# Warship wrecks and their munitions cargo as a threat to the marine environment and humans: the V 1302 "JOHN MAHN" from World War II

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# Introduction

ammunition containing thousand tons of explosives. The fact that submerged





Figure 1: Issues caused by the release of energetic compounds from ship wrecks [7].

### Material and Methods

Together with nine partner institutions participating in this INTERREG North Sea Region program-funded North Sea Wrecks project, we have analyzed whether munition loaded wrecks are a potential threat to the surrounding marine environment [1,5,6]. After extensive archival research, fifteen wrecks off the coasts of the five countries were selected for sampling. Water and sediment samples were collected using CTD water samplers, Van Veen grabs, and by divers directly on the wreck. Biomonitoring using blue mussels and passive samplers were conducted on the vessels, as well as biota and scratch sampling. In addition, common dab (Limanda limanda) and pouting (Trisopterus luscus), sedentary species, were caught for histological and toxicological examination [6]. Samples were analyzed by GC-MS/MS and LC-MS/MS for the energetic compunds (EC) 1,3-DNB, 2,4-DNT, RDX, HMX, TNT and its metabolites 4-ADNT and 2-ADNT [8].

Figure 2: Map of the wracks examined in the project.

#### Experimental Results



The investigations revealed different releases of energetic compounds from the wrecks. While on some wrecks (e.g. SMS Mainz, a WWI light cruiser) the amounts of EC were barely above the detection limit, on other wrecks, such as the WW I minelayer submarine UC30, the WW I light cruiser SMS Ariadne, and the WW II outpost boat V1302, significantly elevated concentrations of TNT and its metabolites 2- and 4-ADNT were detected in all sample types examined [7]. In some sediment and water samples from the wreck of the UC30, TNT concentrations could be measured up to the  $\mu g/kg$  and  $\mu g/L$  range, respectively. On all three wrecks, TNT or its metabolites 2- and 4-ADNT were also detected in bile and muscle tissue of fish. In addition, there is evidence of a correlation between TNT concentration in tissues and an accumulation of liver diseases including liver tumors in adult fish, compared to a reference area considered uncontaminated.



Figure 3: Results of analysis of water, sediment, passive samplers, mussels (*M. edulis*), and filet and bile of pouting (*Trisopterus luscus*) collected from the shipwreck of the German "Vorpostenboot 1302", which was sunk in an air raid on February 12th, 1942, with almost one metric ton of nitroaromatic explosives still onboard [7].

# Conclusion

• The research clearly shows that World War wrecks can be a point source of energetic compound pollution to the marine environment.

- Exposure of marine fauna to various energetic compounds has been measured in wrecks with high concentrations in water and sediment, therefore, if detected in these, contamination can be assumed.
- For the risk assessment of a wreck, a historical research of the expected munitions cargo, as well as a sampling of different martrices (mainly water and sediment) is necessary.
- The data obtained will be incorporated into a risk assessment tool to assist policy makers in making clearing decisions. In a first instance, the remediation of a contaminated wreck is already in the planning stage.
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