Årsnotat –
dumpede våben i danske farvande

2020

Fagligt notat fra DCE – Nationalt Center for Miljø og Energi

Dato: 11 januar 2021 | **02**

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Indhold

1 Forord, formål og baggrund

Forord: Nærværende beskrivelse af aktiviteterne i 2020 er udarbejdet inden for rammeaftalen mellem Miljø- og Fødevareministeriet (nu Miljøministeriet) og Aarhus Universitet om forskningsbaseret myndighedsbetjening. Miljøstyrelsen har haft et udkast til notatet til kommentering. Kommentarerne og håndteringen heraf kan findes her via dette link: (kommentering).

Formål og baggrund: Formålet med dette notat er at beskrive aktiviteterne inden for dumpede våben i danske farvande for 2020. Ifølge rammeaftalen følger DCE området, deltager i internationale arbejdsgrupper, rådgiver ifm. potentielle miljøeffekter, samt indgår i faglig sparring med Miljøstyrelsen. Arbejdet med dumpede våben i danske farvande er bl.a. relevant i forbindelse med rådgivning af potentielle effekter af dumpet ammunition med henblik på sikring af god miljøtilstand under havstrategidirektivet.

2 Aktiviteter i 2020

De primære aktiviteter i 2020 har været omkring kommentering af to konkrete HELCOM BSAP forslag om håndtering af dumpede våben samt anbefalinger omkring opdatering af dette arbejde i HELCOM regi (se kommentarer i bilag 1 og 2). Desuden er der leveret kommentarer til rapporten om *HELCOM Thematic Assessment on Hazardous Submerged Objects in the Baltic Sea (Submerged Assessment), Volume 1 - Warfare Materials in the Baltic Sea* (se bilag 3).

I 2020 deltog Hans Sanderson i JPI Oceans aktiviteter omkring dumpede våben i form af deltagelse den 16. & 17. september i JPI Oceans Joint Action *Munitions in the Sea - towards a knowledge hub*. Workshoppen var online. Efterfølgende fik Hans Sanderson formidlet kontakt med tyske forskere fra Umweltministerium Schleswig-Holstein og GEOMAR, der leder flere relevante projekter på emnet og fik afholdt et Zoom møde med dem, MST og DEP den 27. november omkring fællesinteresser angående marine forskningsaktiviteter omhandlende dumpede våben. Desuden er Kim Lundgreen og Hans Sanderson nu officielle kontaktpersoner til JPI Oceans omkring dumpede våben og knowledge hub.

Endelig, har Hans Sanderson i 2020 bidraget til udarbejdelse af to videnskabelige artikler angående dumpede våben. Den første artikel omhandler indsamling af eksperimentelle akut-giftighedsdata af arsen-baserede kampstoffers giftighed overfor dafnier (Czub et al 2021, *Aquatic Toxicology*, vol. 230, https://doi.org/10.1016/j.aquatox.2020.105693) – se artiklens abstract nedenfor :

Abstract:

Sea dumping of chemical warfare (CW) took place worldwide during the 20th century. Submerged CW included metal bombs and casings that have been exposed for 50–100 years of corrosion and are now known to be leaking. Therefore, the arsenic-based chemical warfare agents (CWAs), pose a potential threat to the marine ecosystems. The aim of this research was to support a need for real-data measurements for accurate risk assessments and categorization of threats originating from submerged CWAs. This has been achieved by providing a broad insight into arsenic-based CWAs acute toxicity in aquatic ecosystems. Standard tests were performed to provide a solid foundation for acute aquatic toxicity threshold estimations of CWA: Lewisite, Adamsite, Clark I, phenyldichloroarsine (PDCA), CWA-related compounds: TPA, arsenic trichloride and four arsenic-based CWA degradation products. Despite their low solubility, during the 48 h exposure, all CWA caused highly negative effects on Daphnia magna. PDCA was very toxic with 48 h *D. magna LC50 at 0.36 μg × L⁻¹ and Lewisite with EC50 at 3.2 μg × L⁻¹. Concentrations at which no immobilization effects were observed were slightly above the analytical Limits of Detection (LOD) and Quantification (LOQ). More water-soluble CWA degradation products showed no effects at concentrations up to 100 mg × L⁻¹.*

Den anden artikel er et review, hvor forfatterkredsen har samlet alle publicerede eksponeringsdata for kemiske kampstoffer i Østersøen samt alle de seneste giftighedsdata for stofferene. Der er i artiklen benyttet de seneste modeller til modellering af transport og skæbne af stofferne til beskrivelse af udbredelsen af eksponeringsniveauer samt eventuelle risici i vandet. Denne artikel vil blive indsendt til et relevant peer-reviewed tidsskrift i starten af 2021.

