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**Cruise Report****FFS „Clupea“****376 Cruise,**

03.07.-13.07.2023

Leading Scientist: Dr. Jörn Peter Scharsack

**CONMAR-Fish: Effects of marine dumped munition on fish in the Baltic Sea****Summary**

The fishery research trip was carried out to examine flatfish, especially dabs (*Limanda limanda*), near ammunition dumping areas in German waters of the Baltic Sea for diseases and residues of munition compounds (MC). Dabs from the Kolberger Heide ammunition dumping area in the Bay of Kiel and in the Bay of Flensburg east of the coast of Falshöft were caught and examined using ground gillnets. While dabs from the Kolberger Heide have already been sampled in previous surveys, this research trip was the first time that dabs were caught and examined in the 'Falshöft' area (Schleimünde Nord and Schleimünde Nord Ost). The research trip was hampered by bad weather and technical problems on the ship and unfortunately it was not possible to catch and examine the planned number of 30 dabs per location. Nevertheless, both locations, including the control locations, were sampled. Water samples were taken and dabs were caught and examined for disease on board. Body fluids and tissue samples were taken from the dabs and frozen for later laboratory studies on STV. Later analysis of dab samples in the laboratory revealed the presence of MC in bile fluid of dab investigated at Kolberger Heide and Schleimünde NO.

**Background**

During and after the First and Second World Wars, large quantities of ammunition were dumped in the Baltic Sea (approx. 300,000 t). Due to corrosion of ammunition casings, munition compounds (MC) enter the marine environment and can have negative effects on biota, including fish. After the Second World War, around 30,000 t of ammunition from Kiel city were dumped in the Kolberger Heide area (restricted area)

(Fig. 1.). MCs are known to leak from ammunition and have also been detected in dabs (Koske, Straumer et al. 2020, Kammann, Töpker et al. 2024). The aim of this research trip was to further investigate the pressure on fish in the Kolberg Heath as a time series.

In the ammunition dumping area east of Falshöft (Fig. 1.) a number (approx. 100) large ordnance such as torpedo heads were dumped. In this area, no fish have yet been examined for possible effects of old ammunition. As part of the BMBF-funded research project CONMAR (CONcepts for conventional Marine Munition Remediation in the German North and Baltic Sea), the situation picture of the contamination of fish in the vicinity of marine ammunition dumps is to be completed. This is why the investigations are carried out at known contaminated sites such as Kolberger Heide, has been expanded to include locations such as Falshöft, where so far little is known about the pollution of the marine environment by contaminated waste. In fact, STV was detected in galls of dabs caught in the Schleimünde NO area (Kammann, Töpker et al. 2024).

