Toxic Legacies of War - North Sea Wrecks Symposium 2023

Microbial Community Responses to a Wartime Wreck: the John Mahn Case Study

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USS Arizona, Pearl Harbor

MV Schiedyk, Bligh Island

Z2 Georg Thiele, Rombaken

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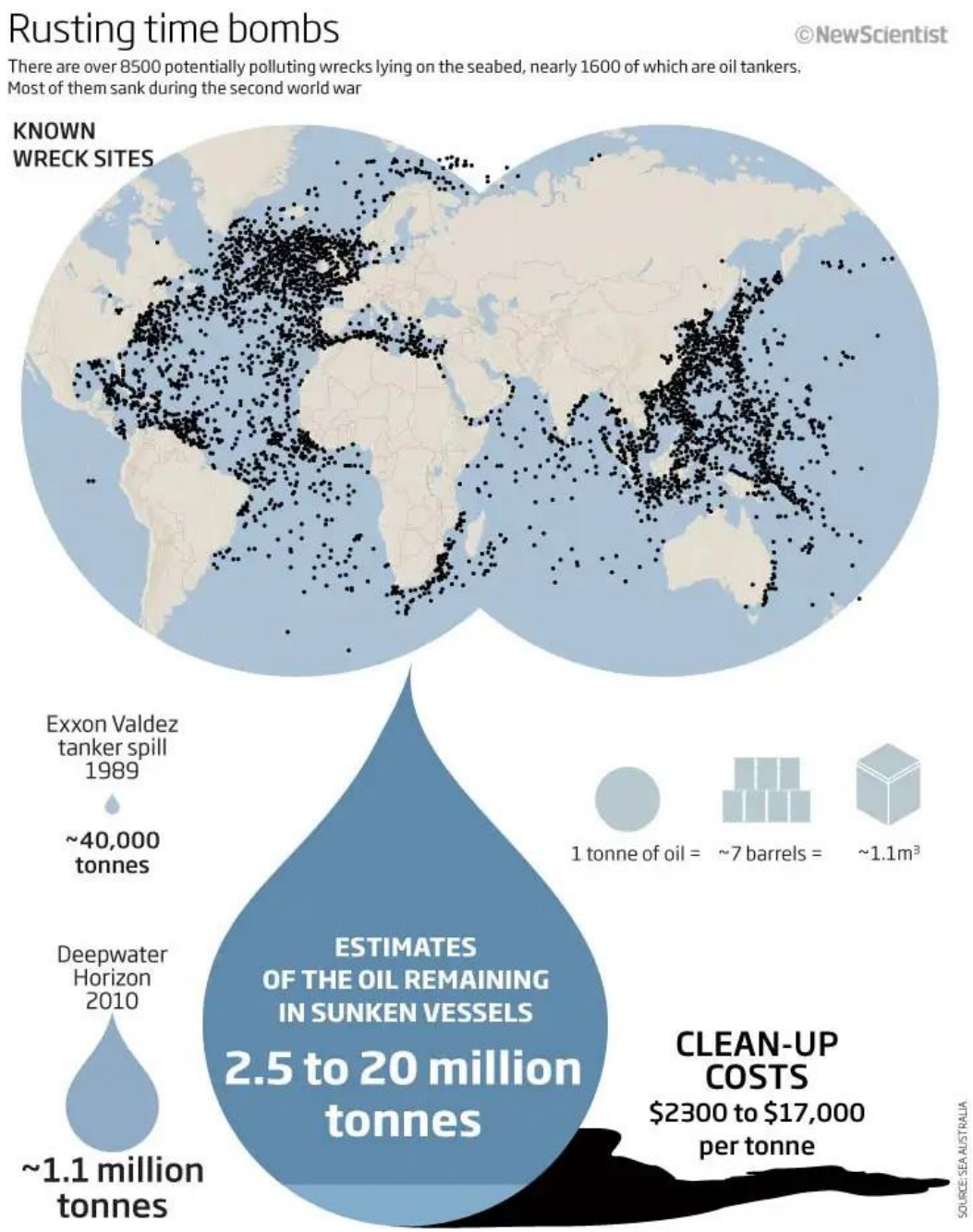
Environmental Risks

Other types of fuel
Munitions
Hazardous cargo

Intrinsic ship properties
- Oils and lubricants
- Antifouling paints (Cu, Hg)
- Various chemicals
- Solid metal(s)

Complex chemical fingerprint
Dynamic (release / degradation)
Seldomly characterized

Environmental impact?
Biodegradation?



