

Decision Aid for Marine Munitions, Practical Applications.

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Situation of Baltic Sea dumped munitions



CHEMSEA
CHEMICAL MUNITIONS
SEARCH & ASSESSMENT



MODUM
TOWARDS THE MONITORING
OF DUMPED MUNITIONS THREAT

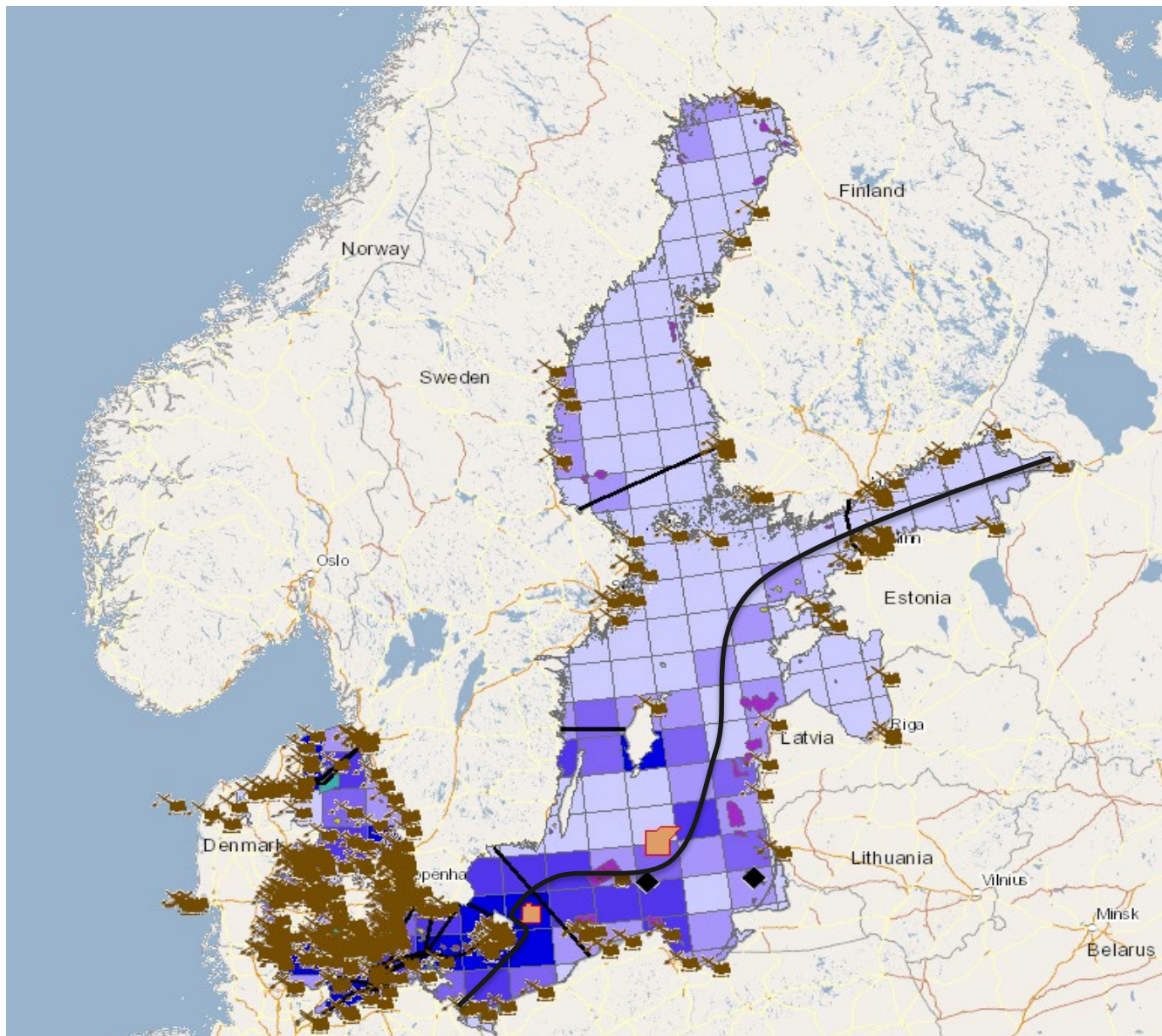
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Decision Aid for Marine Munitions

