Impact of sea dumped munitions on Baltic Sea environmental services

Towards cost-benefit analyses

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Lech Kotwicki

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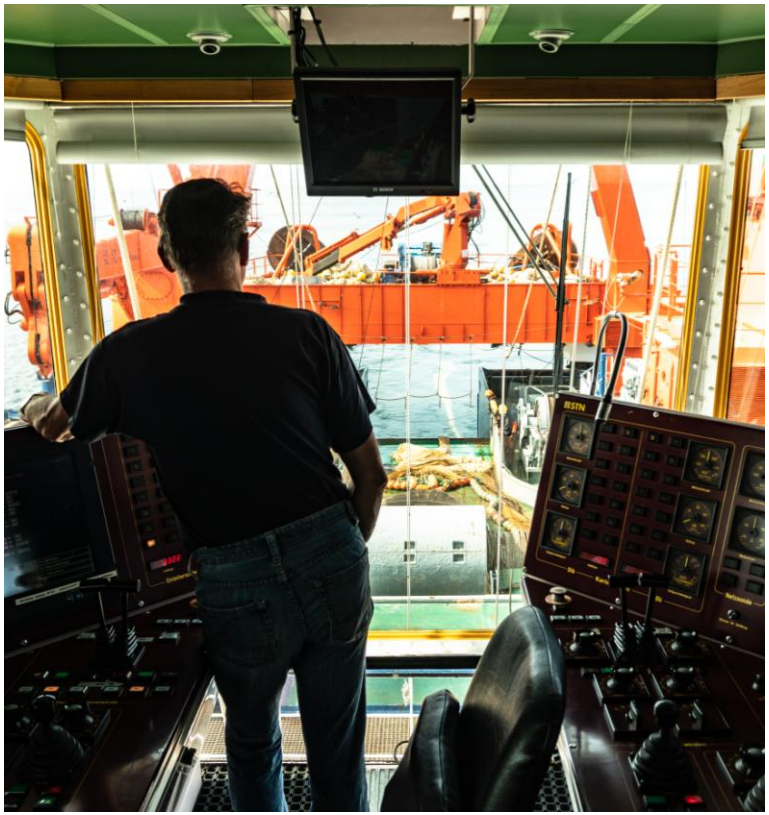
State of art

The Baltic Sea is a severely disturbed marine ecosystem that has previously been used as a dumping ground for Chemical Warfare Agents (CWA).

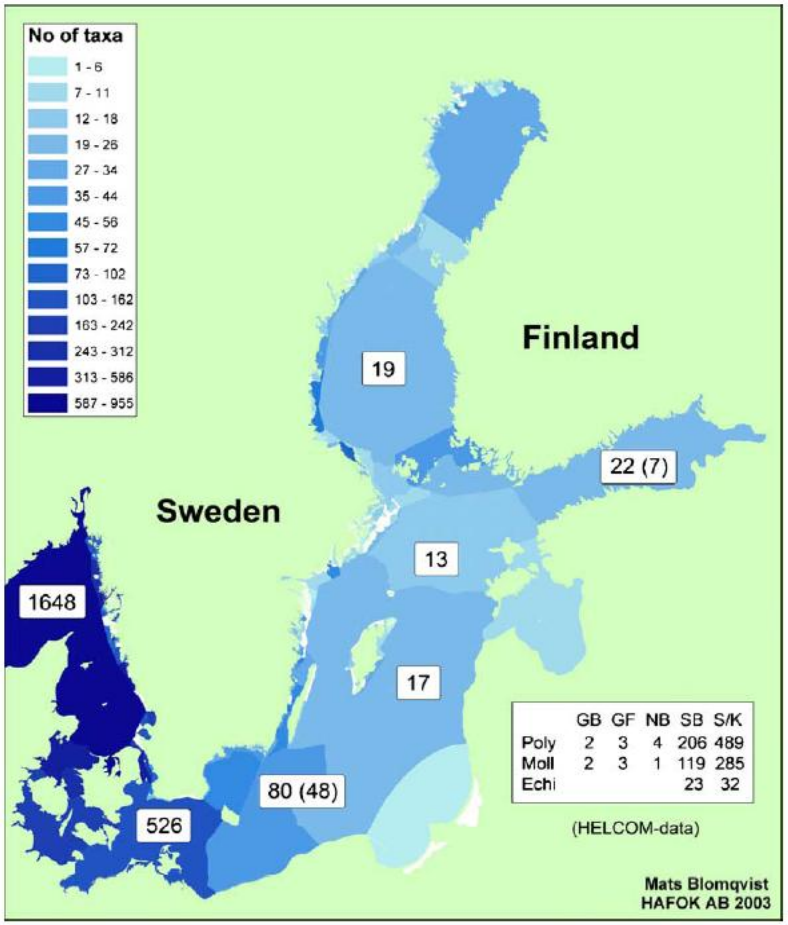
The presence of unexploded underwater ordnance is an additional risk factor for offshore activities and an environmental risk for the natural resources of the sea.