Based on Michel et al. (2005)

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Effects on microbial communities

Center for Microbial Ecology; Prof. Nico Boon & Dr. Josefien Van Landuyt

Research questions

1. Are there residual pollutants components (organic aromatic compounds; heavy metals; explosives) present in the sediments surrounding an old shipwreck?
2. Does the shipwreck (steel) and the residual pollutants influence the microbial composition and how far away can this influence be seen in the sediments?
3. Are there taxa that are clearly correlated with the aromatic compounds?
4. Why are these bacterial species correlated; can it be linked to functionality?
5. Biodegradation- / Bioremediation- / Biomonitoring-potential?

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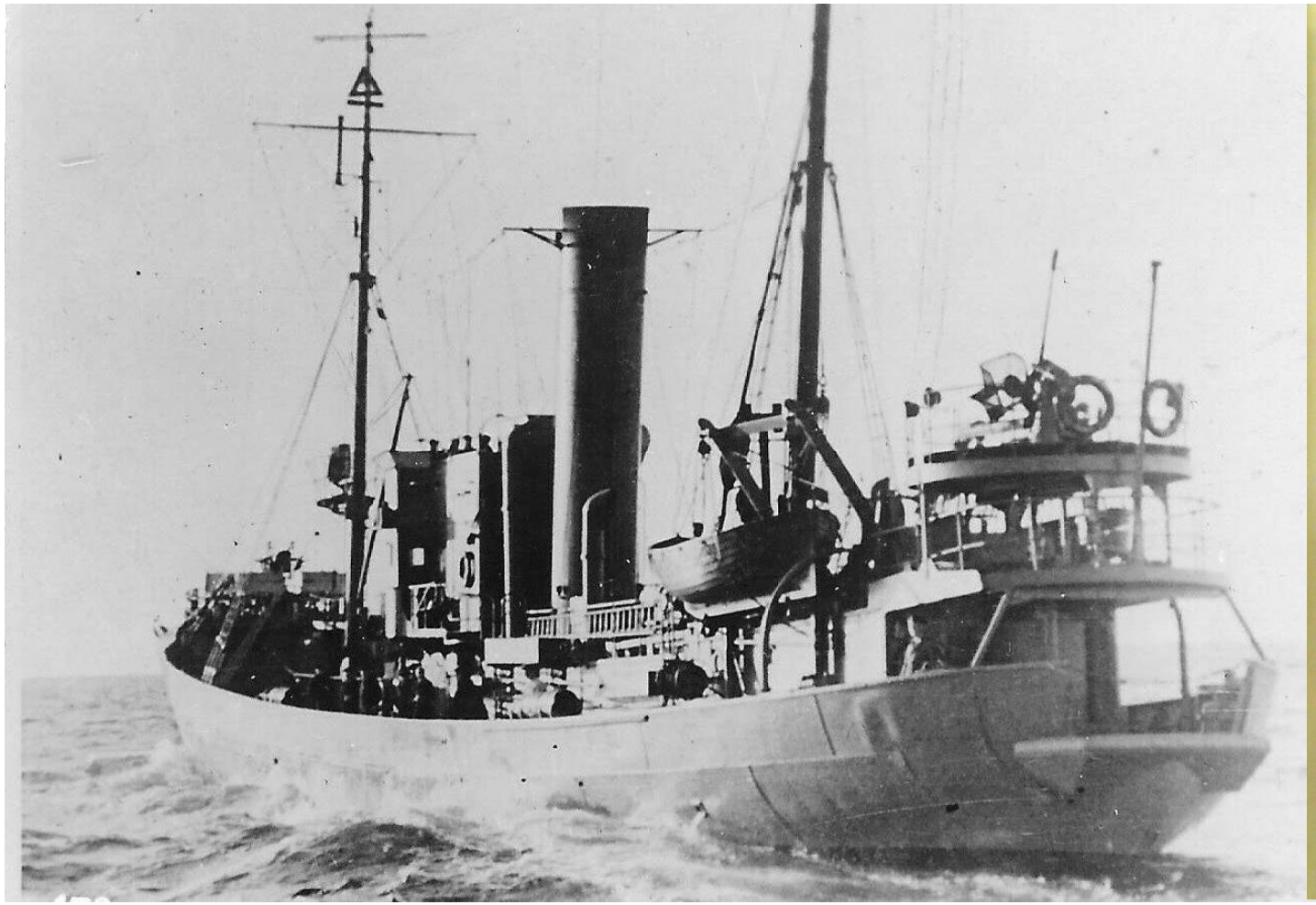
V-1302 John Mahn

