Computer Graphics Research (IGD), Rostock, Germany
Aaron Beck	GEOMAR Helmholtz Centre For Ocean Research, Kiel, Germany
Jacek Beldowski	Institute of Oceanology PAS, Sopot, Poland
Sander von Benda-Beckmann	Netherlands Institute for Applied Scientific Research (TNO), The Hague, Netherlands
Claus Böttcher	Ministry of Energy, Agriculture, the Environment, Nature and Digitalization, Kiel, Germany
Emilio F. Campana	JPI Oceans MB / National Research Council of Italy (CNR) Rome, Italy
Sandro Carniel	National Research Council of Italy , CNR-ISMAR, Venice, Italy
Amedeo Cesta	National Research Council of Italy, CNR-ISTC, Rome, Italy
Elena Ciappi	National Research Council of Italy, Institute of Marine Engineering (CNR-INM), Rome, Italy
Enrico De Bernardis	National Research Council of Italy, Institute of Marine Engineering (CNR-INM), Rome, Italy
Matteo Diez	National Research Council of Italy, Institute of Marine Engineering (CNR-INM), Rome, Italy
António Sérgio Ferreira	Laboratorio de Sistemas e Tecnologia Subaquática, Porto, Portugal
Peter Frost	NKT HVC, Rotterdam, Netherlands
Mareike Kampmeier	GEOMAR Helmholtz Centre For Ocean Research , Kiel, Germany
Endre Grimsbø	Institute of Marine Research, Bergen, Norway
Roberta Ivaldi	Italian Navy, Genova, Italy
Sven Koschinski	Meereszoologie, Nehmten, Germany
Anastasios Lekkas	Norwegian Institute of Science and Technology, Trondheim, Norway
Cecilia Leotardi	National Research Council of Italy, Institute of Marine Engineering (CNR-INM), Rome, Italy
Claudio Lugni	National Research Council of Italy, Institute of Marine Engineering (CNR-INM), Rome, Italy
Edmund Maser	Institute of Toxicology and Pharmacology, Kiel, Germany
Peter Menzel	University of Rostock, Rostock, Germany
Tine Missiaen	VLIZ – Flanders Marine Institute, Ostende, Belgium
Giovanni Modugno	Italian Navy, La Spezia, Italy
Pier Francesco Moretti	JPI Oceans Secretariat /CNR, Brussels, Belgium
Paul Müller	Fraunhofer Institute for Chemical Technology, Pfinztal, Germany
Stefano Pacchierotti	Italian Navy, Rome, Italy
Daniele Ranocchia	National Research Council of Italy, Institute of Marine Engineering (CNR-INM), Rome, Italy
Svend Otto Remøe	Research Council of Norway, Lysaker, Norway
Maurizio Ribera d'Alcalà	Stazione Zoologica Anton Dohrn, Naples, Italy
Helle Kristin Rossland	Norwegian Defence Research Establishment, Kjeller, Norway
Inger Oline Røsvik	Research Council of Norway, Lysaker, Norway