 **Interreg**
Baltic Sea Region



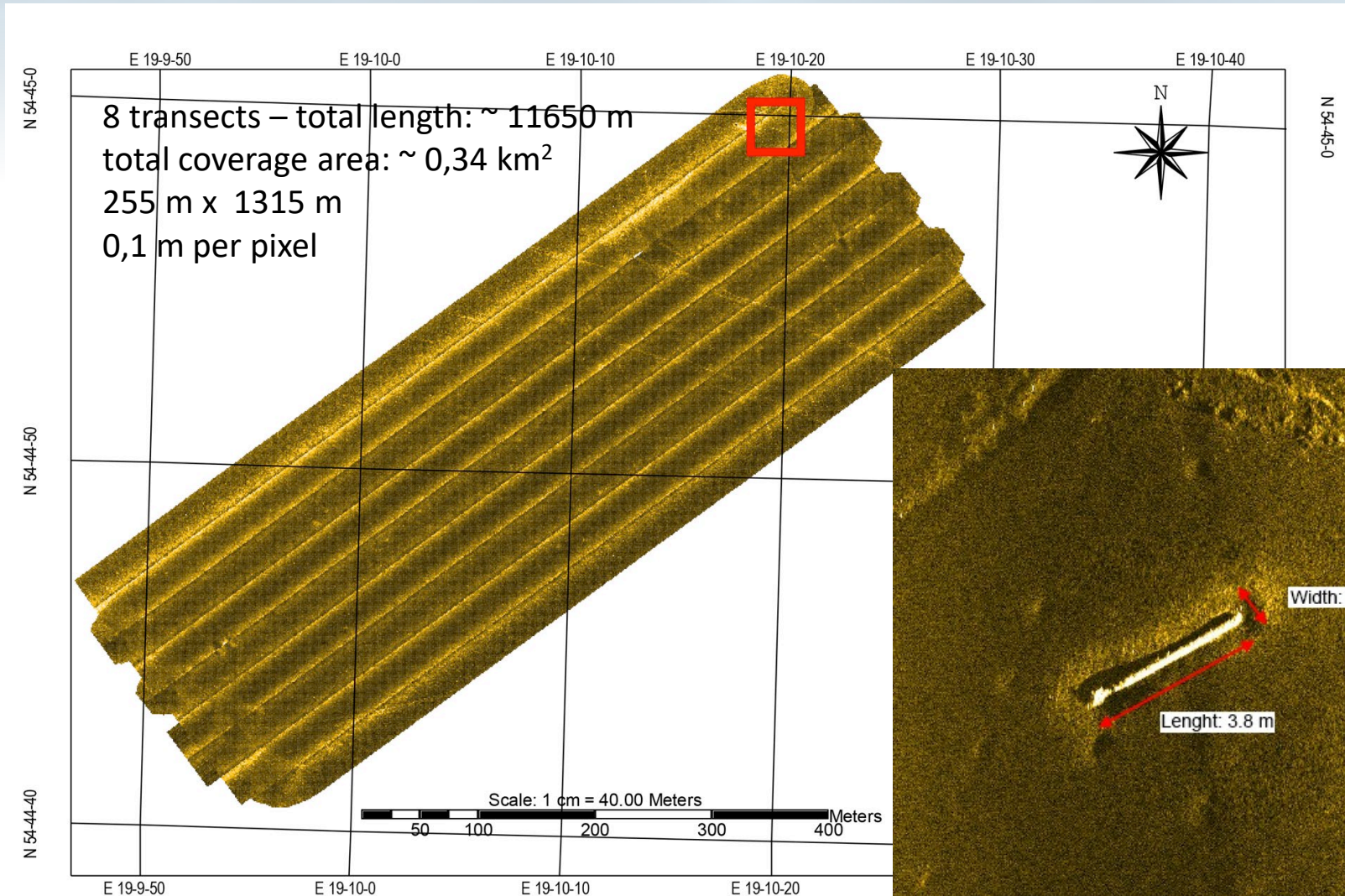
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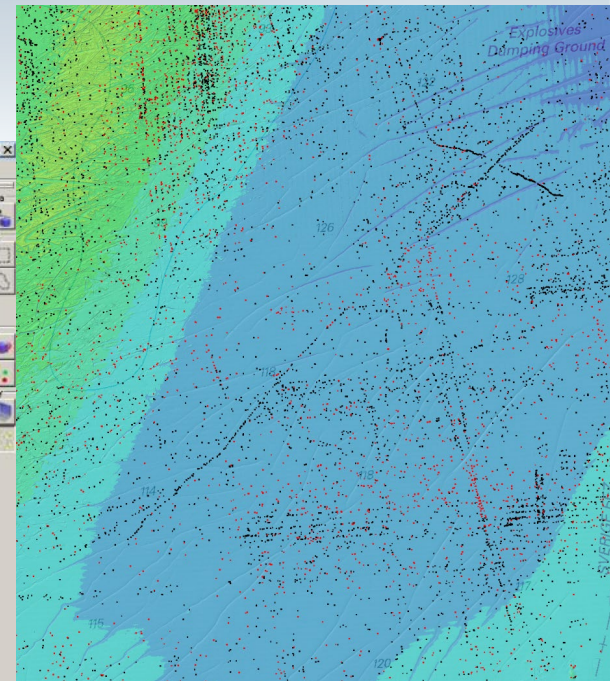
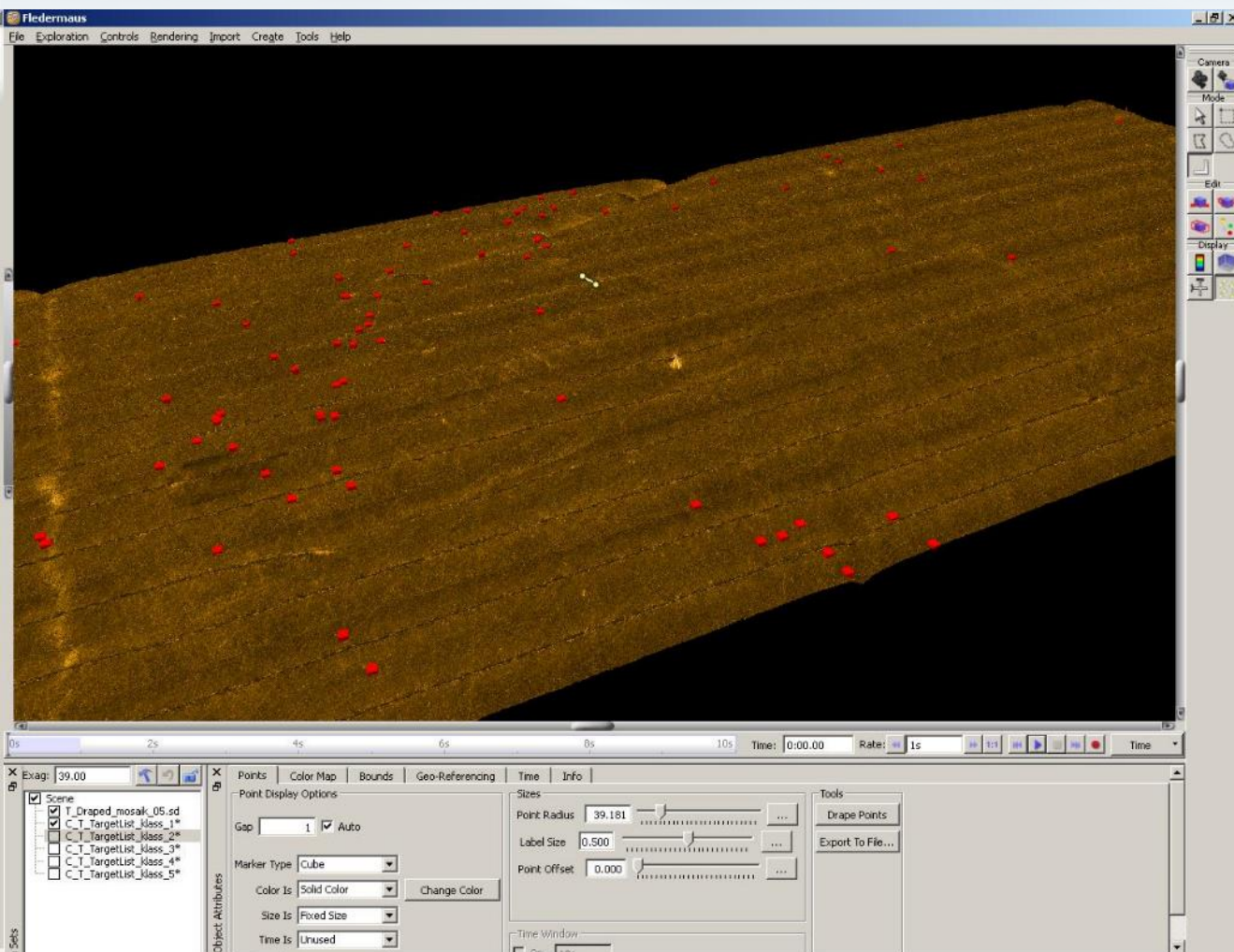
Legend:

- CWA Dumps
- Dredge sites
- Offshore wind farms (planned)
- Bottom Trawling intensity
- Pipelines and Cables

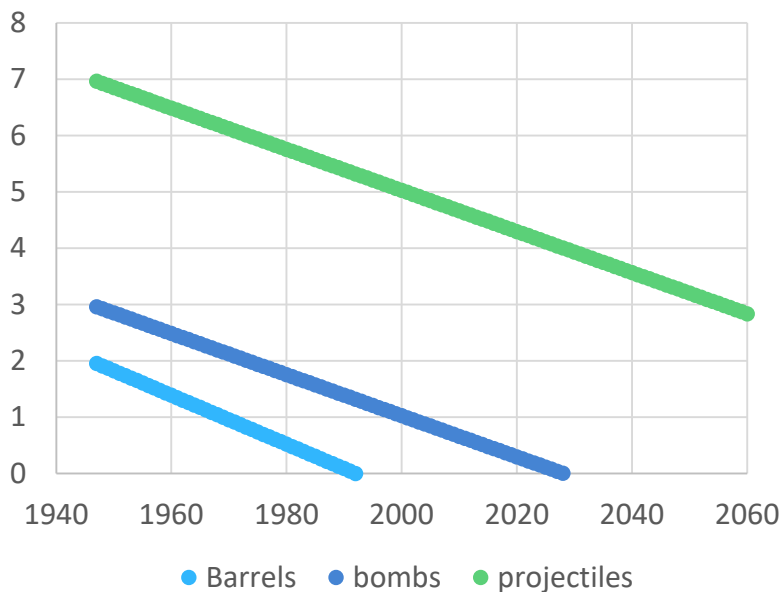
Detection



Classification



Corrosion



Barrels $V_k=0,0434$ mm/rok
 Bombs $V_k=0,0365$ mm/rok
 In sediments $V_k=0,0313$ mm/rok