Requisitioned steam trawler, rapidly sunk by RAF bombers in 1942



53
12

Gefechtsbericht von Vp. 1302
zum Fliegerangriff am 12.2.42.

Am 12.2.42 stand die Rotte Vp. 1302/03 auf Position 2 Quadrat 8755 mitte oben. Die Gruppe war für eine Markbootaufgabe auf diese Position ausgelegt, dazu Vp.1303 vor Anker.

Vor und nach Passieren des Schlachtschiffverbandes um 15.00 Uhr war starke Fliegertätigkeit. Einmotorige Maschinen zeitweilig bis zu 20 Stück kreisten in einer Höhe von 1000 - 2000 m über den Booten. Deshalb war ab 15.00 Uhr Fliegeralarm für Vp. 1302 befohlen. Um 15.53 Uhr kamen 6 einmotorige Flugzeuge in nord-östlicher Richtung (STB achteraus von Vp. 1302) in Sicht. Da zunächst nicht auszumachen war, ob es sich um feindliche Maschinen handelte und die Anflugrichtung parallel zum Kurs des Bootes verlief, wurde erst beim Aufzudrehen der Maschinen im rechten Winkel auf Vp.1302 bezw. 1303 Feuer eröffnet. Entfernung beim Feuereröffnen 300 m. (siehe Skizze) Es wurden auf der am rechten Flügel fliegenden Maschine einwandfreie Treffer beobachtet; diese stürzte nach dem Überfliegen des Bootes ab. Dabei wurde die Mastspitze des von Vp.1302 berührt und abgebrochen. Gleichzeitig erhielt Vp. 1302 zahlreiche Treffer durch Bordwaffen auf den achteren Flakstand und zwei Bombentreffer. Die erst Bombe traf Schornsteinfuß und detonierte im Heizraum . Die zweite Bombe traf das Achterschiff, durchschlug den Achterflakstand und Dom und detonierte im Wellentunnel. Durch diesen Bombentreffer sank das Boot innerhalb einer halben Minute über den Achtersteven mit STB Schlagseite. Die Geschützbedienung des vorderen MG C/38 erzielte die vorgenannten Treffer. Erst nach dem das Sinken des Bootes ein weiteres Schießen nicht mehr ermöglichte und die Bedienung vom Wasser weggerissen wurde, Feuer eingestellt.

Wetterlage z.Zt. des Angriffs: Wind WSW Stärke 7 - 8, See 4-5 Wolkenhöhe 400 m, Sicht 3 sm.

Munitionsverbrauch: nicht mehr festzustellen.

gez. Telgmann
Lt.z.S. u. Komdt.