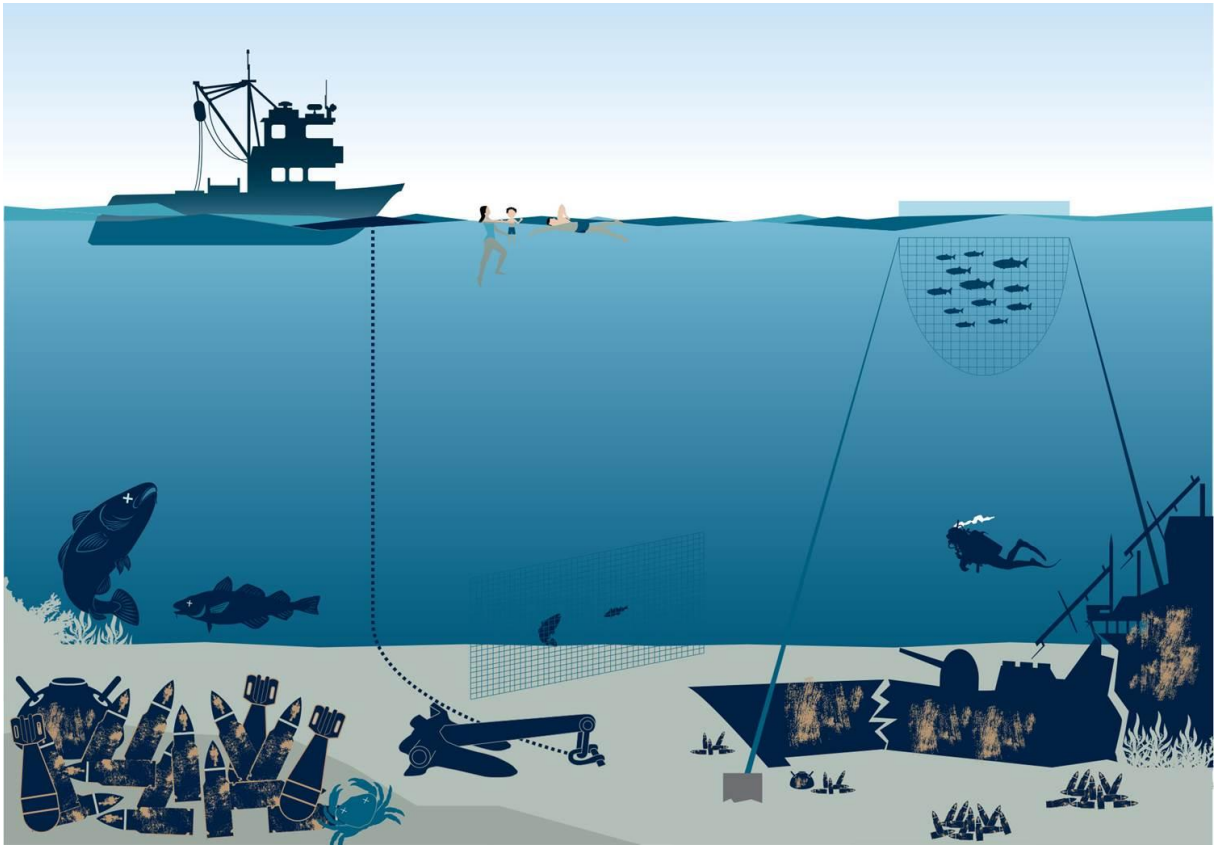
Name	Institution
Frank Seubering	Heinrich Hirdes EOD Service GmbH, Hamburg, Germany
Jens Sternheim	Ministry of Energy, Agriculture, the Environment, Nature and Digitalization, Kiel, Germany
Jennifer Strehse	Institute of Toxicology and Pharmacology, Kiel, Germany
Janis Thal	Geo-Engineering.org GmbH, Bremen, Germany
Jann Wendt	EGEOS GmbH, Kiel, Germany
Armin Keßler	Fraunhofer Institute for Chemical Technology, Pfinztal, Germany
Daniele Dessi	National Research Council of Italy, Institute of Marine Engineering (CNR-INM), Rome, Italy

ANNEX 3 – EXTRACT OF THE OSLO REPORT

Munitions in the Sea – Report from Scenario workshop

June 6-8, 2018

Oslo, Norway



Dumped munition and war remnants constitute a threat to the environment and to society. Illustration FFI

JPI Oceans initiated a joint action on "Munitions in the sea" in 2015, to facilitate research coordination and exchange of knowledge across European countries. The workshop was arranged as part of this initiative, to bring together researchers, regulators/authorities, industry, and operational EOD-operators to discuss new technology and best practice. The objective was to exchange information and establish good practice recommendations on technology, risk assessment, and procedures regarding munitions in the sea. It was further an objective to identify knowledge gaps and prioritize which gaps are the most important or urgent to close. Totally the workshop was attended by 55 participants from eight countries. List of participants is enclosed in annex I.

The workshop was held at the premises of the Research Council of Norway (https://www.forskningsradet.no) in Oslo. It was jointly organized by the Research Council of Norway and the Norwegian Defence Research Establishment (FFI).

The workshop was supported by the CSA Oceans 2 project which has received funding from the European Union's Horizon 2020 research and innovation program.

