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Review

Synthesizing the impact of sea-dumped munition and related chemicals on humans and the environment

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ABSTRACT

Marine environments are globally impacted by vast quantities of munition disposed following both World Wars. Dumped munitions contain conventional explosives, chemicals warfare agents as well as a variety of metals. Field monitoring studies around marine dumpsites report the presence of munition constituents in water and sediment samples. The growing interest and developments in the ocean as a new economic frontier underline the need to remediate existing dumpsites. Here, we provide a comprehensive assessment of the magnitude and potential risks associated with marine munition dumpsites. An overview of the global distribution of dumpsites identifying the most impacted areas is provided, followed by the currently available data on the detection of munition constituents in environmental samples and evidence of their toxic potential to human and environmental health. Finally, existing data gaps are identified and future research needs promoting better understanding of the impact of the dumped material on the marine environment suggested.

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First evidence of explosives and their degradation products in dab (*Limanda limanda* L.) from a munition dumpsite in the Baltic Sea

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ABSTRACT

Corrosion and disintegration of munition shells from the World Wars increase the risk that explosives are released into the marine environment, exposing a variety of organisms. Only few studies investigated contamination of fish with explosives in the field under environmental conditions. Here we present a comprehensive study on the contamination status of dab (*Limanda limanda*) from a munition dumpsite and from reference sites in the Baltic Sea. Bile of 236 dab from four different study sites, including a dumpsite for conventional munitions, was investigated and explosive compounds were detected by high performance liquid chromatography-mass spectrometry. Five explosive compounds were identified, including 2,4,6-trinitrotoluene, 4-amino-2,6-dinitrolouene, and hexahydro-1,3,5-trinitro-1,3,5-triazine. 48% of the samples from the dumpsite contained at least one explosive compound. The results prove that toxic explosive compounds from a dumpsite in the Baltic Sea are accumulated by flatfish and may therefore pose a risk to fish health and human food safety.

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Article

Ecotoxicological Risk of World War Relic Munitions in the Sea after Low- and High-Order Blast-in-Place Operations

Edmund Maser,* Katrine J. Andresen, Tobias H. Bünning, Ole R. Clausen, Uwe Wichert, and Jennifer S. Strehse

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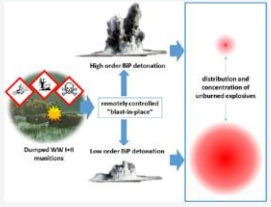
ABSTRACT: Submerged munitions from World War I and II are threatening human activities in the oceans, including fisheries and shipping or the construction of pipelines and offshore facilities. To avoid unforeseen explosions, remotely controlled "blast-in-place" (BiP) operations are a common practice worldwide. However, after underwater BiP detonations, the toxic and carcinogenic energetic compounds (ECs) will not completely combust but rather distribute within the marine ecosphere. To shed light on this question, two comparable World War II mines in Denmark's Sejerø Bay (Baltic Sea) were blown up by either low-order or high-order BiP operations by the Royal Danish Navy. Water and sediment samples were taken before and immediately after the respective BiP operation and analyzed for the presence of ECs with sensitive GC-MS/MS and LC-MS/MS technology. EC concentrations increased after high-order BiP detonations up to 353 ng/L and 175 μg/kg in water and sediment, respectively, while low-order BiP detonations resulted in EC water and sediment concentrations up to 1,000,000 ng/L (1 mg/L) and >10,000,000 μg/kg (>10 g/kg), respectively. Our studies provide unequivocal evidence that BiP operations in general lead to a significant increase of contamination of the marine environment and ecotoxicological risk with toxic ECs. Moreover, as compared to high-order BiP detonations, low-order BiP detonations resulted in a several 1000-fold higher burden on the marine environment.



KEYWORDS: *submerged munitions, blast-in-place detonations, energetic compounds, TNT toxicity, TNT carcinogenicity, low-order BiP detonations, high-order BiP detonations*

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Marine bivalves as bioindicators for environmental pollutants with focus on dumped munitions in the sea: A review

Jennifer S. Strehse, Edmund Maser

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Table 1
Physicochemical properties of conventional explosives and related chemicals detected in water and sediment samples from dumpsites.