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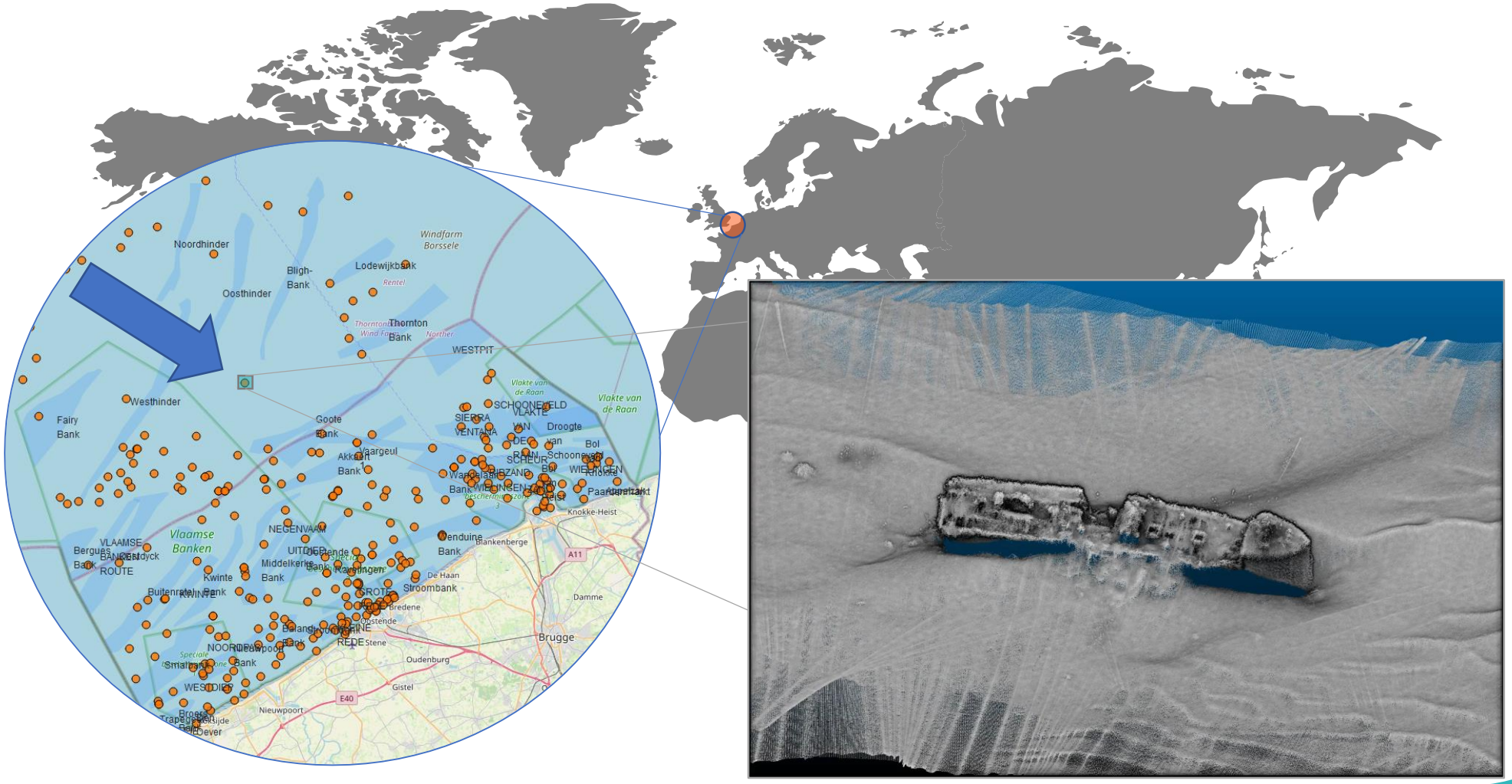
V-1302 John Mahn