Det er bestemt relevant fremadrettet at overveje både dumpede kemiske og konventionelle våben i danske farvande. De dumpede kemiske våben er primært relevante i farvandet omkring Bornholm. Analyserne og viden omkring disse er ganske fremskredne. Dumpede konventionelle våben er mere relevante fx i danske farvande omkring Femern Bælt samt muligvis i relation to Nordsøen og Vadehavet og disse er pt relativt mindre belyst med hensyn til forekomst og risici end de kemiske våben.

Bilag 1: Kommentering af HELCOM BSAP fusionerede forslag om håndtering af dumpede våben

2.1 Title

Development of Best Environmental Practice (BEP) and control of threats posed by munitions, wrecks and other hazardous submerged objects in the Baltic Sea, including the preparation for the remediation of areas contaminated with munitions

2.1.1 Submitted by:

SUBMERGED Expert Group, Coalition Clean Baltic

2.2 Description of measure

Dumped and abandoned conventional and chemical munitions corrode and subsequently release their toxic content to the Baltic Sea eco-system. In addition, shipwrecks from the 20th century onwards, containing oil and various cargo, release hazardous substances to the surrounding water. Today, munitions and wrecks release of toxic contaminants. Besides being sources of pollution they also pose physical obstacles on the sea-floor and a risk factor for maritime workers. In summary, munitions and wrecks constitute a currently unknown risk for the environment, offshore economy, fishing and tourism. Risk assessment using decision support tools should be performed for conventional and chemical dumped munitions, wrecks, lost cargo and sea-dumped waste (in summary: hazardous submerged objects). Measures should then be applied accordingly, to control the effects:

1. Desktop studies: historical and contemporary document research
2. Survey: investigations of contaminated areas and wrecks (e.g. sonar, magnetometers, underwater video, divers, chemical and biological sampling)
3. Documentation: GIS supported data collation e. g., position, type, quantity of potentially hazardous objects their condition,and whether an object has been destroyed/salvaged.
4. Decision support: processing of georeferenced information e. g., by DAIMON DSS
5. Risk assessment and measures: Evaluation of hazardous objects on the seabed and in the sediment based on decision support results. Risk assessment, definition and, prioritisation of clearance requirements for hazardous submerged objects. Balancing of associated risks of site-specific remediation options (e.g., leave as it is, monitoring, recovery).
6. Monitoring of hot spots.
7. Development of national contingency plans for dealing with hazardous submerged objects in an open transparent process, that is based on best available science.
8. Development and selection of Best Available Techniques (BAT) and Best Environmental Practices (BEP) of environmentally friendly, secure and cost-effective low-noise and low-pollution practices and technologies for the remediation of hazardous submerged objects (e.g. robotic technologies).

Hence, the proposed action includes the whole chain from archive research, surveys, object identification and assessment, to remediation. For future activities, connections between the private economy sector, researchers and responsible authorities should be established in order to promote technology development.

2.2.1 Activity:

Military operations (infrastructure, munitions disposal)
Offshore structures (other than for oil/gas/renewables)
Fish and shellfish harvesting (bottom-touching towed gears, professional, recreational)
Restructuring of seabed morphology (dredging, beach replenishment, sea-based deposit of dredged material)
Renewable energy generation (wind, wave and tidal power), including infrastructure
Non-renewable energy generation (fossil fuel and nuclear powerplants)
Transmission of electricity and communications (cables)

Commented [HS1]: Please define the threats more clearly

Commented [HS2]: This covers virtually all dumped materials can you be more specific? Or at least prioritize the contaminants?

Commented [HS3]: Can you prioritize the areas?