Ecosystem services



- functions and processes through which ecosystems, and the species that they support, sustain and fulfil human life.
- are sometimes divided into goods, referring to items given monetary value, and services, which are valued but rarely bought and sold.

Baltic Sea region



- Total area: 415 000 km2
- Average depth: 52 m
- Deepest: 459 m (Landsort)
- PSU: 1-20
- Average PSU: 7
- Moderate Climate
- Limited water exchange
- Low biodiversity

- Site specific case studies

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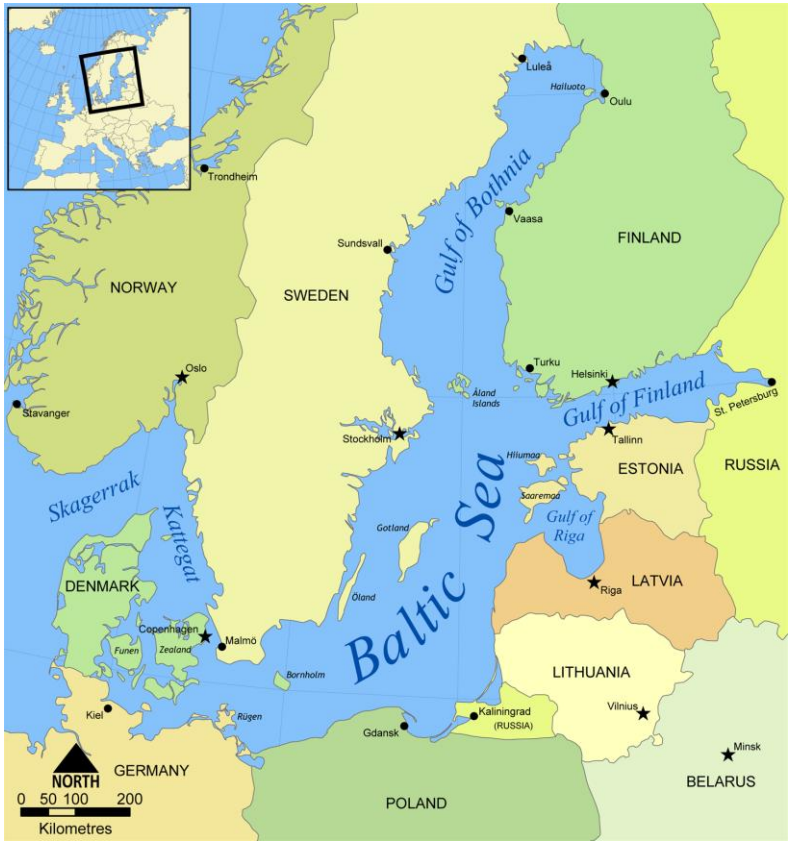
Ecosystem services



9 countries

- ~85 million people in the Baltic Sea drainage
- 15 mio within 10 km
- 29 mio within 50 km

Direct End Users
Non Direct End Users

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Types of service

Categories according to SEPA 2008

Supporting
Biogeochemical cycling (O_2; C; N; P)
Water circulation and exchange
Primary production
Food web dynamics
Diversity
Habitat
Resilience

Cultural
Recreation
Scenery
Science & education
Cultural heritage
Inspiration
Legacy of the sea

Provisioning
Food
Inedible resources
Genetic resources
Chemical resources
Ornamental resources
Energy
Space and waterways

Regulating
Climate & atmospheric regulation
Sediment retention
Mitigation of eutrophication
Regulation of hazardous substances

Healthy environment
Sustainability

functions and processes through which ecosystems, and the species that they support, sustain and fulfil human life.