Wall thickness:
 Barrels 1.5 do 2 mm
 Bombs 3 mm
 Projectiles 5-7 mm

Munition Status

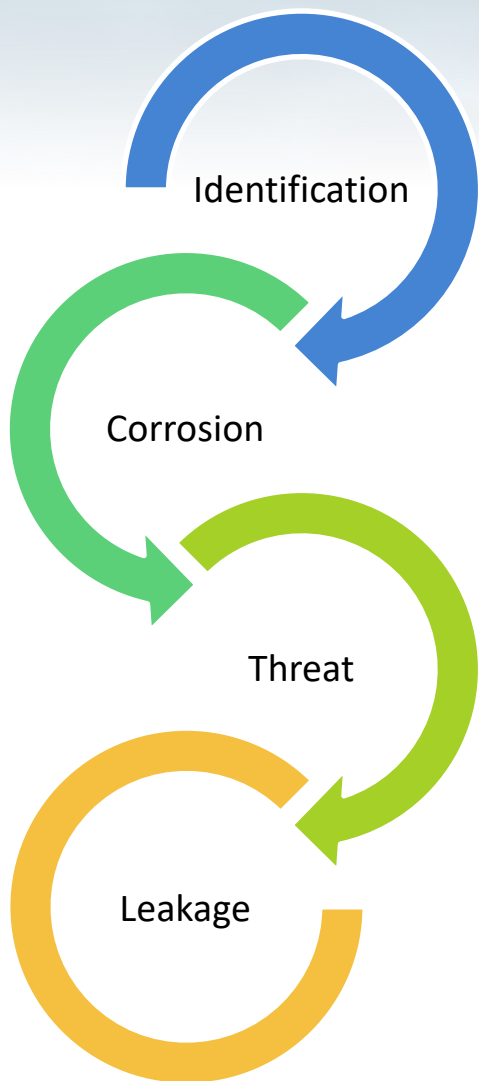


Figure 1

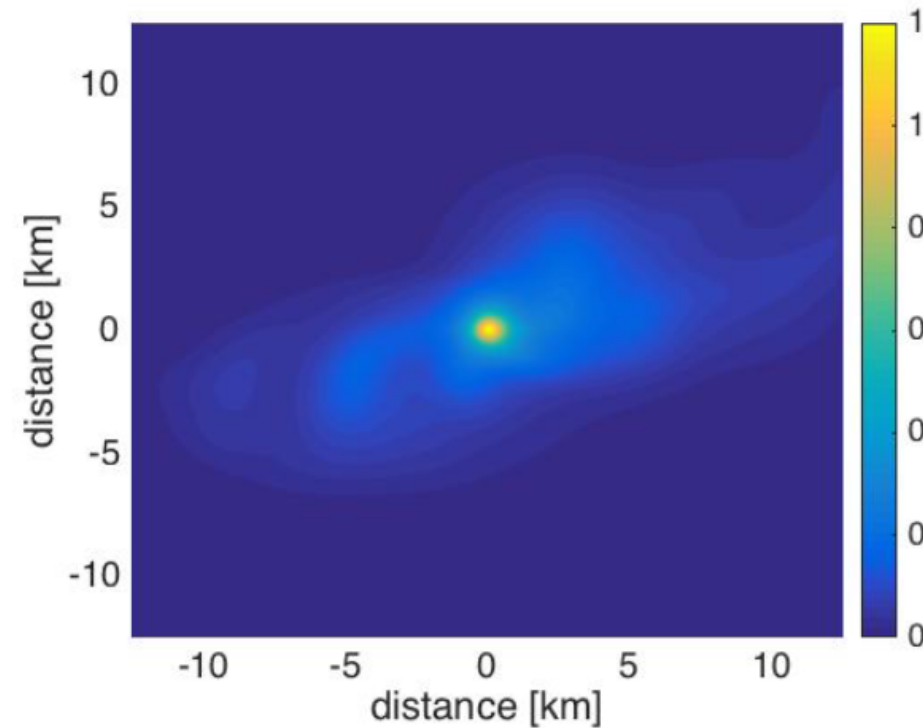
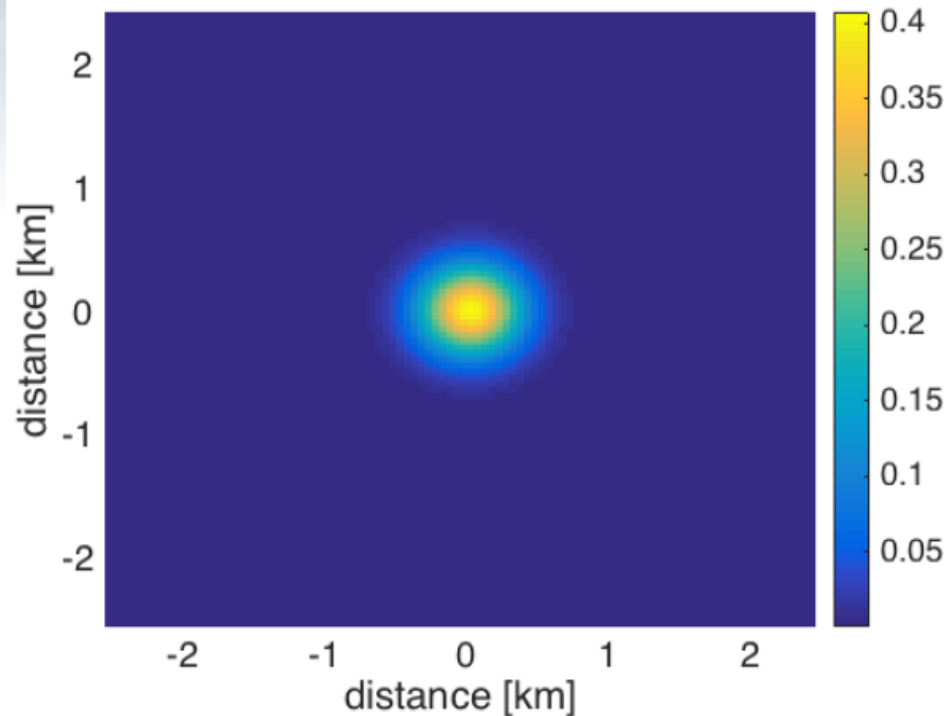


Figure 2



Figure 3

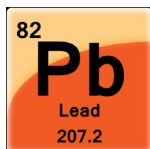
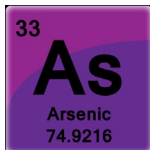
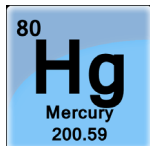
High Resolution Model (HRM)-Bornholm Deep (constant leakage)



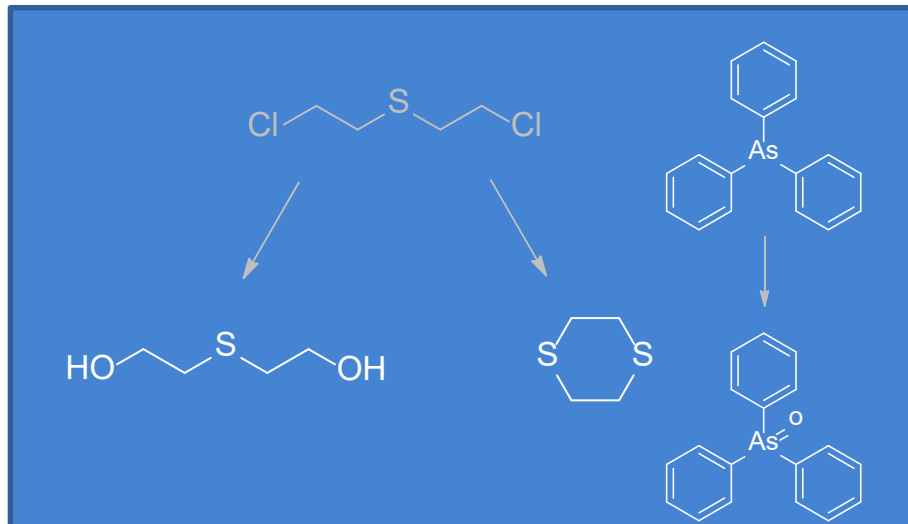
Initial state and situation after 5 days of estimated potential leakage. Horizontal and vertical axes represent distance in relative units. Color scale can be interpreted as the level of contamination.