WORKSHOP STRUCTURE:

To bring up relevant issues the workshop was organized around a specific scenario: *A pipeline or cable will be put on the sea floor from the coast and across the seabed. Because of the bottom topography, the trajectory had to pass through a known dump site for ammunition. In other areas, the risk of encountering explosive war remnants was not known. The depth ranged from 10-50 m close to the coast to several hundred meters at high sea. The bottom sediment was partly soft and partly hard.*

The workshop was divided into the following working groups:

1. Management of munitions in the sea and organization of authority
2. Planning the cable trajectory - technologies for detection and classification
3. Environmental risk and human safety
4. Technologies for demolition/remediation

The first day was devoted to key presentations of selected themes to update the group on recent progress. The first part of the second day was filled with national presentations about management and challenges related to dumped munitions. This gave a common fundament for the workgroup sessions the rest of the second day. The last day was devoted to discussions about knowledge gaps, priorities and summing up. The workshop program is enclosed in annex II.

Fifty-five participants from 8 different European countries at the JPI-Ocean Munition workshop in Oslo in June 2018. Delegates included expert researchers, regulators/authorities, industry, and operational EOD-operators. Photo: Merete Rosenberg, RCN.

RESULTS FROM WORKING GROUPS

Power point presentations from each workshop is enclosed in annex III.

WORKING GROUP 1: MANAGEMENT OF MUNITIONS IN THE SEA AND ORGANIZATION OF AUTHORITY

This group had a somewhat different task than the other groups. Instead of focusing on knowledge and capability gaps, the group tried to capture differences in how the munition issue is managed in different European countries. The role of military and police authorities differ between countries, so also the role and private companies. Similarities and differences are captured in the table below.

Phase	Germany		Norway	Spain	Belgium
	Territorial waters	Exclusive economic zone			
Phase I: Desk top study, historical survey & environmental impact assessment	Execution: Consulting company	Execution: Consulting company	Execution: Consulting company/Governmental company	Execution: Consulting company	Execution: Consulting company Approval by: Environmental Impact assessment by MUMM (OD Nature/RBINS) together with advice for Minister/Secretary of State responsible for North Sea who gives final approval
Phase II: Survey & mapping	Execution: Survey Company Approval by: State bomb disposal team, (Federal Maritime and Hydrographic Agency)	Execution: Survey company Approval by: Federal Maritime and Hydrographic Agency, Authority for occupational Safety and Health	Execution: Norwegian Navy, Military & Civilian Research companies, Commercial Survey Companies Approval by: Norwegian Armed Forces, Coastal Administration, Harbour Authorities	Execution: Consulting company Approval by: Ministry of Development Verified/Controlled by: Ministry of Defence (UW Cultural Heritage, UXOS, Submarine obstructions) Ministry of Environment	Execution: Demander/Consulting company
Phase III: Risk mitigation plan & site investigation	Execution: EOD service company, State bomb disposal team Approval by: State bomb disposal team	Execution: EOD service company Approval by: Authority for occupational Safety and Health	Execution: Naval EOD, EOD service Companies Approval by: Coastal Administration	Execution: EOD authorized company Approval by: Ministry of Development Verified/Controlled by: Ministry of Defence	Execution: Demander/Consulting Company
Phase IV: Clearance & disposal	Execution: EOD service company, State bomb disposal team Supervision and approval by: State bomb disposal team, (Federal Maritime and Hydrographic Agency)	Execution: EOD service company Approval by: Federal Maritime and Hydrographic Agency, Authority for occupational Safety and Health	Execution: Military EOD Approval by: NJHQ & Police	Execution: EOD authorized company Approval by: Ministry of Defence	Execution: EOD Belgian Army/paid by demander

THE GROUP ALSO DISCUSSED HOW AN IDEAL MANAGEMENT OF MUNITIONS IN THE SEA COULD BE ORGANIZED, WHICH IS SHOWN IN THE NEXT TABLE.

Phase	Involved actors	Supporting structures

Framework conditions	• National authority (county director) with the following tasks:
	  • Enforcing national plan and regulation
	  • Defining standardized procedures (national guidance document)
	  • Approving agents for work on each Phase
		• National prioritization list
		• Regular site monitoring
		• Knowledge management

Phase I: Desk top study, historical survey & environmental impact assessment	Execution: Consulting company/governmental institution	• National database • National historical archive

Phase II: Survey & mapping	Execution:
	Survey company/governmental agency
	Approval by:
	National authority of some sort
		• Certification system including:
		  • Testing and proving ground
		  • Approved standard
		• Reporting system

Phase III: Risk mitigation plan & site investigation	Execution: EOD service company/governmental agency Approval by: National authority of some sort	
Phase IV: Clearance & disposal	Execution: EOD service company/governmental agency Approved by National authority of some sort	

WORKING GROUP 2: PLANNING THE CABLE TRAJECTORY - TECHNOLOGIES FOR DETECTION AND CLASSIFICATION

The next table presents the gaps identified by the working group 2 and commented in the plenary session.