Centrally located within the Belgian North Sea



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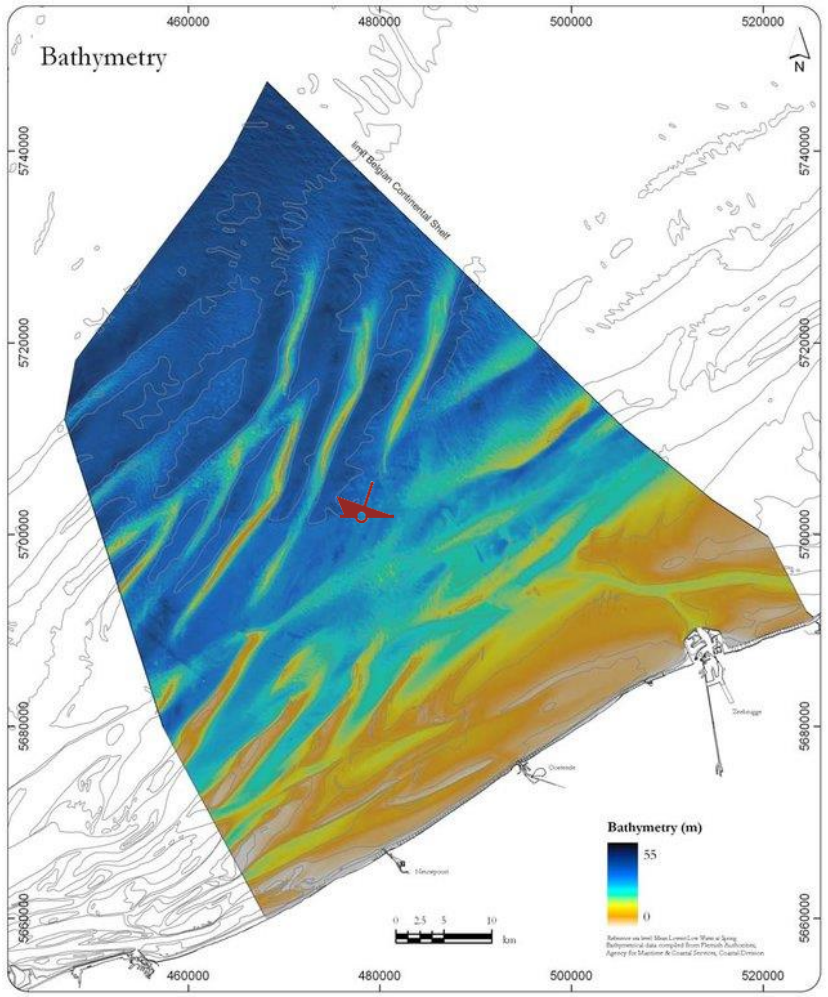
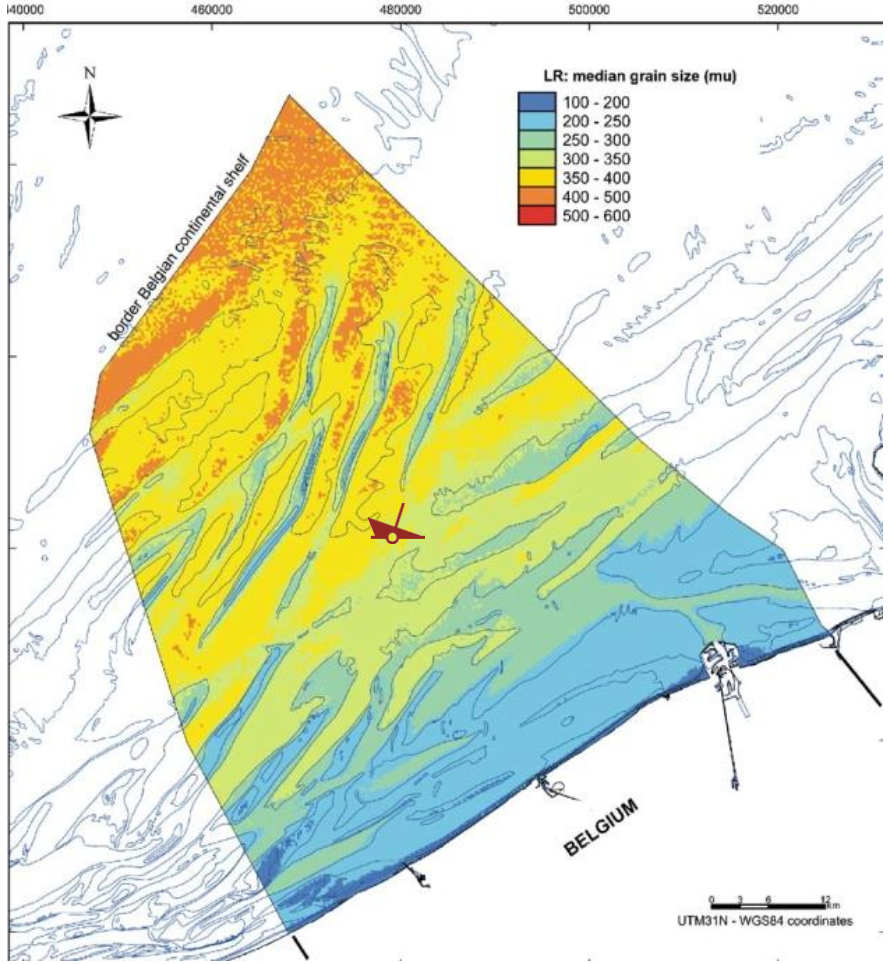
V-1302 John Mahn