Commented [HS4]: Site specific risk assessments have to follow guidelines e.g. EU TDG; HELCOM or national guidelines. Risk assessment is not performed using decision support tools. Decision support tools are risk management tools to be used after the risk assessment and integrated in the risk analysis

Commented [HS5]: This is extremely broad – please prioritize.

Commented [HS6]: Such as?

Commented [HS7]: What do you mean by control the effects? Are you hinting towards risk management strategies – if so you need to define the risks you are managing.

Commented [HS8]: Of what precisely?

Commented [HS9]: Again of what and where?

Commented [HS10]: Where? All of the Baltic?

Commented [HS11]: Not sure what you mean? Can't manage a risk without having it assessed accurately first and then develop the management options from this, e.g. protection aims and acceptable risks?

Commented [HS12]: See above first assess and document the risk

Commented [HS13]: Where fulfilling which criteria?

Commented [HS14]: Define more this whole bullet.

Commented [HS15]: Do you have any idea of costs and time needed? Sound very large.

Extraction of oil and gas, including infrastructure (e.g. pipelines)

2.2.2 Pressure:

Input of other substances (e.g. synthetic substances, non-synthetic substances, radionuclides) — diffuse sources, point sources, atmospheric deposition, acute events
Input of anthropogenic sound (impulsive, continuous)
Disturbance of species: Other (e.g. barriers, collission)
Physical loss (due to permanent change of seabed substrate or morphology and to extraction of seabed substrate)

2.2.3 State:

Hazardous substances Litter
Noise
Mammals
Fish
Birds
Seabed habitats

2.2.4 Extent of impact:

Recent research showed that substances from munitions enter the marine environment and can be detected in the marine food web. TNT and its derivates were found in water, sediment, mussels and fish. Chemical warfare agents were found in Norwegian lobster and fish. Elevated occurrence of liver tumors in dab were associated with substances leaking from corroded munitions in a munitions dump site. A simulation model shows that dissolved substances can disperse in the Baltic Sea with currents and affect the marine ecosystem elsewhere.

2.3 Effectiveness of measure

Archive research, survey, documentation, risk assessment and prioritisation are the basis for all subsequent measures. Remediation removes point source emitters and ultimatively prevents release and spreading of contaminants and thus continued contamination of the marine environment and foodborne intake in seafood resources. The action will positively affect marine areas of chemical munition dumpsites in e.g., Bornholm Basin, Gotland Deep and Gdansk Deep, as well as Little Belt and Skagerrak as identified in the HELCOM MUNI report. Identified conventional munition hotspots will also benefit. These are located e.g. in German (Kiel Bight, Lübeck Bight, Flensburg Fjord), Polish (Pomeranian Bay, Gulf of Gdansk), Finnish and Russian waters (Gulf of Finland). Generally it will improve the state of the entire Baltic Sea, as the large numbers of point sources of munitions, wrecks and other hazardous submerged objects are widely dispersed throughout all HELCOM Contracting States' waters. Furthermore adherance to BAT and BEP will enable HELCOM Contracting States to perfom remediation while minimizing environmental impact. In addition, controlling the risk of submerged hazardous objects limits the negative impact on economic activies in the Baltic Sea, including offshore energy, tourism, fisheries etc. Finally, the establishment of an entry point for the private sector will allow new technologies for remediation to be tested in an environmentally safe way.

2.3.1 Cost, cost-effectiveness of measure:

The estimated costs of continuous evaluation of existing data is low and it can be included in running costs of relevant authorities of Baltic Sea countries. At the moment, the activities related to risk assessment of hazardous submerged objects are performed by various governmental agencies, however they do not produce a full picture. Required additional efforts are the consolidation and review of existing actions. Monitoring of compounds originating from hazardous submerged objects can be included into monitoring frameworks such as MSFD monitoring, and can initially be limited to several hotspots in the Baltic Sea. Risk assessment of shipwrecks still containing oil as bunker or cargo can be performed using existing tools. Considering the future costs of environmental damage as well as the benefit of expected technological improvements the systematic approach appears more cost-effective. If the contaminants have been introduced into water body and sediment it is unforseeable how these can be extracted at reasonable cost. As an example, Sweden performed two operations in 2019 during which 299 m^3 and 60 m^3 of oil respectively were removed from two shipwrecks. Removal costs per tonne of oil amounted to EUR 6.788 and