Common chemical name or abbreviation	Class	Chemical abstract service number	Molecular weight (g/mol)[a]	Octanol-water partition coefficient (log Kow)[a]	Organic carbon-water partition coefficient - Koc (L/kg)[b]
1,3-DNB	TNT metabolite	99-65-0	168.12	1.55	351.6
1,3,5-TNB	Parent compound and TNT metabolite	99-35-4	213.1	1.18	1683
2,4-DNT	Parent compound	121-14-2	182.15	1.98	575.6
2,6-DNT	Parent compound	606-20-2	182.5	2.02	587.4
2-ADNT	TNT metabolite	35572-78-2	197.17	1.94	283
2-NT	TNT metabolite	88-72-2	137.14	2.3	370.6
4-ADNT	TNT metabolite	19406-51-0	197.17	1.91	283
4-NT	TNT metabolite	99-99-0	137.14	2.3	363.2
HMX	Parent compound	2691-41-0	296.16	0.17	531.6
NG	Parent compound	55-63-0	227.11	1.62	115.8
PETN	Parent compound	78-11-5	316.17	3.17	647.9
Picric acid	Tetryl metabolite	88-89-1	229.10	1.33	2251
RDX	Parent compound	121-82-4	222.26	0.90	89.07
Tetryl	Parent compound	479-45-8	287.17	1.69	4605
TNT	Parent compound	118-96-7	227.13	1.6	2812

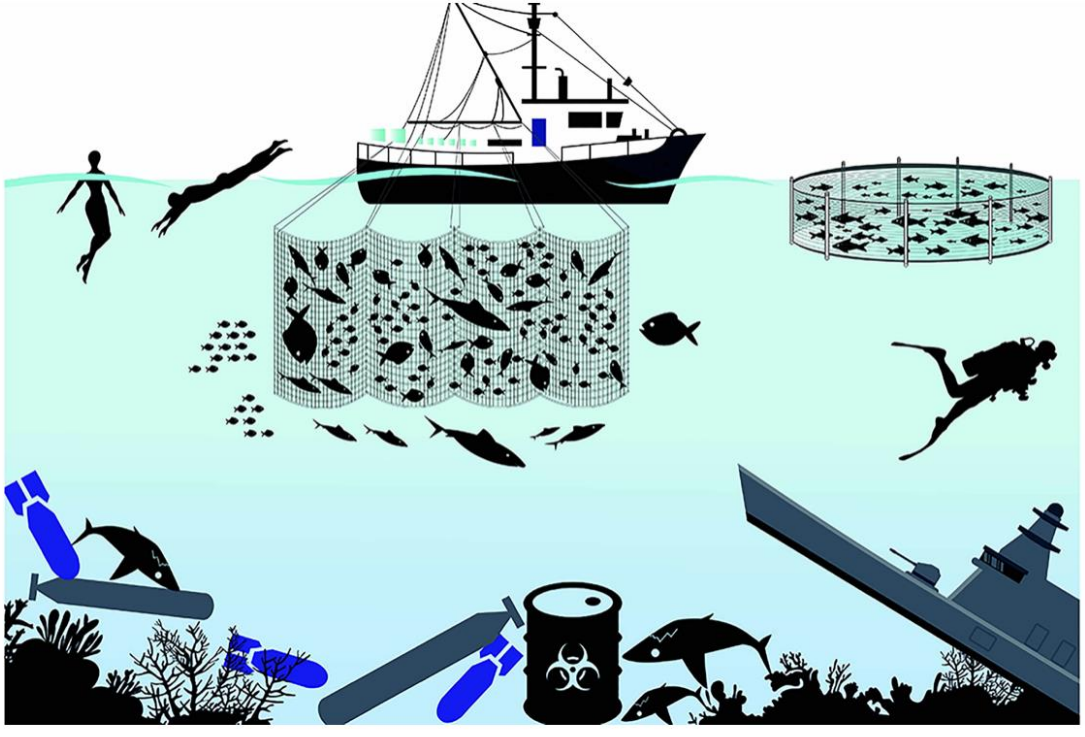
[a] Data retrieved from US EPA CompTox Chemical Dashboard (https://comptox.epa.gov/dashboard/), PubChem (https://pubchem.ncbi.nlm.nih.gov/).
[b] Data retrieved from KOCWIN, from EPI Suite v.4.1, developed by the United States Environmental Agency (USEPA).

Barbosa et al. (2023) Synthesizing the impact of sea-dumped munition & related chemicals on humans & the environment. Marine Pollution Bulletin 187:114601.

Discarded Munition Material & Unexploded Ordnance

- Are Parties regularly reporting on outcomes under ASCOBANS **Resolution 8.8 Addressing the Threats from Underwater Munitions**?

- Establish an ASCOBANS working group on this? Or…?



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