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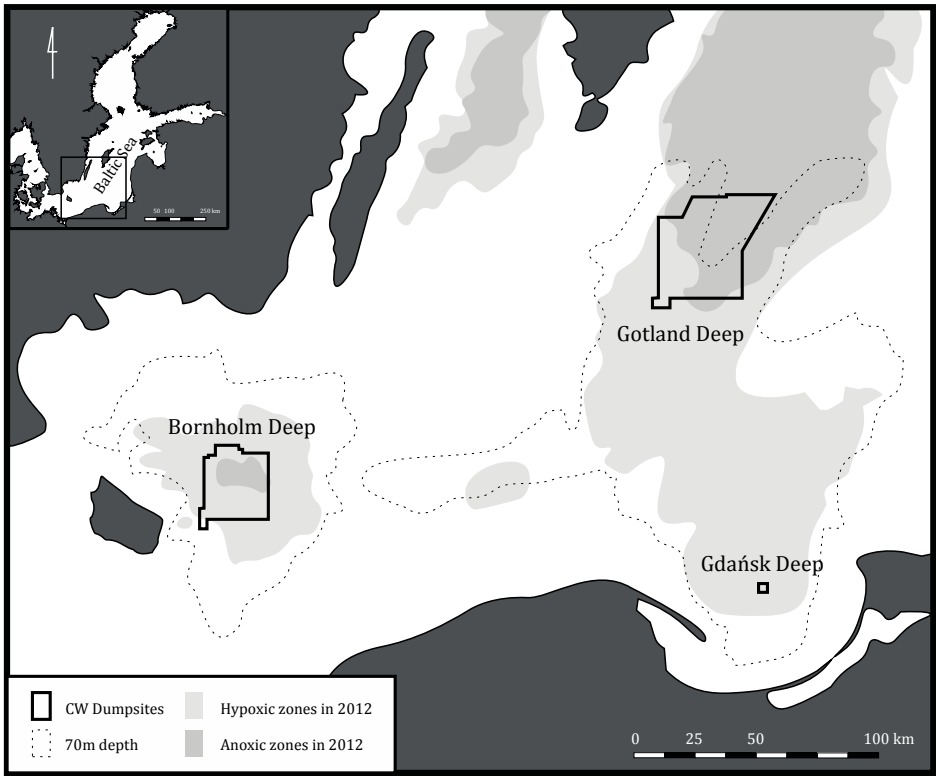
NO COST

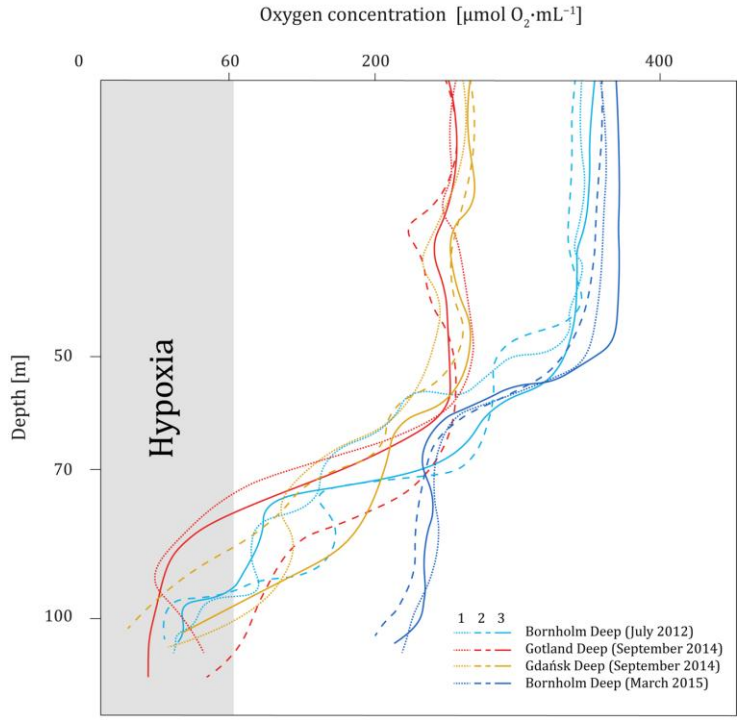
TO SUSTAIN STATUS QUO

ADDED VALUE

Baltic Sea ecosystem

Already affected: eutrophication





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Annual costs of degradation

	EUTROPHICATION	RECREATION	VEGETATION AND FISH STOCK
ESTONIA	21 - 31	11 - 16	3 - 5
FINLAND	176 - 189	76 - 109	42 - 54
DENMARK	125 - 158	51 - 70	43 - 60
GERMANY	1 572 - 1 781	384 - 544	834 - 1 155
LATVIA	8 - 9	9 - 11	5 - 8
LITHUANIA	19 - 22	14 - 22	9 - 14
POLAND	368 - 383	151 - 232	119 - 179
SWEDEN	440 - 674	297 - 415	132 - 190
RUSSIA	1 028 - 1 129	30 - 736	636 - 999
TOTAL (million €)	***3 760 - 4 380***	***1 024 – 2 155***	***1 822 – 2 663***

The cost assessment is based on valuation study of citizens' willingness to pay (WTP) for achieving a good eutrophication status in the Baltic Sea.