Commented [HS16]: The main thing is that there is no evidence of significant risks environmental risks due to the sea-dumped munitions in the Baltic Sea. See *e.g* the most comprehensive review by Greenberg et al 2016: https://www.tandfonline.com/doi/full/10.3109/15563650.2015.1121272?src=recsys; Moreover, Hemström et al 2020 assessed the toxicity of metabolites of the most dumped CWA Mustardgas and found low toxicity (https://www.sciencedirect.com/science/article/pii/S0141113620301999#bib7). In the Bornholm Deep Sanderson et al (2014) reviewed 391 sample sites and found low risk to the fish community (https://www.sciencedirect.com/science/article/pii/S0304389414005573). Sanderson et al 2010 (https://pubs.acs.org/doi/10.1021/es903472a) provides an overview of data needs a decade ago summarizing the MERCW project risk related findings.

Commented [HS17]: Do you have an amount?

Commented [HS18]: A cost?

Commented [HS19]: Cost?

EUR 19.531. This is generally on the same level as reported direct clean-up costs per tonne from known uncontrolled oil spills. In addition to the direct clean-up costs, socioeconomic and environmental costs must also be included. Hence, a proactive approach is cost effective in the long run. A number of institutions in the HELCOM area have been working on the issue on hazardous submerged objects. Hence, personnel and resources are available, which ensures the sustainable and continuous use of experience, knowledge and established connections to ongoing scientific projects. The private sector is interested in performing remediation, thereby generating Blue Growth, which has the potential to economically outweight the costs of this action. The establishment of entry points for partnernships between public authorities and private companies is based on existing administrative resources and is not associated with high costs.

Commented [HS20]: Define long run?

2.3.2 Feasibility:

Munition dumpsites and wrecks in the Baltic Sea were surveyed by both military (i. e. Baltic Sea Ordnance Safety Board, BOSB) and scientific projects (MERCW, CHEMSEA, MODUM, DAIMON, UDEMM), although the exact location and inventory of munitions is often still missing. Tools for risk assessment were created, i. a. as decision aid, and are provided to stakeholders by DAIMON and DAIMON 2 projects, while monitoring schemes and methods were developed by UDEMM, MODUM and DAIMON. Quality requirements for munitions surveys and clearance were developed by RoBEMM. Remediation strategies include blast in place operations (no longer considered safe for the environment), salvage/destruction methods and in situ delaboration. The latter is still in development stage, while recovery of munitions that are not safe to handle has not been done in the Baltic Sea, but experience exists from other areas. Therefore, there is a strong basis for the effective completion of an inventory, execution of risk assessments and provision of decision support. Risk assessment tools also exist for wrecks. One of them is the existing VRAKA model developed and used in Sweden, while other methods are being developed in the INTERREG North Sea Wrecks project. Even though they are available for use, none of those tools are currently be applied on a broad national and European scale. There is strong and growing public support for applying control measures to hazardous submerged objects. Successful execution of this action will promote economic growth in the Baltic Sea area in maritime and fisheries and tourist sectors. The measures both increase security for offshore workers while creating new employment opportunities in the region.

Commented [HS21]: Risk assessment need to be developed to support decision making and risk management. I think this is what is meant?

Commented [HS22]: Safe by whom – please supply the reference scientific and regulatory.

Commented [HS23]: Yes I very much agree that risk assessment is needed first.

Commented [HS24]: I would suggest to assess the site as site specific risk assessments following the relevant guidelines. Not a tool such as VRAKA.

Commented [HS25]: Do you have indicators?

Commented [HS26]: What will they be doing? Suggest jobs and numbers.

2.3.3 Follow-up of measure:

The proposed action includes several detailed recommendations that could be easily followed. Establishment of entry points for clearing and new remediation technology companies can be reported by Contracting Parties during relevant HELCOM meetings. BAT and BEP can be developed by the subsequent versions of HELCOM working group reports, namely the Submerged Expert Group, whereas their adoption by Contracting Parties would follow regular HELCOM processes. Continued data compilation and quality assured repeated assment of monitoring results is required if objects remain in the environment.