Pollution of sediments and water

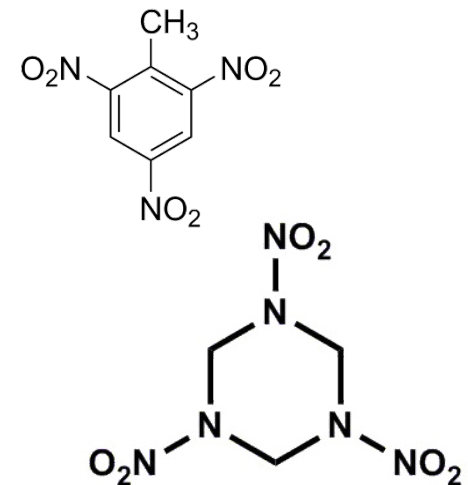
Metals



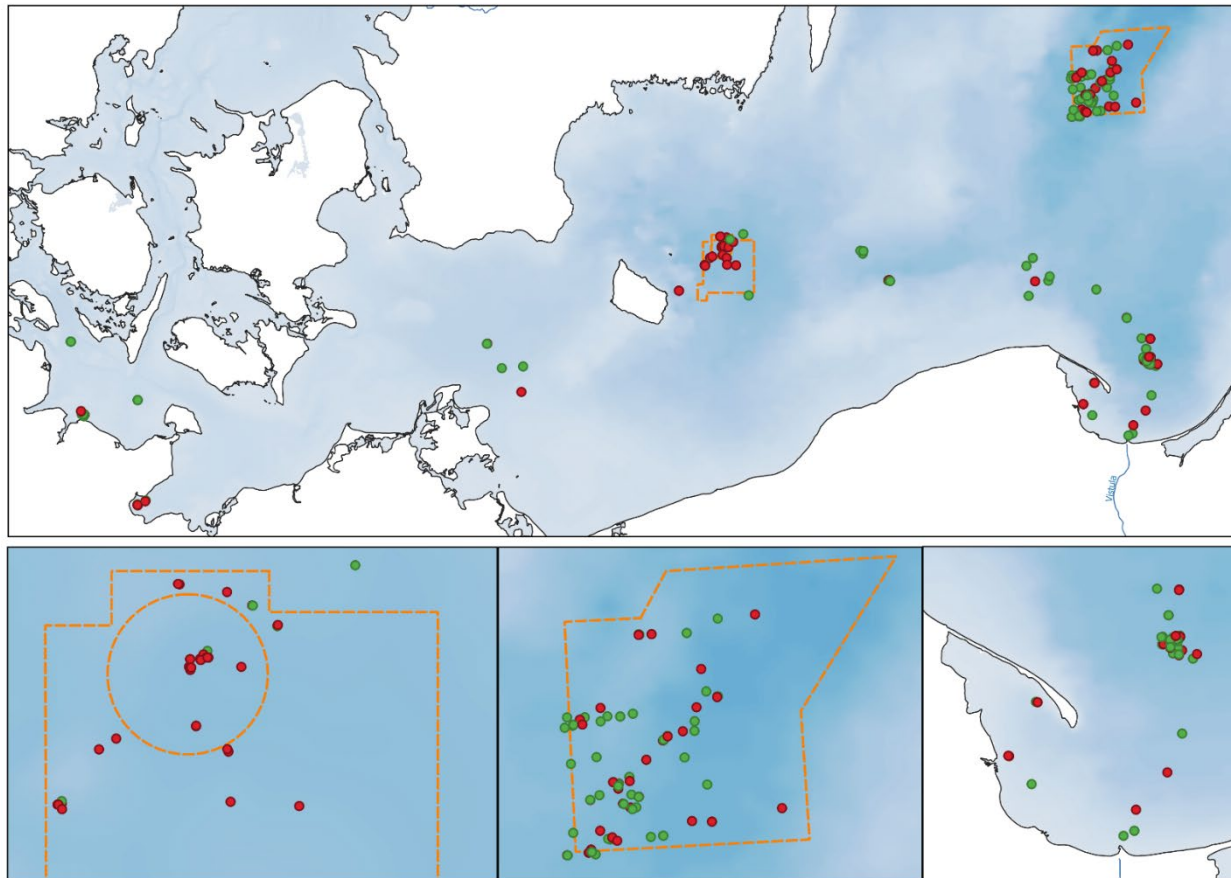
Chemical Warfare Agents



Explosives

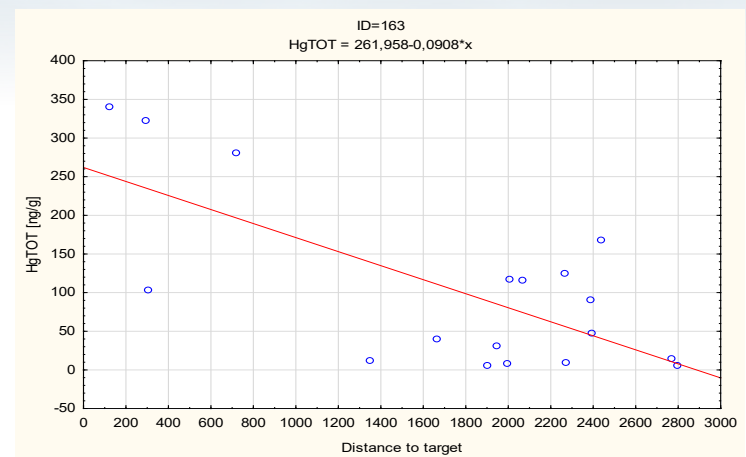
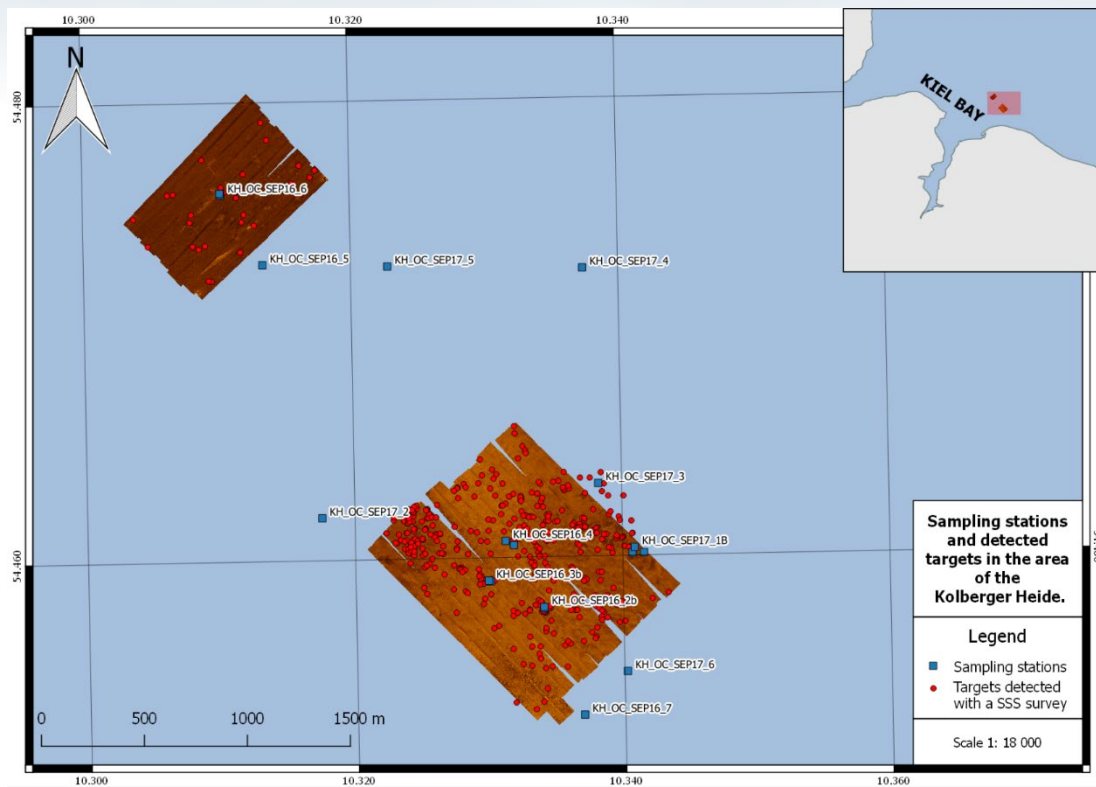