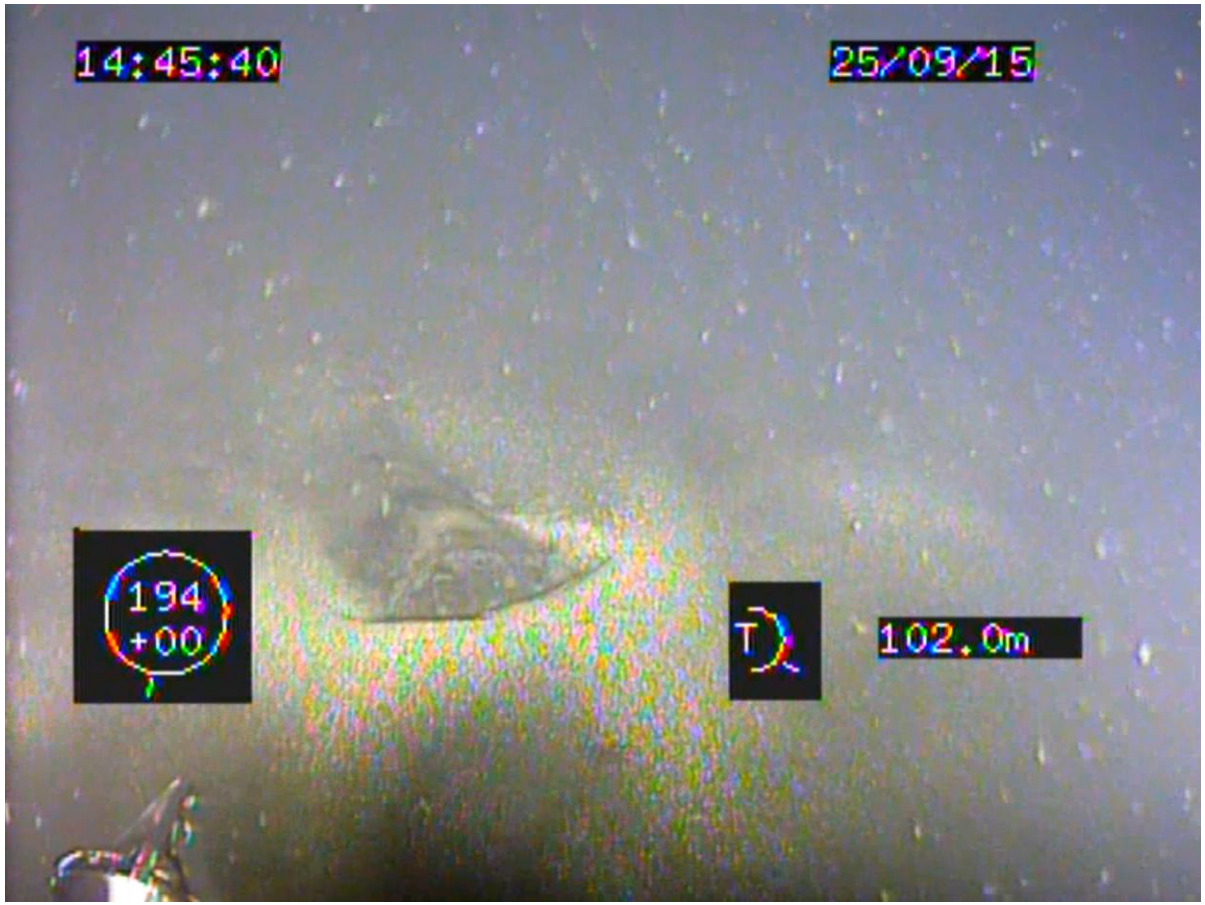
The cost of degradation estimates for recreation are based on a *preference travel-cost* study with the data from surveys performed in all nine coastal countries in 2010 (Czajkowski et al. 2015).