Common depth and sediment type (medium sand)





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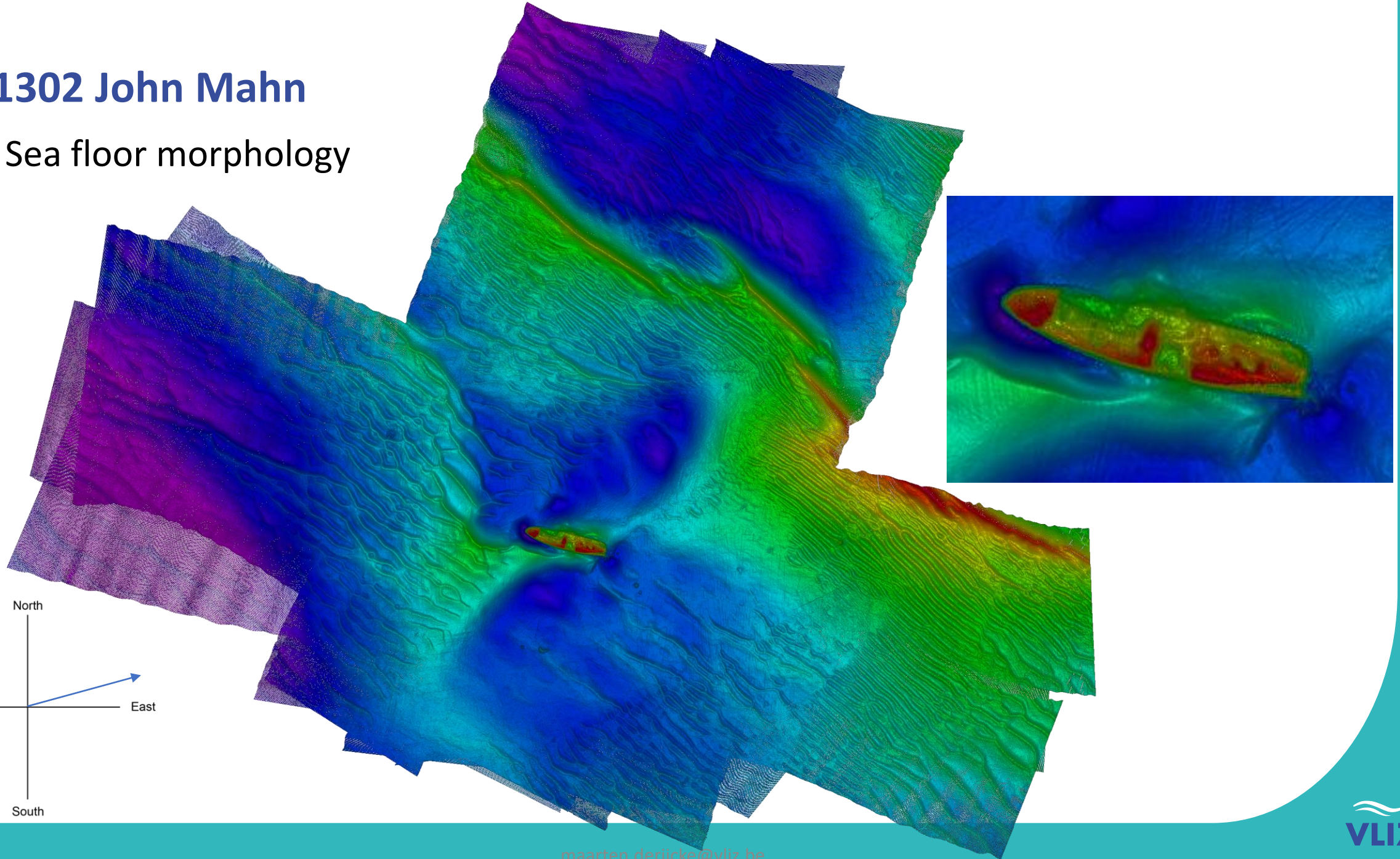
V-1302 John Mahn