Available technologies

The group first debated what technologies are available for finding dumped munitions in the sea. Detection of "objects" is radically different if on the sea-bottom surface or sub-sea. For surface investigation, many good sensing technologies exist and when integrated they can provide useful outputs. For buried objects, the available technologies are not ideal since spatial resolution/depth penetration should be increased.

For the interpretation of the outputs of the detection technologies, the recognition of the objects is still not automatic/accurate for large areas to be monitored. Analytical methods/algorithms need to be improved and scouted from other sectors. An improvement in the classification can result using Artificial Intelligence fed by different layers of information, but at the moment a lack of labelled data to train the algorithms is reported.

Prospects for new technologies/action

The experts identified as priorities which can introduce advances in tackling the challenge of detection buried unexploded ordnance:

- *Ultra-high-resolution 3D sub-bottom profilers*
- *Electromagnetic devices*.
- Miniaturization and reduction of costs has been also addressed as a relevant issue. This is also linked to the possibility of augmented *autonomous exploration via fusion of data and decision making by the vehicles, and adaptive mission planning*.
- For increasing the efficiency and effectiveness in detection/classification, *artificial intelligence can provide a breakthrough but needs appropriate (labelled) data input*.

Working Group 2: - Knowledge gaps

Interpretational technologies:

Analytical methods/algorithms need to be improved/scouted

- Algorithms combining different data layers (data fusion)
- Lack of labelled data to train detection/classification algorithms

Methods to detect buried UXO:

Existing technologies not ideal, *low resolution low coverage*

- Ultra-high-resolution 3D sub-bottom profilers
- Electromagnetic sensors (increase depth and resolution)
- Artificial intelligence (AI)
  - Appropriate data input
- Autonomous exploration (of AUV)
  - Fusion of data and decision making by the vehicle
  - Adaptive mission planning
- Ground truth (recognition)…so:
- Data access
- Cooperation between sectors (public/private)
- Need to get the costs down significantly
  - How to map large areas more effective and cost-efficient accordingly to the task?
  - Cross fertilization from other industries

Comments from plenary session

- Detection technology, important to develop tools for experts to bring in data. Fusion of data. Where AI cannot give the appropriate answer.
- We are losing time waiting for experts to analyse data: this can be done automatically – do not waste time to handle the data by experts (human). Use AI to identify the objects – part of DDS-tool. This must be next step.
- Need to improve survey system and sensors.
- But sometimes human experts must take responsibility, although we want to reduce this. In such a case we need better tools.
- We need cheaper sensors (the ones we have are good – but expensive). Do we also need better sensors?

Good practices/solutions

Current surveys can be considered as "satisfying practices" when associated to many objectives (e.g. removal of threads, rapid responses, clearing of large areas driven and funded by industry). Indeed, accuracy in data positioning (x,y,z) and metadata description need to be improved.

In the future, the *list of relevant information* to be gathered to feed artificial intelligence techniques must be identified. A *standardization of data acquisition* would facilitate the integration and analysis. Moreover, development of *test beds* and their coordination for avoiding duplications, facilitating trans-national access, enabling knowledge-based solution and EU competitiveness is suggested.

Identification of knowledge/technological gaps

Ground-truth (recognition) is considered one priority for advancing in tackling this challenge.

In order to fill this gap, *data access* has to be improved, hopefully increasing the cooperation and partnerships with the private sector. In this regard, *guidelines for smart data request* (including identification of needed, relevant information, value, owners etc.) could help.

Cost-efficiency is an issue to be urgently addressed, also promoting cross-fertilization from other sectors.

WORKING GROUP 3: ENVIRONMENTAL RISK AND HUMAN SAFETY

The table below presents the gaps identified by the working group 3 and commented in the plenary session.