Contamination of sediments

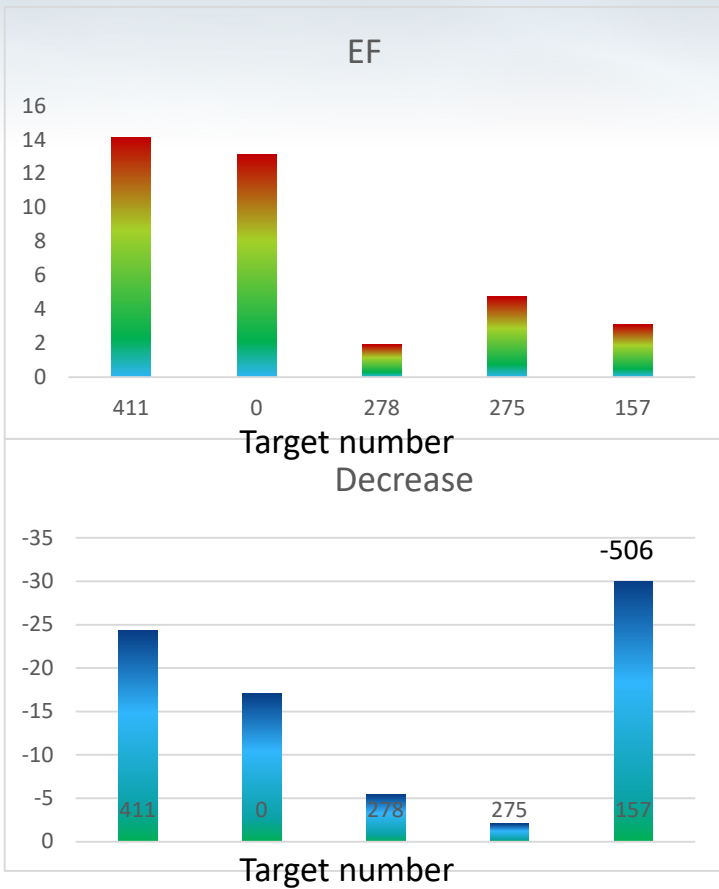


Degradation Products

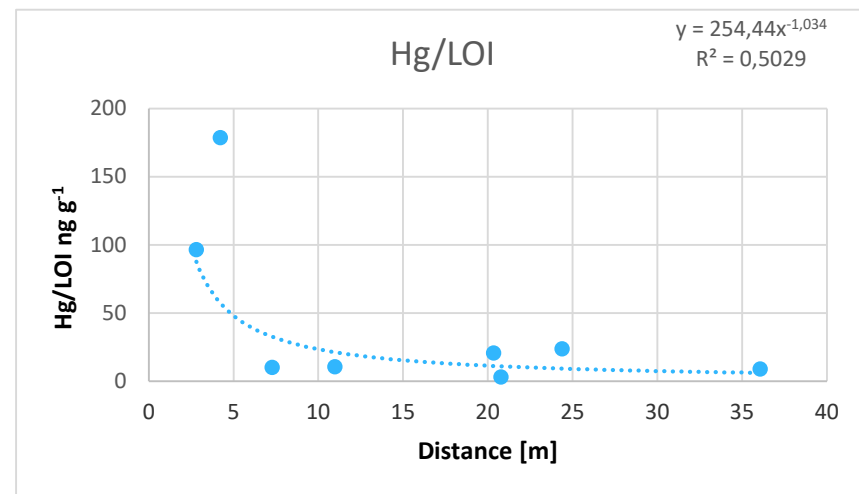
Overall concentrations



Enrichment, range

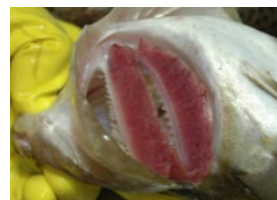
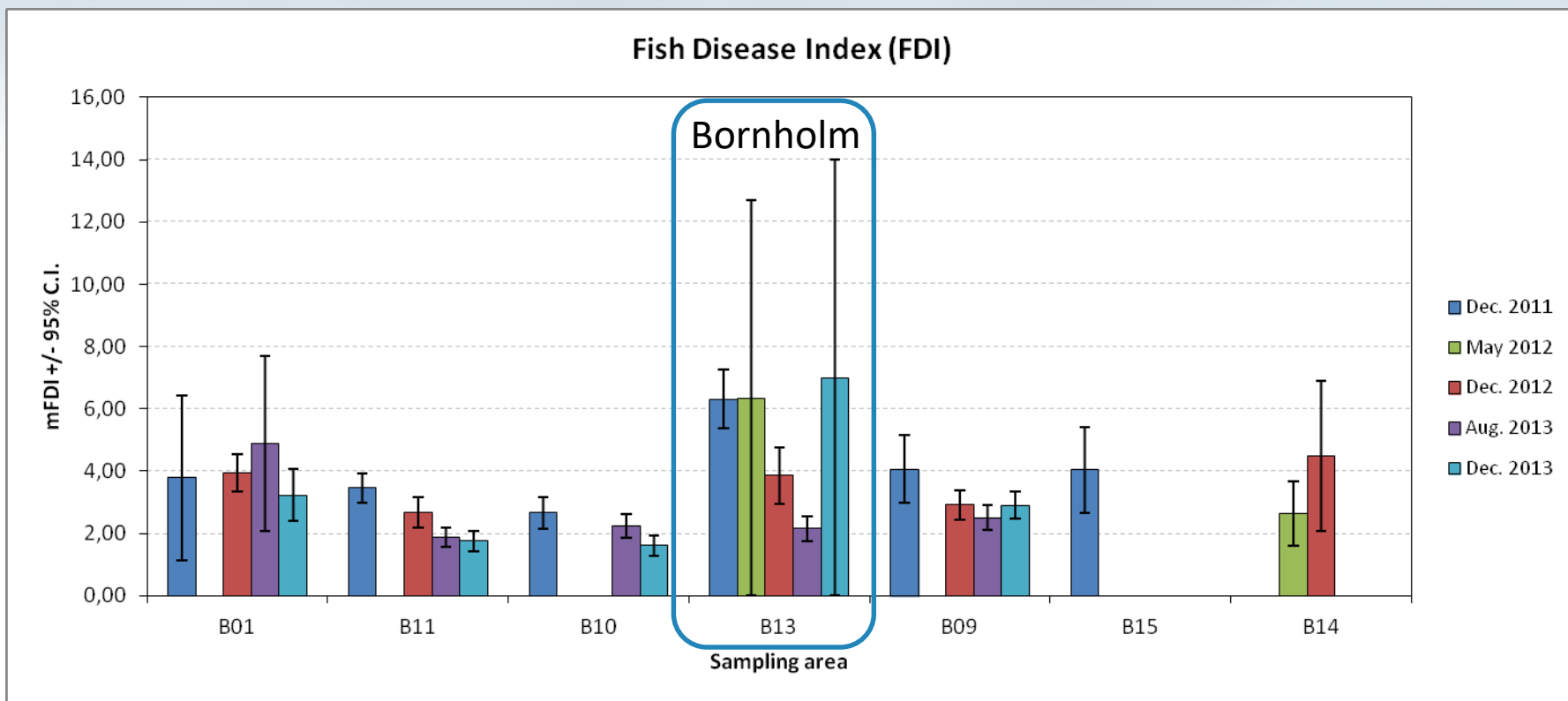


- Large sources predominantly local
- Sharp gradients
- May depend on corrosion
- Range not directly depend on concentration



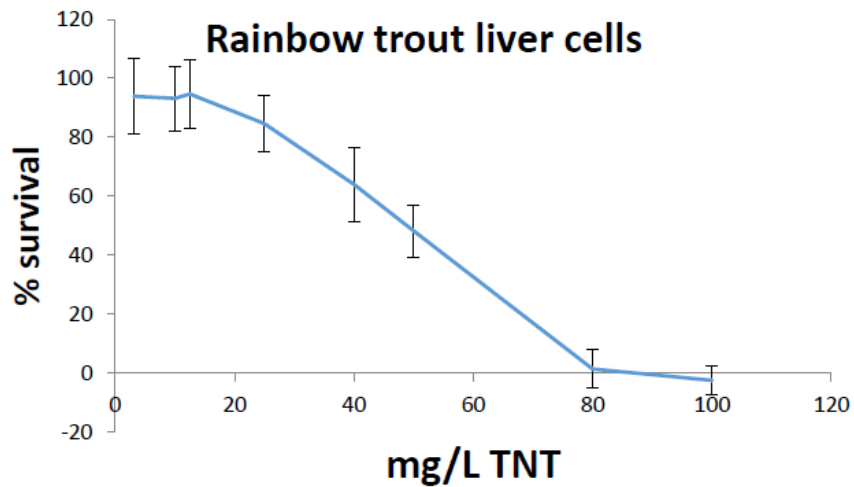
Impact on biota

Fish Disease Index (FDI)