2.3.4 Background material:

In the 2013 Ministerial Declaration it was agreed that by 2015, a one-off HELCOM thematic assessment on environmental risks of hazardous submerged objects covering contaminated wrecks, lost or dumped dangerous goods (e.g. containers), and other objects, also utilizing the 2013 report on dumped chemical munitions be produced. The HELCOM Expert Group on environmental risks of hazardous submerged objects SUBMERGED was formed in 2014 and is currently working on a document with an assessment. The action is based on a compilation of information by this group, including experience of several EU programmes (e.g., MERCW, CHEMSEA and DAIMON), NATO SPS project MODUM and findings reported by national projects such as ROBEMM and UDEMM. It also includes facts published by the special ad hoc working group HELCOM MUNI. The need for action regarding controlling of submerged hazardous objects results from the fact, that at least half a million tonnes of abandoned munitions and thousands of wrecks resting on the Baltic Sea bottom release harmful substances to the nearbottom water and adjacent sediments. This fact was confirmed by numerous publications, listed in the reference section. In the era of reduced anthropogenic emissions, reemission of past contaminants may be an important component of the pollution budget in the Baltic Sea.

Commented [HS27]: What do you mean with controlling?

Commented [HS28]: So assessing the relevant environmental risk. I agree.

2.4 References

- HELCOM MUNI report

Commented [HS29]: This is not a complete nor comprehensive review of the state-of-the-science see e.g. the references mentioned above.

- Draft HELCOM Submerged Assessment
- MODUM
- MERCW
- Decision Aid for Marine Munitions (DAIMON) project website: https://www.daimonproject.com/
- UDEMM project website: https://udemm.geomar.de/
- BASTA project website: https://www.basta-munition.eu/
- Greinert et al. (2019): Practical guide for environmental monitoring of conventional munitions in the Seas (Environmental monitoring for the delaboration of munitions on the seabed, UDEMM). https://udemm.geomar.de/en
- Abbondanzieri et al. (2018): RoBEMM - Entwicklung und Erprobung eines robotischen Unterwasser-Bergungs- und Entsorgungsverfahrens inklusive Technik zur Delaboration von Munition im Meer im Küsten- und Flachwasserbereich, Statustagung "Maritime Technologien", Projektträger Jülich, Berlin: pp. 159-167
- Appel et al. (2018): Bioaccumulation of 2,4,6-trinitrotoluene (TNT) and its metabolites leaking from corroded munition in transplanted blue mussels (*M. edulis*). Marine Pollution Bulletin 135 1072–1078
- Beck et al. (2018): Spread, Behavior, and Ecosystem Consequences of Conventional Munitions Compounds in Coastal Marine Waters. https://www.frontiersin.org/articles/10.3389/fmars.2018.00141/full
- Beldowski et al. (2017): Towards the Monitoring of Dumped Munitions Threat (MODUM). Part of the NATO Science for Peace and Security Series C: Environmental Security book series (NAPSC).
- Frey, T. (2020) Quality Guideline for Explosive Ordnance Disposal. Beuth Verlag GmbH, Berlin
- Maser, E., Strehse, J.S. (2020). "Don't Blast": blast in place (BiP) operations of dumped World War munitions in the oceans significantly increase hazards to the environment and the human seafood consumer, Archives of Toxicology, https://doi.org/10.1007/s00204-020-02743-0
- Strehse et al. (2017): Biomonitoring of 2,4,6-trinitrotoluene and degradation products in the marine environment with transplanted blue mussels (*M. edulis*). Toxicology 390, 117–123
- T. Missiaen, M. Soderstrom, I. Popescu, P. Vanninen, Evaluation of a chemical munition dumpsite in the Baltic Sea based on geophysical and chemical investigations, Science of the Total Environment, 408 (2010) 3536–3553
- M. Soderstrom, A. Ostin, J. Qvarnstrom, R. Magnusson, J. Rattfelt-Nyholm, M. Vaher, P. Joul, H. Lees, M. Kaljurand, M. Szubska, P. Vanninen, J. Bełdowski, Chemical Analysis of Dumped Chemical Warfare Agents During the MODUM Project, NATO Science for Peace and Security Series C: Environmental Security (9789402411522), pp. 71-103
- J. Nawała, K. Czuprynski, S. Popiel, D. Dziedzic, J. Bełdowski, Development of the HS-SPME-GC-MS/MS method for analysis of chemical warfare agent and their degradation products in environmental samples, AnalyticaChimicaActa, 933 (2016) 103-116
- R. Magnusson, T. Nordlander, A. Ostin, Development of a dynamic headspace gas chromatography–mass spectrometry method for on-site analysis of sulfur mustard degradation products in sediments, Journal of Chromatography A, 1429 (2016) 40-52;
- J. Nawała, M. Szala, D. Dziedzic, D. Gordon, B. Dawidziuk, J. Fabisiak, S. Popiel, Analysis of samples of explosives excavated from the Baltic Sea floor, Science of the Total Environment, 708 (2020) 135198
- Beldowski, J., Klusek, Z., Szubska, M., Turja, R., Bulczak, A.I., Rak, D., Brenner, M., Lang, T., Kotwicki, L., Grzelak, K., Jakacki, J., Fricke, N., Ostin, A., Olsson, U., Fabisiak, J., Garnaga, G., Nyholm, J.R., Majewski, P., Broeg, K., Soderstrom, M., Vanninen, P., Popiel, S., Nawala, J., Lehtonen, K., Berglind, R., Schmidt, B., 2016a. Chemical Munitions Search & Assessment-An evaluation of the dumped munitions problem in the Baltic Sea. Deep-Sea Res Pt Ii 128, 85-95.
- Beldowski, J., Szubska, M., Emelyanov, E., Garnaga, G., Drzewinska, A., Beldowska, M., Vanninen, P., Ostin, A., Fabisiak, J., 2016b. Arsenic concentrations in Baltic Sea sediments close to chemical munitions dumpsites. Deep-Sea Res Pt Ii 128, 114-122.
- Czub, M., Kotwicki, L., Lang, T., Sanderson, H., Klusek, Z., Grabowski, M., Szubska, M., Jakacki, J., Andrzejewski, J., Rak, D., Bełdowski, J., 2017. Deep sea habitats in the chemical warfare dumping areas of the Baltic Sea. Sci Total Environ.
- Kotwicki, L., Grzelak, K., Beldowski, J., 2016. Benthic communities in chemical munitions dumping site areas within the Baltic deeps with special focus on nematodes. Deep-Sea Res Pt Ii 128, 123-130.