Working Group 3: Environmental risk and human safety - Knowledge gaps

Generic gaps

- Marine spatial planning and decision aid tools (e.g. DAIMON)
- Biogeochemical models to plan interventions.
- Establish migration models for munition objects and contaminants
- Basic knowledge of animal presence, density and habitat use.
- Model validation
- Identify safe locations for detonations and disposal of munition residuals – establish baseline, EIA and monitoring
- Mapping of dumped munitions
- Destabilization of munitions -– how much time do we have until spontaneous detonation or severe leakage

Gaps related to risk associated with shock waves from demolition

- Establish threshold of death and injury of animals to shock waves
- Improve shock wave propagation models
- Better mitigation measures/technology and knowledge about the effectiveness.

Gaps related to the toxicity of munition compounds

- Develop biomarkers for monitoring contaminants
- Technology and methodology to analyse contaminants (relevant to both environmental and human risk)
- What is left after detonation/deflagration
- Define concentration (threshold) and toxicological endpoint of contaminants and degradation/metabolic product
- To what extend and at what pathways do munition contaminants enter the marine food chain and accumulate?

Regulatory gaps

- Overall need to identify authoritative responsibility in many European countries.
- In order to transfer knowledge to regulators there is a need for an integrated approach to managing munitions.
- Science based legal framework – nationally and internationally
- Transboundary migration of contaminants or munition objects imply a need for international regulation in international waters (e.g. fish ban zones)
- Need to create a marked for munition clearance services to reduce cost

Comments from plenary session

- Divers protection to chemical and detonation exposure (improved suits). In the long term we do not want divers, but in the meantime, we need to improve safety Should be supported with technology.
- Economy bias: we are facing a technology gap on decision making process. There is a general lack of procedures and plans other than for emergencies. We need a change of paradigm to go from emergency management to planned management. We lack a REAL decision-making process.
- Political address: do we have time to wait for a fully developed decision support system?
- If we want to address this: we need to identify how to manage the different process considering the various cultures.
- Should bring in social sciences
- Should describe what will happen if we do nothing – apply risk assessment for this purpose: argue for action political and funding wise. Need to demonstrate the risk to safety and environment.

This group had a very big topic to consider, including both human safety and societal risk as well as environmental risk. The group started by structuring the problem in three dimensions;

- environmental risk vs human safety and societal risk,
- risk associated with shock waves from detonations (spontaneous or planned demolitions),

- vs risk associated with contaminants from munitions at the different steps of the scenario (planning, risk mitigation, intervention and operation) including a step 0 – generic risk of munition not associated with the scenario.

THE GROUP THEN IDENTIFIED ALL THE DIFFERENT RISK AND BASED ON THIS DISCUSSED THE KNOWLEDGE AND CAPABILITY GAPS ASSOCIATED WITH THESE (SEE TABLE ABOVE). THE GROUP DID NOT HAVE MUCH TIME TO DISCUSS MITIGATION MEASURES, BUT FRANS-PETER LAM PRESENTED A NICE OVERVIEW OF AVAILABLE MITIGATION MEASURES FOR DEMOLITIONS (SHOCK WAVE) AT THE PLENUM SESSION. THE GROUP ALSO DID NOT HAVE TIME TO DISCUSS ESTABLISHED GOOD PRACTICE NOR TO PRIORITIZE THE KNOWLEDGE GAPS.

WORKING GROUP 4:

The table below presents the gaps identified by the working group 2 and commented in the plenary session.

Working Group 4: Technologies for demolition/remediation- Knowledge gaps

- Aging effects of dumped munition not fully understood (prognosis of development over time) – they do not come with a data sheet….
- Corrosion process – corrosion models and validation for decision support in management
- Effects on safety of filling material applied – need to be investigated
- Destiny / state of remaining materials & chemicals after demolition / remediation; impact on safety and environment
- Many methods are applied to blow-off munitions; remains after the various methodologies is not fully understood/clear.
- How to handle chemicals; safety procedure on site (example mustard gas)
- We do not understand the actual mechanisms of the bubble curtain – need to know to improve and make less expensive
- Effect of fragmentation under water – need models to understand fragmentation better

Comments from plenary session

- Reduce cost of mitigation measures, like bubble curtains.
- What kind microbe remediation measures can be applied? Has anyone looked into this? Neutralising materials?
- Non-destructive degradation mechanisms/technologies
- Cutting/steaming/microorganisms (chicken manure)
- How to deal with an explosive that poses a threat.
- Low order: break the explosive mechanisms/remove fuse=very important
- High order: remove object – if safe you do not have to blow it up
- TNT is picked up, but only larger / detectable pieces.
- Chinese scientist working on microorganism breaking down TNT, same in Belgium.
- Should look into the work of the biotech community to improve knowledge and potential solutions.
- Acceptable levels for food are lower than values given as toxic to the organisms itself…..