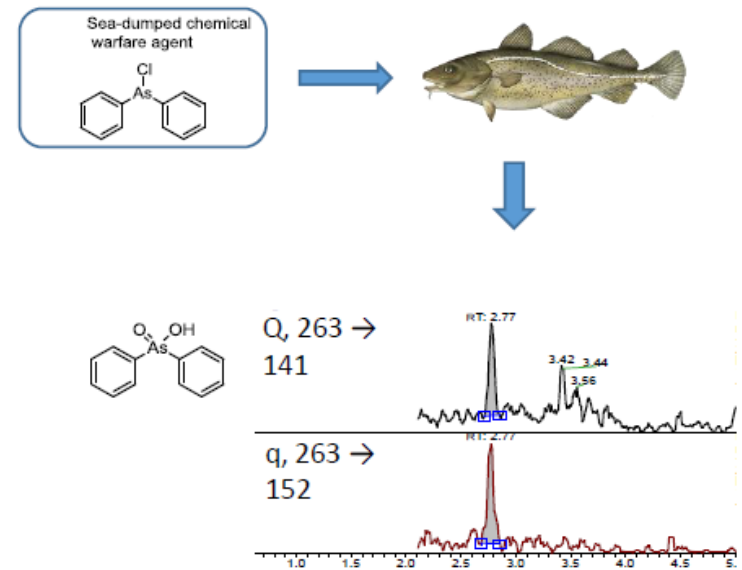


Impact

Toxicity



Bio accumulation



Fish results

- 3 out 100 reference cod muscle contained TPAox
- No DPA detected from Bornholm reference area
- 13 % of studied cod muscle samples collected from Bornholm dumpsite have contained arsenic CWAs
 - 20 % analysed cod liver samples have contained TPAox

Species	Sampling area	Number of samples	Muscle		Liver	
			DPA	TPAox	DPA	TPAox
Cod	Bornholm reference site B09	100	-	3/100	0/10	0/10
Cod	Bornholm dumping site B13	120	9/120	10/120	0/10	3/15
Saithe	Måseskär	9	NA	NA	0/9	0/9
Hagfish	Skagerrak (wreck 13)	20	10/20	19/20	NA	NA

Food web impact

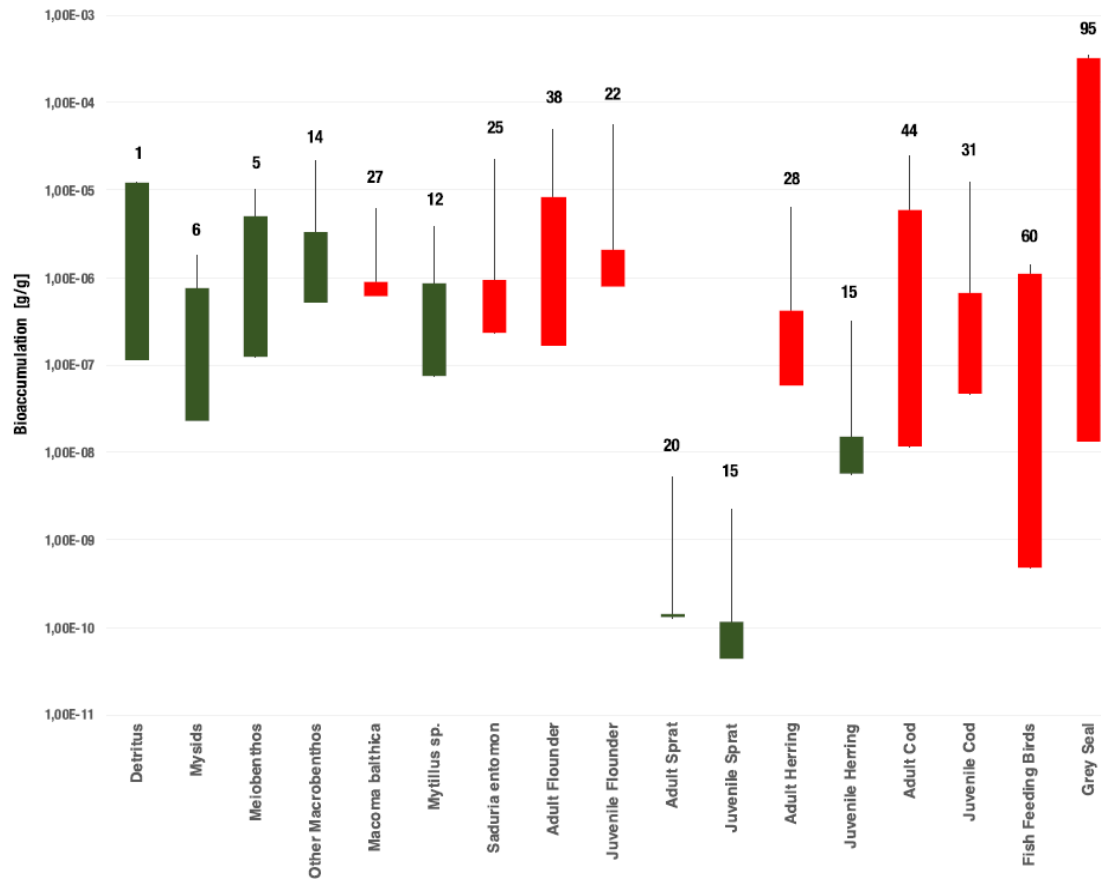


Figure 3.

Modelled t_0 , t_{end} and maximum concentrations of Clark I + degradation products in biota and detritus per 1 gram of biomass. Green color represents a decrease and red color an increase of concentration during 10 years from leakage. Numbers above each box represent the months when maximum concentrations occurred.

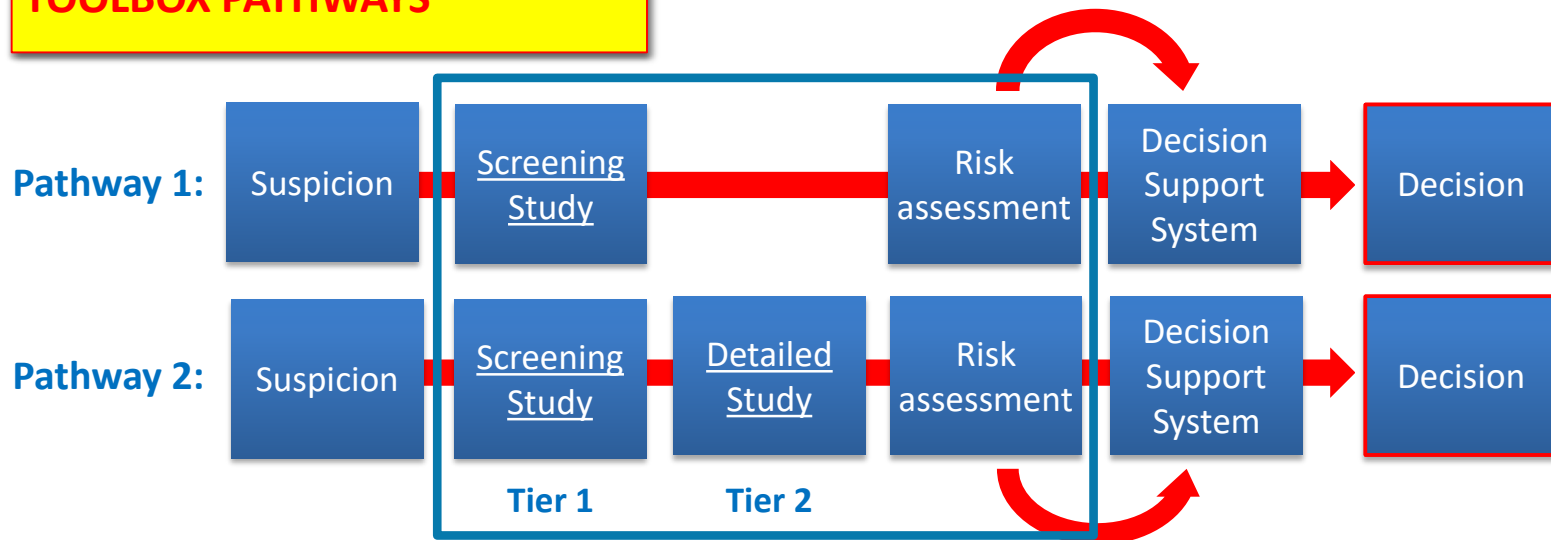
3 Questions

Presence	Leakage	Impact
Detection	Sediments	Biodiversity
Identification	Biota	Conditions
	Porewaters	Biomarkers