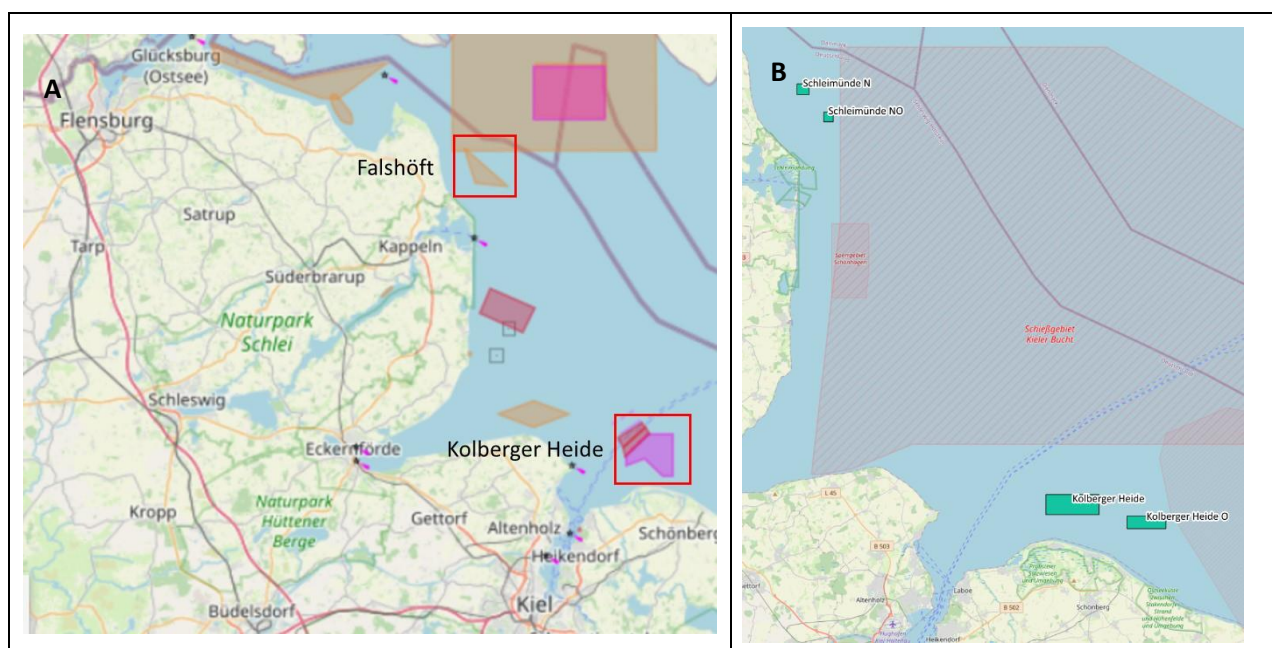


Fig. 1. Maps of sampling areas. A The underlying map with the indicated ammunition dumps (red and brown fields) was taken from <https://legacy.amucad.org/map>. The sampling took place in areas with red frames with ground nets (green areas in B) immediately next to the Schleimünde NO and Kolberger Heide ammunition and at a distance of 2-4 nautical miles from the old ammunition (Schleimünde N and Kolberger Heide O).

## Methods

### Collection of flat fish

A suitable method for catching flatfish alive near dumped ammunition in the Baltic Sea is to use bottom gillnets. In areas where ammunition is dumped, it is not possible to use fishing gear that touches the ground, as there is a risk of picking up ammunition that is still ignitable, explosive or could be harmful in some other

way. For this reason, fishing gear that was in contact with the ground, in this case ground gillnets, was used in the immediate vicinity of ammunition dumping areas.

During this trip, gill nets with a mesh size of 60mm and a length of 50m were used. The nets were connected into sections of 2, 4 or 5 as required, always using two sections of equal length, one for the ammunition and one at a distance of a few nautical miles as a control. The gillnets were set for 2-4 hours during the day, but usually overnight (15-20 hours).

At each location, a CTD measurement and a water sample were first taken for STV measurements. Nets were only set if more than 50% oxygen saturation was measured 1m above ground.

### *Sampling of fish*

The focus of the investigations was on dabs (*Limanda limanda*), a bottom-dwelling flatfish species that lives on the seabed in the immediate vicinity of sunken ammunition. The collected fish were kept on board in tanks with seawater flow through until sampling. The dabs were killed by brain cutting, examined for externally visible diseases, and weight and length were measured. Body fluids (blood, bile, urine) and tissue samples (liver, spleen, muscle) were collected and stored frozen for later laboratory analysis. The livers were examined for tissue changes, particularly nodules (potential tumours). Samples from each individual fish were shared between the participating laboratories (AWI and Thünen) with different analysis focuses. The AWI focused on liver samples to analyse the activities of detoxifying enzymes, and Thünen collected body fluids and tissue samples to examine for TNT residues.

### **Narrative**

The scientific crew embarked in Rostock on Monday, July 3, 2023 and installed the scientific equipment on board with the help of the crew. On July 4th brought the Clupea to Kiel in relatively bad weather (strong wind and swell). On July 5th there was a storm warning for the Bay of Kiel and the Clupea remained in the port of Kiel. The planned participation of research divers during this time could not be carried out. On July 6th The Kolberger Heide Ost was approached, the CTD measurement showed oxygen above ground >50% saturation. After this first use the CTD was defective and was repaired on Friday July 7th repaired in Flensburg.