The group started out with presentations from Niels Scheffer (Boskalis Hirdes) and Leif Nebel (Eggers Kampfmittelbergung) on experiences in Germany and the Netherlands prior to discussing specific technologies for demolition and remediation.

Presently the situation is that process and technology(ies) to be applied needs to be detailed for each specific case and often there is a need to use a broad range of technologies in combination. The technology(ies) to be applied depends among others upon type of munition (conventional or chemical munition), volume and condition of the munitions and water depth. This is time consuming as well as cost driving. In a perfect world there would be one tool to identify type and state of each piece of munition as well as one platform to be applied for demolish/remediation in a safe and

environmental accepted way on site. Realising that such a perfect world is hard to achieve an important step would be to establish a set of international standards for operation, HSE and quality management, training, technologies and documentation.

SUMMARY OF OUTCOME OF THE WORKSHOP

From rapid response to long term planning

The aim of the workshop was to identify knowledge and technological gaps to tackle potential challenges on the matter of dumped munitions when cables/platforms are to be installed at sea.
Indeed, participants addressed many general aspects and reflections of the issue of munitions in the sea at large.

First, the understanding of the difference in managing the planning of activities for industrial use of the marine space and related emergencies has improved. In fact, there is a wide recognition of the experience in dealing with munitions in the sea by the EOD teams or specialized companies/agencies when they are asked to remove the threat and guarantee the safety of the citizens. In many cases, their intervention will also include the protection of the environment.

When dealing with decisions to be adopted for planning interventions to detect, classify, monitor, remove and remediate munitions in the sea for the use of the marine space, the complexity of the system in terms of end-users, responsibilities, competences and resources requires a different and integrated approach. This is also needed to manage the threats linked to self-explosions and leakages.
There is a shift of paradigm from tackling threats to manage risks, and therefore providing different options for appropriate solutions. This results also in different costs and timescales, addressing the assessment of risks, intervention logics and options, in a balanced evaluation between pros and cons plus feasibility and impacts. In this context, research and innovation can contribute either for providing solutions or structuring the approach to the risk assessment and support to decisions.

It is therefore fundamental to clearly identify the objectives to be achieved and the parameters which will indicate the success of an intervention: there are many good practices in the field but they need to be contextualized. These objectives can span from the safety of the divers, to the installation of industrial infrastructures, the protection of the ecosystem, the stability of trans-national relations, or a combination of them. For this reason, the uncertainties of some aspects and the involvement of all the agents influencing the decision process should be considered in assessing the risks and the evaluation of consequences of interventions. In this regard, “Munitions in the Sea” has been recognized to have many aspects usually addressed when fulfilling the Marine Spatial Planning and Marine Strategy Framework Directives, in particular for the environmental impacts to be evaluated and the integrated approach to be adopted.

From outputs to outcomes

The outputs of the workshop can be grouped into two main outcomes:

- identified knowledge and technological gaps that will feed into the organization of the next workshop which will address scientific debates for tackling specific challenges;
- ideas and suggestions to be elaborated by the Secretariat of JPI Oceans and transmitted to the leading countries of the action, for eventually submitting to the Management Board of JPI Oceans a proposal for “low hanging fruits”-joint activities where JPI Oceans can bring the EU added value.

For this reason, the outputs of the four groups of the workshop will distinguish between the “gaps” and the “suggestions”.

THE WAY FORWARD

Italy will arrange a workshop in December 2018 in Rome were scientific gaps identified in Oslo will be followed up. A comprehensive report on both workshops will be released in early 2019 to identify joint activities to be proposed to Management Board for adoption.