Bilag 2: Kommentering af HELCOM BSAP separate forslag (Annex 1 og Annex 2) om håndtering af dumpede våben

Annex 1: *Overordnet set er Annex 1 fint. Det er relevant at overveje om, hvor, og evt. hvordan der kan/skal ryddes op efter de dumpede våben. Det er en ganske kort impact analyse og der mangler videnskabelige reference for nogle af effekterne på levertumor på fisk. Residual fund af nedbrydningsprodukter af stofferne i marine organismer bør også sættes i en toksikologisk reference og risikoanalyse, det fremgår ikke af den korte tekst. Dette vil kræve en sted specifik risikoanalyse hvor både eksponering, effekt, og sandsynlighed af uacceptable effekter er indgår for at kunne lave en velunderbygget risikovurderingen og derefter de tiltag der kan foretages for at reducere risici. VRAKA, modellen, som der henvises til, (se figur) er et udmærket hjælpeværktøj i analysen men det kan ikke stå alene, der er behov for detaljeret stedspecifik risikoanalyse jf. ovenfor. Modellen er semi-kvantitativ - fx er toksicitet af stofferne ikke beskrevet i deres artikel fra 2016 omkring metoden (Front. Environ. Sci., **22** July 2016 (https://doi.org/10.3389/fenvs.2016.00049). (Frontiers publishers har være på Bealls liste som tvivlsomme tidsskrifter: https://www.nature.com/news/backlash-after-frontiers-journals-added-to-list-of-questionable-publishers-1.18639 - nuværende status kendes ikke). På den baggrund vil det kræve en del arbejde at dokumentere risici efter en grundig problemformuleringsfase.*

Annex 2: *Lige som i Annex 1 er der i højere grad tale om at de foreslår at basere risikohåndtering, herunder oprensning på baggrund af en farevurdering frem for en faglig miljørisikovurdering, hvor de identificerede stoffer er præsenteret, deres miljøkoncentration bestemt, udbredelsen af denne, samt deres giftighed. Disse oplysninger kan så sammenstilles i en risikovurdering og relevante tiltag kan overvejes. Jeg er enig i at der er behov for forbedret videns grundlag og ydereligere kortlægning af risici, det vil sige at kvalificere og kvantificere de farer som Annex 2 henviser til i en risikokontekst.*

Den primære kommentar drejer sig om behovet for, at HELCOM's analyser er mere klare omkring hvilke risici, de vil prioritere at undersøge og håndtere. Dokumentationen vurderes til stadig at være mangelfuld, hvilket vanskeliggør en præcis og faglig vurdering af prioriteringerne, hvorfor dette er påpeget i kommentarerne.