Same results suggest that the value of coastal and marine recreation in the Baltic Sea could increase ***by 1 - 2 billion Euro annually*** *if the environmental conditions improved. The results suggest that citizens' welfare would increase* ***1.8 – 2.6 billion euros annually****, if the state of the perennial vegetation and fish stocks improved.*

Socio-economic indicators related to different socio-economic indicators (based on HELCOM 2017) (data for 2014)

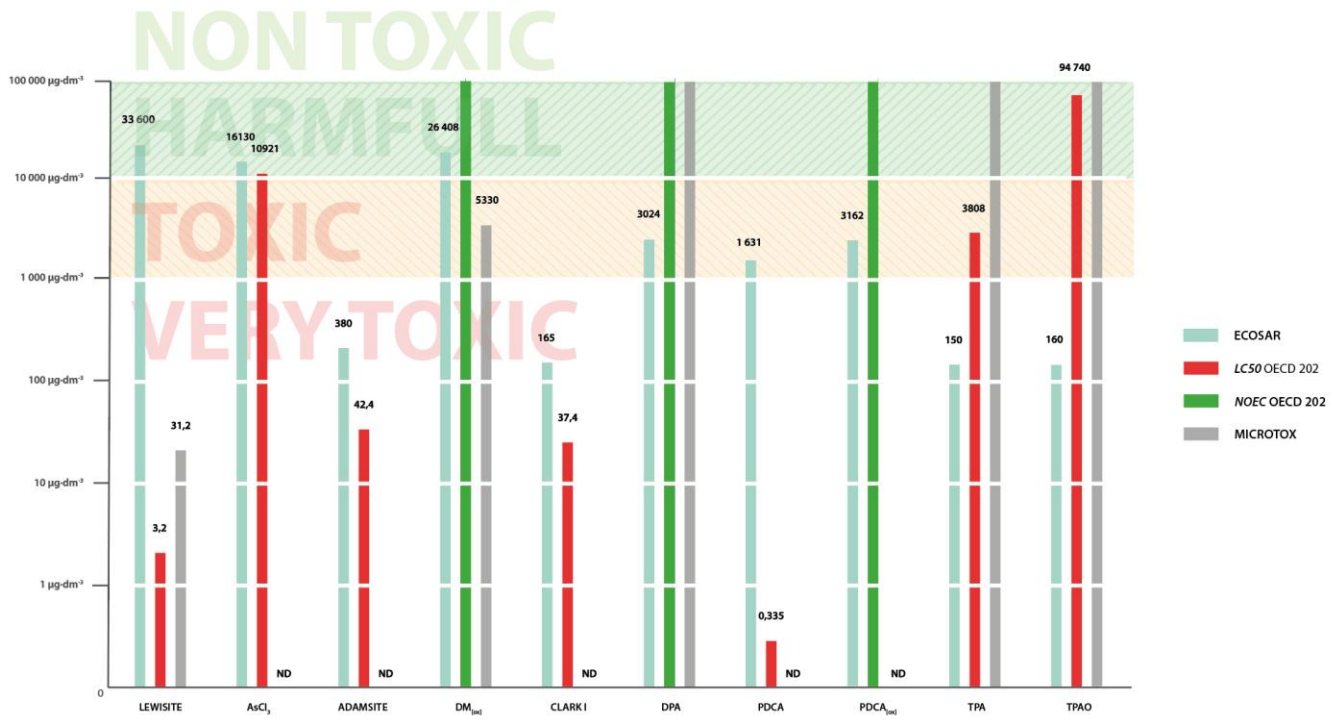
	ESTONIA	FINLAND	DENMARK	GERMANY	LATVIA	LITHUANIA	POLAND	SWEDEN	RUSSIA	TOTAL (million €)
FISH AND SHELLFISH HARVESTING										
Annual value of landings	14.5	40.4	32.8	15.1	19.5	4.2	47.9	43.5	-	218
Estimated annual gross	9.3	15.5	12.6	5.1	7.2	0.7	21.7	22.7	-	95
MARINE FINFISH AQUACULTURE										
Annual turnover	0	20.2	57.4	-	0	0	0	1.6	-	79
Annual gross value	0	4.8	9	-	0	0	0	0.535	-	14
TOURISM AND LEISURE										
Annual tourism accommodation	79	156	771	2345	63	16	246	1121		4 797
Annual recreation visit	150	1040	720	5140	110	190	2070	4430	940	14 790
RENEWABLE ENERGY										
number of existing offshore wind turbines	0	7	341	102	0	0	0	81		
MARINE TRANSPORT										
number of ports	11	39	47	17	6	2	8	63	6	
Annual freight transport	-	403	-	3420	12	30	100	287	-	4 252
Annual passanger transport	11.7	278.6	517.3	1049	-	-	27.3	333.2	-	2 217