ANNEXES:

1. List of participants
2. Program
3. Working groups

Munitions in the Sea – Scenario workshop

June 6-8, 2018

Oslo, Norway

	First name	Last name	Company/organization
1	Jan	Savelkoels	ADEDE bvba
2	Liesbet	Van der Burght	ADEDE bvba
3	Niels	Scheffer	Boskalis Hirdes
4	Mario	Sprovieri	CNR - IAMC
5	Sandro	Carniel	CNR-ISMAR
6	Jann	Wendt	EGEOS GmbH
7	Leif	Nebel	EGGERS Kampfmittelbergung GmbH
8	Matthias	Grün	EGGERS Kampfmittelbergung GmbH
9	Oliver	Geisler	EGGERS Kampfmittelbergung GmbH
10	Rene	Kollmann	EGGERS Kampfmittelbergung GmbH
11	Sven	Koschinski	Federal Agency for Nature Conservation (Germany)
12	Tine	Missiaen	Flanders marine Institute (VLIZ)
13	Uwe	Freiherr von Lukas	Fraunhofer Institute for Computer Graphics Research IGD
14	Armin	Keßler	Fraunhofer Institute for Chemical Technology, ICT
15	Johannes	Brock	Geo-Engineering.org GmbH
16	Eric	Achterberg	GEOMAR Helmholtz Centre for Ocean Research
17	Aaron	Beck	GEOMAR Helmholtz Centre For Ocean Research Kiel
18	Jens	Greinert	GEOMAR Helmholtz Centre For Ocean Research Kiel
19	Jens	Sternheim	Ministerium für Energiewende, Landwirtschaft, Umwelt, Natur und Digitalisierung
20	Torsten	Frey	Institute for Infrastructure and Resources Management, Leipzig University
21	Endre	Grimsbø	Institute of Marine Research
22	Michal	Cztub	Institute of Oceanology
23	Edmund	Maser	Institute of Toxicology, University Medical School SH, Kiel, Germany
24	Jennifer	Strehse	Institute of Toxicology, University Medical School SH, Kiel, Germany
25	Giovanni	Modugno	IT NAVY
26	Kathrine	Angell-Hansen	JPI Oceans
27	Pier Francesco	Moretti	JPI Oceans
28	Harald	Nordås	Norwegian Food Safety Authority
29	Emilio Fortunato	Campana	National Research Council, Italy
30	Frans-Peter A.	Lam	Netherlands Organization for Applied Scientific Research TNO
31	Wiggo	Korsvik	NJHQ
32	Peter	Frost	NKT High Voltage Cables (formally ABB HVC)
33	Hans Petter	Mortensholm	Norwegian Coastal Administration
34	Eddy Arnold	Lindholm	Norwegian Defence Research Establishment
35	Helle Kristin	Rossland	Norwegian Defence Research Establishment
36	John Aasulf	Tørnes	Norwegian Defence Research Establishment
37	Petter	KVADSHEIM	Norwegian Defence Research Establishment
38	Torstein Olsmo	Sæbø	Norwegian Defence Research Establishment
39	Øyvind	Voie	Norwegian Defence Research Establishment
40	Marianne	Olsen	Norwegian Environment Agency
41	Magne	Markhus	Norwegian Ministry of Justice and Public Security
42	Anne Mari	Voll	Norwegian Ministry of Trade, Industry and Fisheries
43	Anastasios	Lekkas	NTNU
44	Christina	Abildgaard	Research Council of Norway
45	Christian	Wexelsen - Riiser	Research Council of Norway
46	Hanna Lee	Behrens	Research Council of Norway
47	Inger Oline	Røsvik	Research Council of Norway
48	Kristin	Thorud	Research Council of Norway
49	Marit	Heller	Research Council of Norway
50	Merete	Rosenberg	Research Council of Norway
51	Frederic	Francken	Royal Belgian Institute of Natural Sciences - OD Nature
52	Tom	Mathisen	Scanwaste as
53	Antonio Miguel Gutierrez	Albert	Spanish Army, Ministry of Defense
54	Matthias	Reuter	TU-Clausthal
55	Polly	Hill	UK Ministry of Defence

Munitions in the Sea – Scenario workshop

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Oslo, Norway

Final program

Workshop agenda – day 1

12:00-13:00 **Lunch**

13:00:14:00 **Opening** (Chaired by Inger Oline Røsvik, Research Council of Norway RCN)