On July 6th from 10:00 a.m., 2 x 50m nets were put in place at the Kolberger Heide restricted area and 2x50m nets at Kolberger Heide Ost. As of 12:30 p.m., the nets were recovered again because there were fears that the nets could be contaminated by floating algae due to the storm. In fact, there was only a little algae in the nets, but also only a few fish. In the afternoon, 1x4x50m net was set up at Kolberger Heide West and 1x4x40m net was set up in the Kolberger Heide West control area overnight. On July 7th Both nets were recovered, at the Kolberger Heide there were only three dabs in the net, and a little more in the control net.

After retrieving the nets, the Clupea moved to Flensburg, where it was moored over the weekend. On Monday 10.7., without CTD measurement (the program could not be started), 1x5x50m net was set in the Falshöft dumping area at the Schleimünde North East site and 1x5x50m net in the Schleimünde North area at a depth of 14m each.

On Tuesday July 11th The nets were lifted, but only contained 6 dabs in the Schleimünde North East area and only one dab in the Schleimünde North area. After clearing the nets, CTD measurements were carried out with water samples at both locations and nets were repositioned as 5x50m sections. Another CTD was carried out at the Falshöft Nord Ost Munition site, oxygen saturation was > 50% at 12m but no net was set up here as the area is in a shipping lane.

On Wednesday July 12th the Clupea had problems with the navigation system and the captain drove by sight and found the nets. The nets again contain relatively few fish, more plaice than dabs. A grey lump in the net, which gives off a yellow colour when touched, turned out to be suspected gun wool when asked later by Uwe Wiechert, an expert on old munitions. Due to technical problems with the navigation system, the sampling was completed a day earlier than planned and the Clupea headed for Kiel to make the necessary repairs. On Thursday July 13th Dismantling took place in Kiel and the return journey to Bremerhaven.

### First results

A total of 26 dabs (*L. limanda*) >15 cm were sampled during the research trip, most of them in the size class 20–24 cm (Table 1).

<b>Species length cm</b>	<b>Location</b>	<b>N fish</b>
Dab 20 bis 24	Kolberger Heide	2
Dab >= 25	Kolberger Heide	10
Dab 20 bis 24	Kolberger Heide O 1	1
Dab >= 25	Kolberger Heide O 2	2
Dab >= 25	Schleimünde N	1
Dab 20 bis 24	Schleimünde NO	5
Dab >= 25	Schleimünde NO	5
<b>Sum</b>		<b>26</b>

Table 1. Size class and number of dabs caught per study area.

Location	N	unt	Ly	EpPap	Ulc	FloF	i	KieHy	Mel	Skel	Steph	Acanth	Lepe	Cryp
KH	12	0	0	0	0	0	0	41.7	0	0	0	0	0	0
KHO	3	0	0	0	0	0	0	66.7	0	0	0	0	0	33.3
SchleiN	1	0	0	0	0	0	0	0	0	0	0	0	0	0
SchleiNO	10	0	0	0	0	0	0	0	0	0	0	0	0	10
SUMME	26													

Table 2. Externally visible fish diseases of the examined dabs (viral: Lymphocystis - Ly, epidermal papilloma - EPap, bacterial: ulceration of the skin - Ulc and fins - FloF, parasitic: *Stephanostomum baccatum* - Steph, *Lepeophtheirus pectoralis* - Lepe, *Acanthochoondria cornuta* - Acanth, Gill hyperplasia – KieHy, skin melanoma – Mel and skeletal deformities – Skel).

### Scientific staff

Name	Institution	Function
Jörn Peter Scharsack	TI-FI	Scientist in Charge
Lea Riemeier	TI-FI	Technician
Romina Schuster	AWI	Scientist

### Acknowledgements

We would like to thank Captain Maik Schünemann and the crew of the FFS "Clupea" for their competent support and hospitality on board and the trip participants for their reliable and responsible teamwork.

### Literature

Kammann, U., V. Töpker, N. Schmidt, M. Rödiger, M.-O. Aust, M. Gabel and J. Scharsack (2024). "Explosives leaking from dumped munition contaminate fish from German coastal waters: a reason for chronic effects?" Environmental Sciences Europe **36**.

Koske, D., K. Straumer, N. I. Goldenstein, R. Hanel, T. Lang and U. Kammann (2020). "First evidence of explosives and their degradation products in dab (*Limanda limanda* L.) from a munition dumpsite in the Baltic Sea." Marine Pollution Bulletin **155**: 7.