Cthulu vs Unicorns



DAIMON findings

CWA / Explosives toxicity



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DAIMON findings

CWA/Explosives get bioaccumulated

analytical chemistry

Article

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Detection of Chemical Warfare Agent-Related Phenylarsenic Compounds in Marine Biota Samples by LC-HESI/MS/MS

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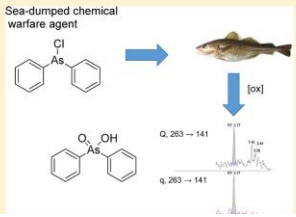
Supporting Information

ABSTRACT: A new method has been developed to determine oxidation products of three chemical warfare agent (CWA) related phenylarsenic compounds from marine biota samples by a liquid chromatography-heated electrospray ionization/tandem mass spectrometry (LC-HESI/MS/MS). The target chemicals were oxidation products of Adamsite (DM[ox]), Clark I (DPA[ox]), and triphenylarsine (TPA[ox]). Method was validated within the concentration range of 1−5, 0.2−5, and 0.2−5 ng/g for DM[ox], DPA[ox], and TPA[ox], respectively. The method was linear, precise and accurate. Limits of quantification (LOQ) were 2.0, 1.3, and 2.1 ng/g for DM[ox], DPA[ox], and TPA[ox], respectively. A total of ten fish samples and one lobster sample collected from near Swedish coast, Måseskär dumpsite were analyzed. Trace concentrations below LOQ values were detected in three samples and the elemental composition of oxidized form of Clark



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Bioaccumulation of 2,4,6-trinitrotoluene (TNT) and its metabolites leaking from corroded munition in transplanted blue mussels (*M. edulis*)

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ARTICLE INFO

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Dumped munitions
Marine environment
Trinitrotoluene (TNT)

ABSTRACT

Bioaccumulation of 2,4,6-trinitrotoluene (TNT) and its main metabolites 2-amino-4,6-dinitrotoluene (2-ADNT) and 4-amino-2,6-dinitrotoluene (4-ADNT) leaking from corroded munitions at a munitions dumping site (Kolberger Heide, Germany) was evaluated in transplanted blue mussels (*Mytilus edulis*). Six moorings with mussel bags were placed east and west at varying positions near the mine mound. In order to monitor any differences resulting from changing seasons, three exposure times were chosen. First exposure period: April–July 2016 (106 days); second exposure period: July–December 2016 (146 days); third exposure period: December 2016–March 2017 (92 days). We found amounts of 4-ADNT in mussel tissue ranging from 2.40 ± 2.13 to 7.76 ± 1.97 ng/(g mussel wet weight). Neither TNT nor 2-ADNT could be detected. Considering seasonal differences, orientation and distances of the moorings to the mine mound no correlation between levels in mussel tissue was evident.

Socio-economic indicators related to different socio-economic indicators (based on HELCOM 2017) (data for 2014)

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Bornholm: 40%

Kolberger Heide: 7%

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NO ACTION

COST:

Lost control of a problem, discontinuation of research, increasing the costs of remediation in the future, increasing environmental losses that already exist, increasing risk of loosing the monetary value of goods and services

- ca. 20 billion Euro/year

BENEFIT:

Saving funds at the very moment, avoiding negative impacts of “wrong action”

MONITORING

COST:

”no action”

BENEFIT:

Establishing scientific network, constant implementation and evolution of methods and in-situ exploration.

Alerting system formation, potentially raising public awareness, that is filling knowledge gaps and improves threats categorization and risk assessment. Possibly lowering costs of remediation in the future.

LIMITATION OF ACTIONS

COST:

BENEFIT:

Establishing administrative network, implementation of policies, controlling offices**.** Diminishing potential of accidents occurrence, raising public awareness that involves direct end-users.

NEUTRALIZATION AT SEA
DETONATION IN SITU
RECOVERY AND DESTRUCTION

COST:

Create new problem if performed incorrectly. Can have their specific negative impacts on ecosystem

BENEFIT:

Proper clean up and removal of a threat

CONCLUSIONS

- Baltic Sea provides multiple goods and services that need to be secured
- Sea dumped warfare poses a specific threat to each o them, and any forms of action would have to be site specific
- Potential environmental costs of different management can be predicted
- Potential monetary value and benefits depend on the “market demand”, which is directly related to public awareness.

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Interreg
Baltic Sea Region

EUROPEAN UNION
EUROPEAN
REGIONAL
DEVELOPMENT
FUND

EU STRATEGY FOR THE BALTIC SEA REGION
FLAGSHIP

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