- *Welcome* (Inger Oline Røsvik, RCN)
- *Opening statements* (Christina Abildgaard, RCN)
- *The JPI Ocean's joint action on munitions in the sea* (Emilio Fortunato Campana, The Italian Research Council, CNR)
- *The workshop scenario and agenda* (Øyvind Voie, Norwegian Defence Research Establishment FFI)

14:00-18:30 **Key notes** (Chaired by Petter Kvadsheim, FFI) (25min presentations)

Management, procedures and good practice

- *Norwegian practice for handling of UXOs* (CDR Wiggo Korsvik, Norwegian Defence Operational Headquarters)
- *Experience from an underwater explosive ordnance disposal operation within an environmental rehabilitation project* (CDR Giovanni Modugno Italian Navy).
- *The Bigger Picture of European Quality Initiative for the Treatment of UXO* (Torsten Frey, Leipzig University, Institute for Infrastructure and Resources Management).

15:30-16:00 *Coffee*

Environmental risk and human safety

- *Effect of shock waves on marine mammals* (Frans-Peter Lam, Netherlands Organization for Applied Scientific Research TNO)
- *Moving towards best practices in environmental risk assessment and monitoring strategies for conventional WWII munition* (Jens Greinert, GEOMAR Helmholtz Centre For Ocean Research Kiel)
- *The DAIMON risk assessment and management tool* (Michał Czub, Polish Institute of Oceanology).

Relevant technologies

- *Robothesized technologies to find dumped munition* (Torstein Sæbø, FFI).
- *Some existing methods for clearance of explosives at sea* (Niels Scheffer, Boskalis Hirdes)

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19:00 **Joint dinner in house**

CSA OCEANS 2
JPI Oceans support action

Munitions in the Sea – Scenario workshop

June 6-8, 2018

Oslo, Norway

Final program

Workshop agenda – day 2

09:00-12:00 **National presentations of management and challenges related to munitions in the sea**

(Chaired by Øyvind Voie, FFI) (20min presentations)

- *National presentation from Belgium* (Frederic Francken, Royal Belgian Institute of Natural Sciences)
- *National presentation from Germany* (Jens Sternheim, Helcom-Submerged and the German cross adm. working group on underwater munitions)
- *National presentation from Norway (*Øyvind Voie, FFI*)*
- *National presentation from UK (*Polly Hill, UK Ministry of Defence)
- *National presentation from Spain (*LCDR Antonio M. Gutierrez Albert, Spanish Navy Diving Center)
- *National presentation from Netherland (*CDR René Dekeling of RNLN/ Frans-Peter Lam TNO)
- *National presentation from Italy*

10:30-11:00 *Coffee*

12:00:13:00 **Lunch**

13:00-17:00 **Work group session**

Introduction – group tasks (Petter Kvadsheim, FFI)

Group 1: Management of munition in the sea and organization of authority (Lead by Øyvind Voie, FFI)

Group 2: Planning the cable trajectory - technologies for detection and classification (Lead by Pier Francesco Moretti, JPI Oceans/CNR)

Group 3: Environmental risk and human safety (Lead by Petter Kvadsheim, FFI)

Group 4: Technologies for demolition/remediation (Lead by Jens Sternheim, Ministerium für Energiewende, Landwirtschaft, Umwelt, Natur und Digitalisierung)

15:00-15:30 *Coffee*

18:00 **Joint dinner on the docks**

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Workshop agenda – day 3

09:00-10:30	**Presentation of available technologies, good practice and knowledge gaps** (Chaired by Inger Oline Røsvik, RCN) (15 min presentations) ▪ *Group 1 – Differences and commonalities* (Øyvind Voie, FFI) ▪ *Group 2 - Gaps and priorities* (Pier Francesco Moretti, JPI Oceans/ CNR) ▪ *Group 3 - Gaps and priorities* (Petter Kvadsheim, FFI) ▪ *Group 4 - Gaps and priorities* (Jens Sternheim, MELUND)
10:30-11:00	*Coffee*
11:00:12:00	**Discussion of gaps and priorities** (Chaired by Voie & Kvadsheim, FFI)
12:00:12:30	**Next step (**Emilio Fortunato Campana, CNR and Pier Francesco Moretti, JPI Oceans) **Closing statements** (Inger Oline Røsvik, RCN and Petter Kvadsheim, FFI)
12:30	**Lunch**