Bilag 3: Kommentering af HELCOM Submerged Assessment rapporten

1, page 1	*DK: I am not sure if the language in the first four paragraphs are appropriate for a HELCOM document, might want to consider the wording and tone of the text?*
1, page 2	*DK: Section 1.2 needs to be more elaborated and specific - surely, there is a prioritization of hazardous objects (and not just all kinds) and surely, there is also a prioritization of types of risks? Please clarify here.*
1, page 2	*DK: Section 1.3 and 1.4 needs to be clarified, otherwise its not possible to accurately comment on the report - if the objective and scope is not stated…*
2, page 8	*DK: In addition to the cited numerous reports I would suggest to include the HELCOM reports also*
2, page 8	*DK: There are some language issues different places in the report, which will need proof reading. The sentence: The CWA presence was finally verified by pore-water (Belodowski et al 2016) is an example. Some words are missing for this to make sense.*
2, page 10	*DK: Please insert the equation for current-induced mobilisation*
2, page 12	*DK: So what is the conclusion of the first paragraph?*
2, page 12	*DK: So what is the conclusion of the section about movement?*
Chapter 2	*DK: It is a nice summary of information but since I don't know the objective of the report it is difficult to assess the relevance of the chapter, which maybe should be deleted, amended or expanded? I am left with a So What or Now What?*
Chapter 3, 3.1	*DK: Please be specific and insert references in the section - these are all very different compounds.*
Chapter 3, 3.1.3	*DK: Very general - please be more specific*
Chapter 3, 3.1.4.1	*DK: An example of very general and broad statements: Although CWA compounds have not bee widely detected in the water column they can the found in high concentrations in the porewater. Would be good withf more specific information about detections. In the sections below it is clear that the compounds dissipate exponentially with distance to the source in the water column to low ng/L levels with little or no toxicological relevance?*
Chapter 3, page 44	*DK: Might again need to be more specific about the compounds and not only talk about CWAs as they are very different. E.g. organo arsenicals, and mustard gas are very different (e.g. no As in mustard).*
Chapter 3, page 44	*DK: Second last paragraph, please insert numbers for the many documented incidents*
Page 46 first paragraph	*DK: Include mentioning the no fishing zones as a management strategy and maybe how to enforce this?*
Page 46, third last paragraph	*DK: Provide a reference please to the statement*
Page 51, first paragraph	*DK: Please address the As in the fish meat as outlined in Sanderson et al 2009.*
Page 52, Pipelines	*DK: Please update the section there has been both reports and scientific papers reporting the findings of the Nord Stream pipeline*
P 53, 3.4	*DK: Please be specific about the different compounds and provide the toxicity values for each compound (also metabolites)*
P 54, 3. paragraph	*DK: Update the toxicity of the munitions in a table*
P 57 3 last paragraph	*DK: There will be a need for targeted site specific risk assessments at the sites of greatest concern following national and international guidelines*
P 59, 3 paragraph	*DK: LOECs are not sound endpoints please use ECx instead.*

P. 98, 5.3.2	*DK: Please fill*
P. 102, 5.5.5.4	*DK: Add MERCW*
P 126, chapter 6	*DK: Insert a first recommendation: do a site specific risk assessment*
P 126, point 2	*DK: Add AI*
P 126, point 4&5	*DK: Delete these bullets.*
P 129, 6.9; 6.10; 6.11	*DK: Please add*
Page 129	*DK: Please add the reference list*
Chapter 6	*DK: It is a nice summary of information but since I don't know the objective of the report it is difficult to assess the relevance of the chapters - should some be deleted, amended or expanded? It is hence also difficult to assess the recommendations.*