ECOTOX Toolbox

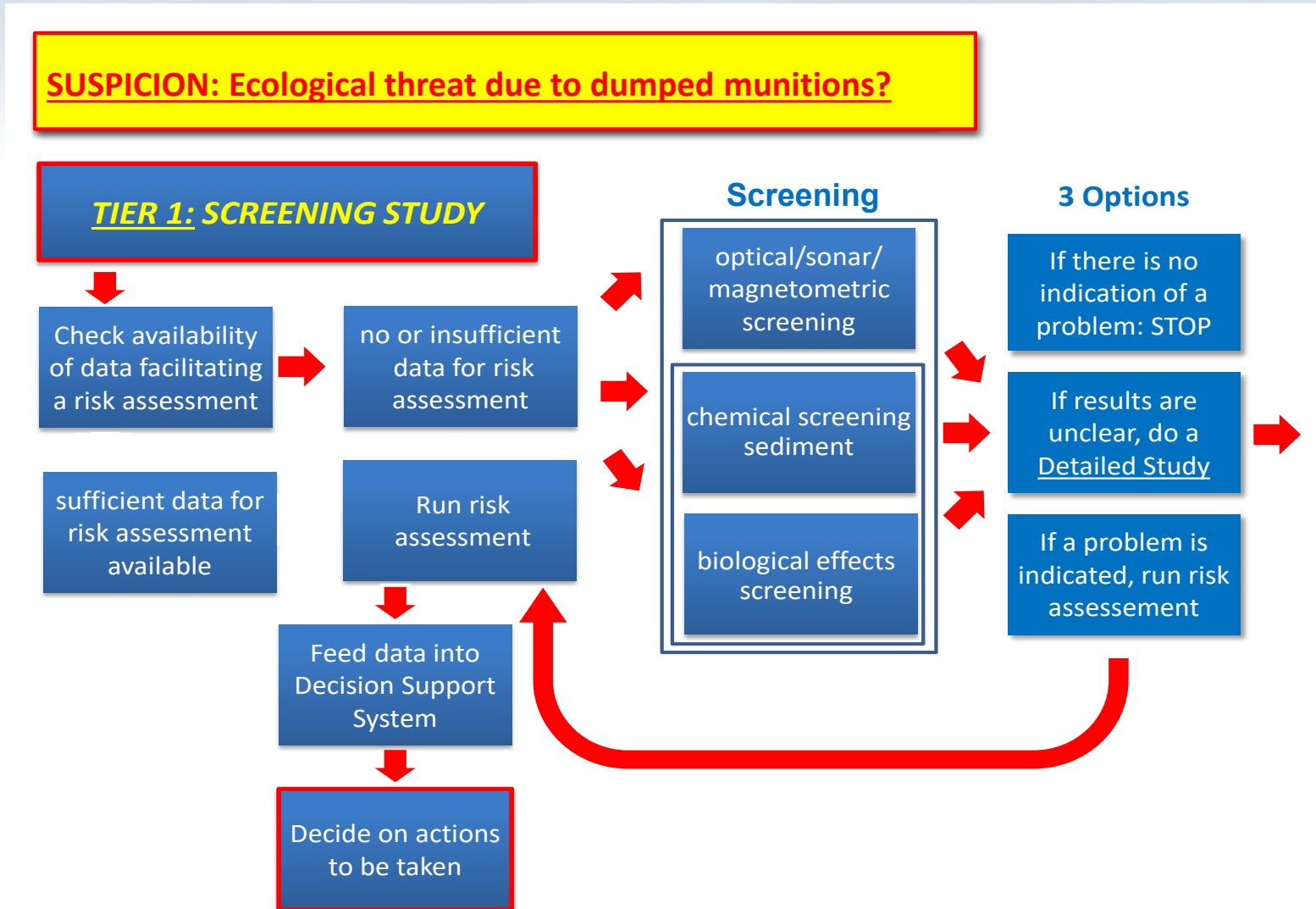
Concept & strategy

TOOLBOX PATHWAYS



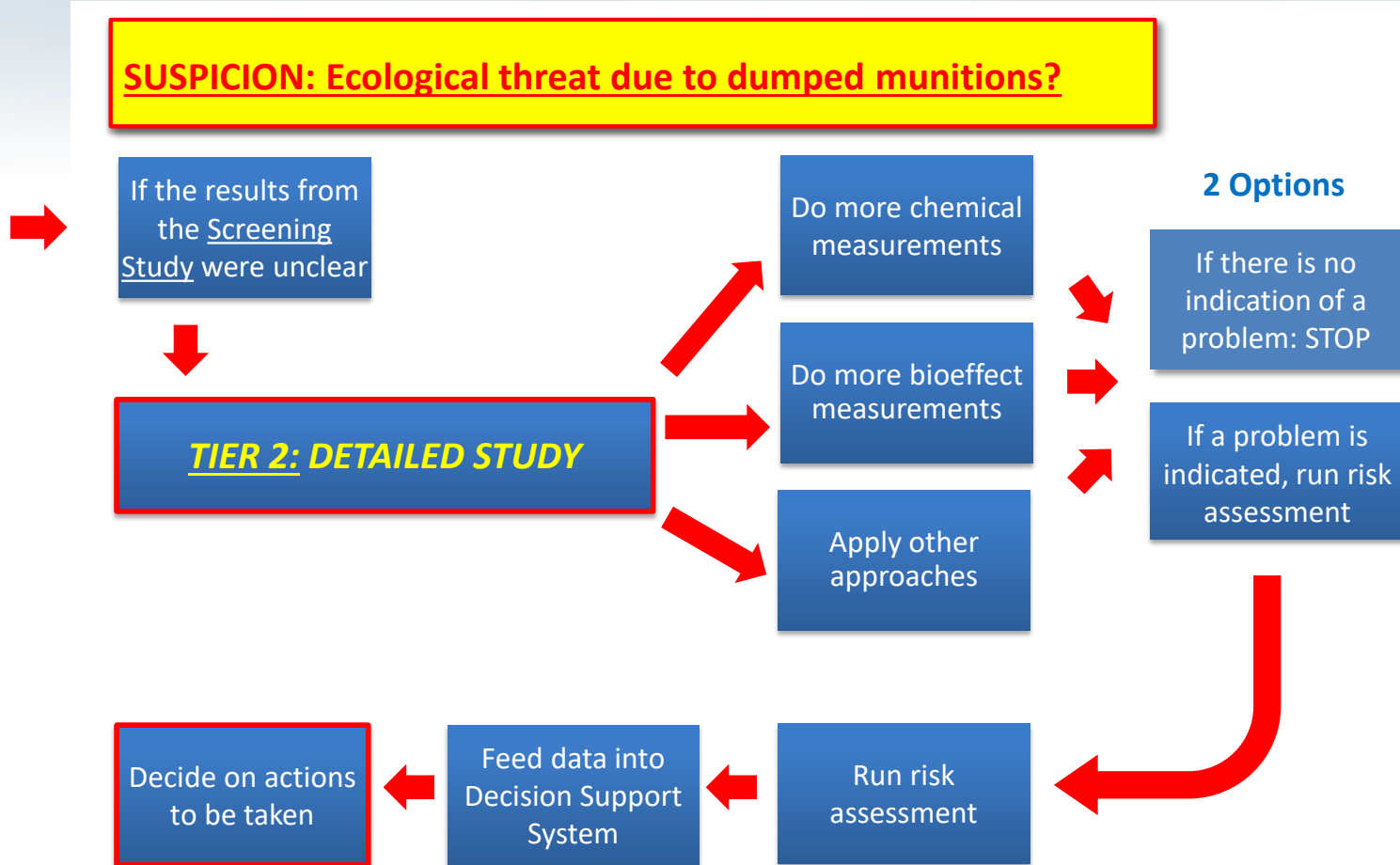
DAIMON A 2.5 Toolbox

Tier 1: Screening Study

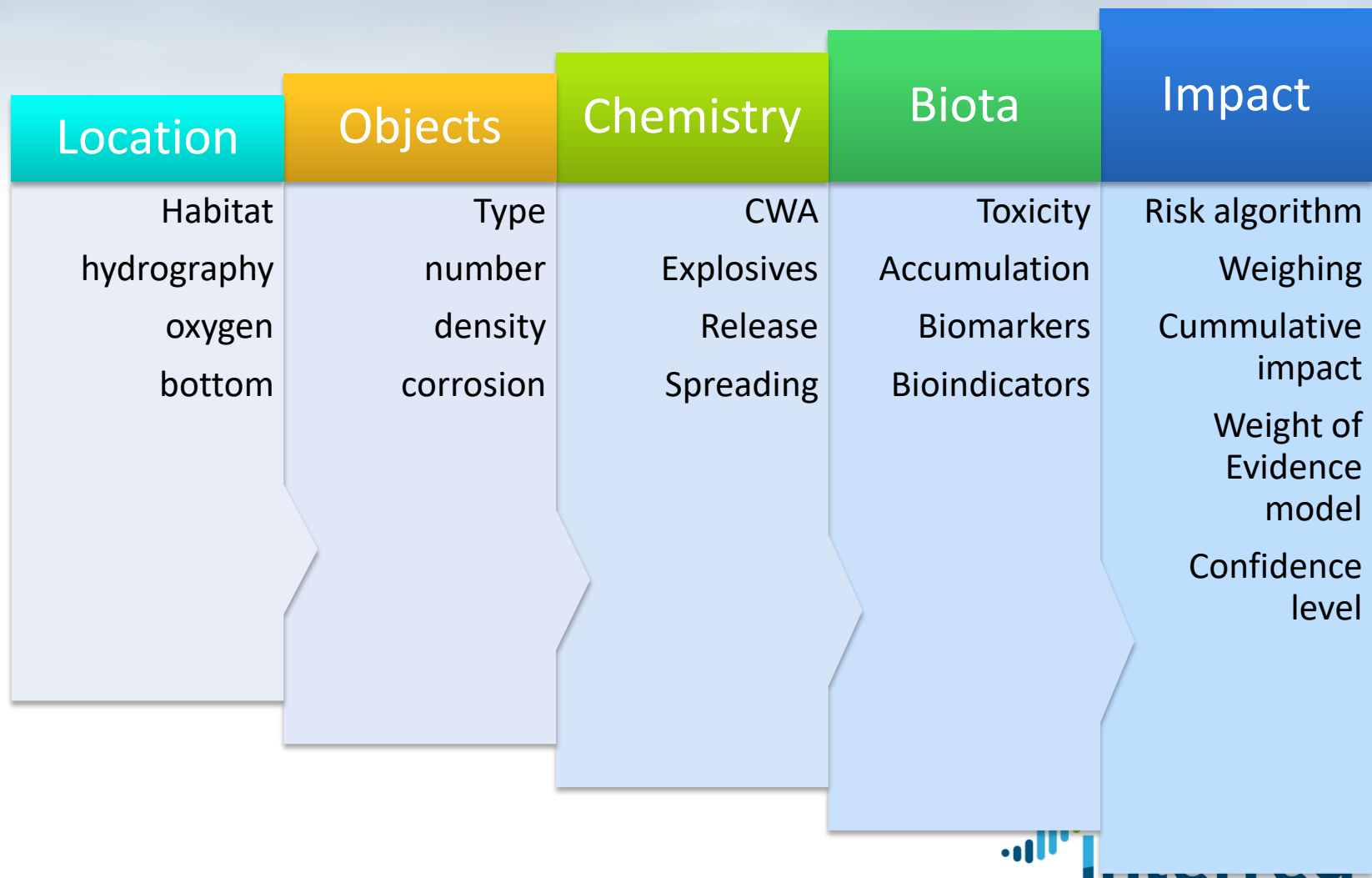


ECOTOXToolbox

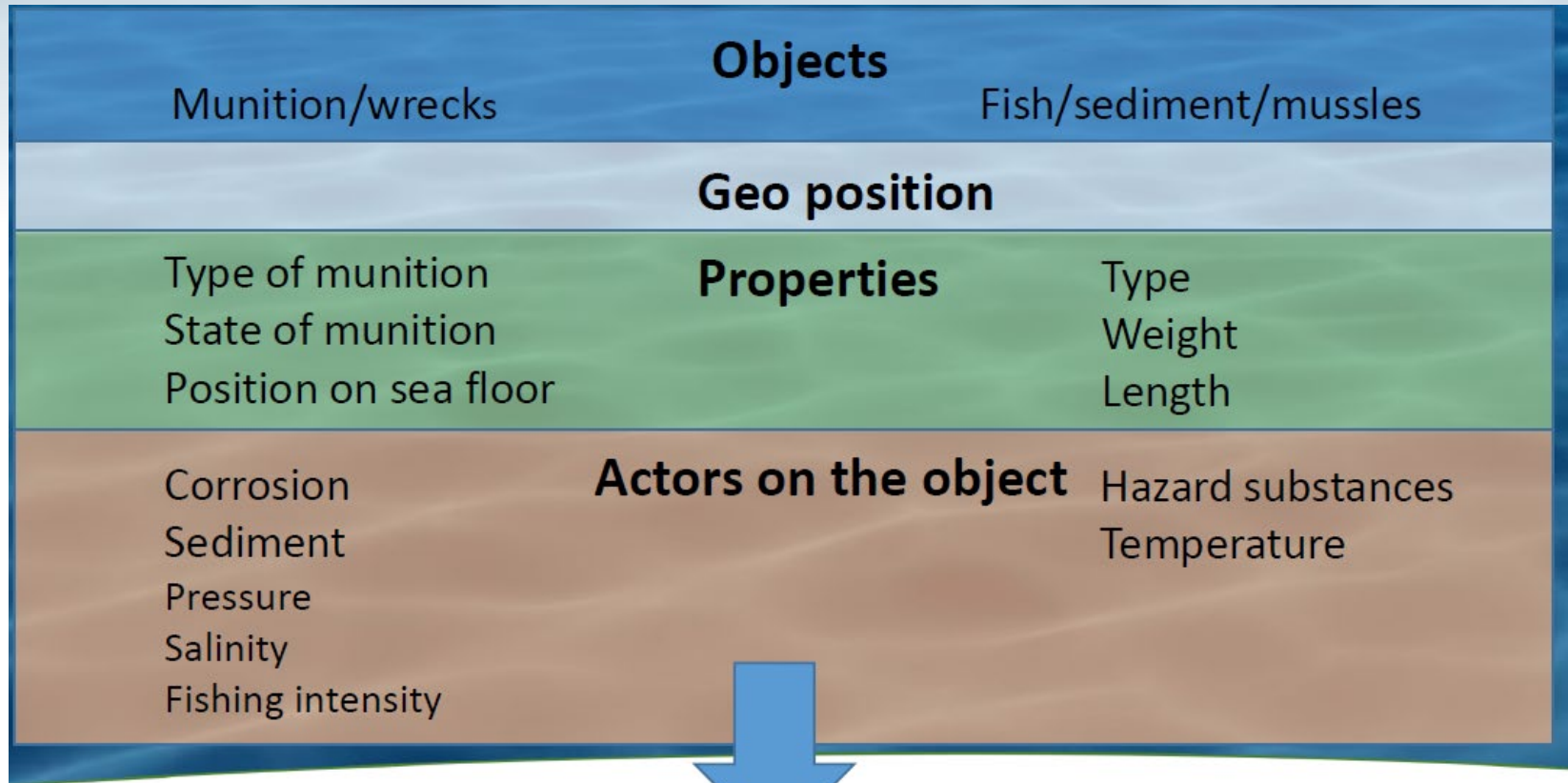
Tier 2: Detailed Study



DSS – Decision Support System



DSS



State of hazardness

Remediation options



Costs



Environmental impact



Legal considerations



Decision support tool

Thank You for attention



1) 'The research work was funded by the European Union (European Regional Development Fund) under the Interreg Baltic Sea Region Programme 2014-2020, project #R013 DAIMON'

2) 'The research work was financed by the Ministry of Science and Higher Education from the 216-2019 science funding allocated for the implementation of international co-financed project'