Sea floor morphology



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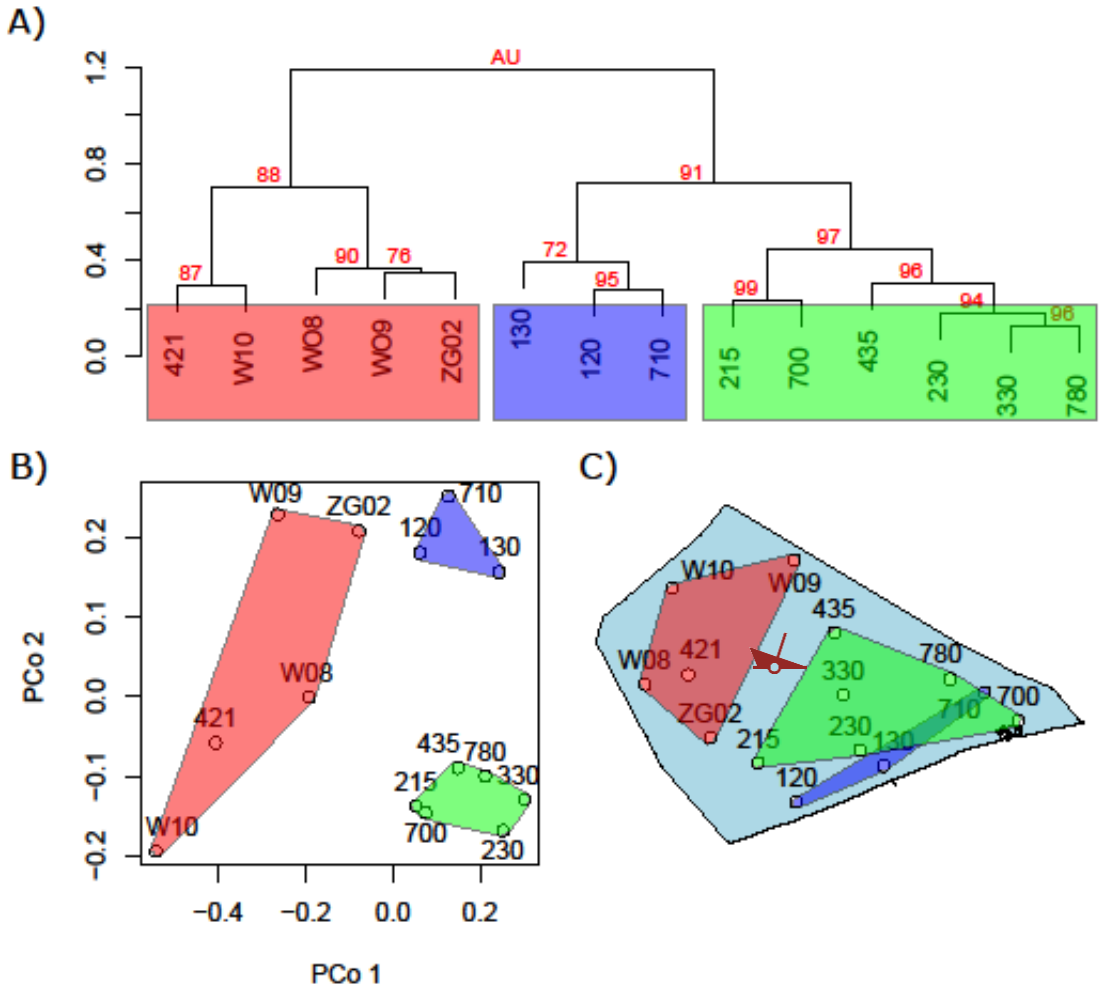
V-1302 John Mahn

Common bacterial species composition (16S rRNA seq.)



(unpublished data)

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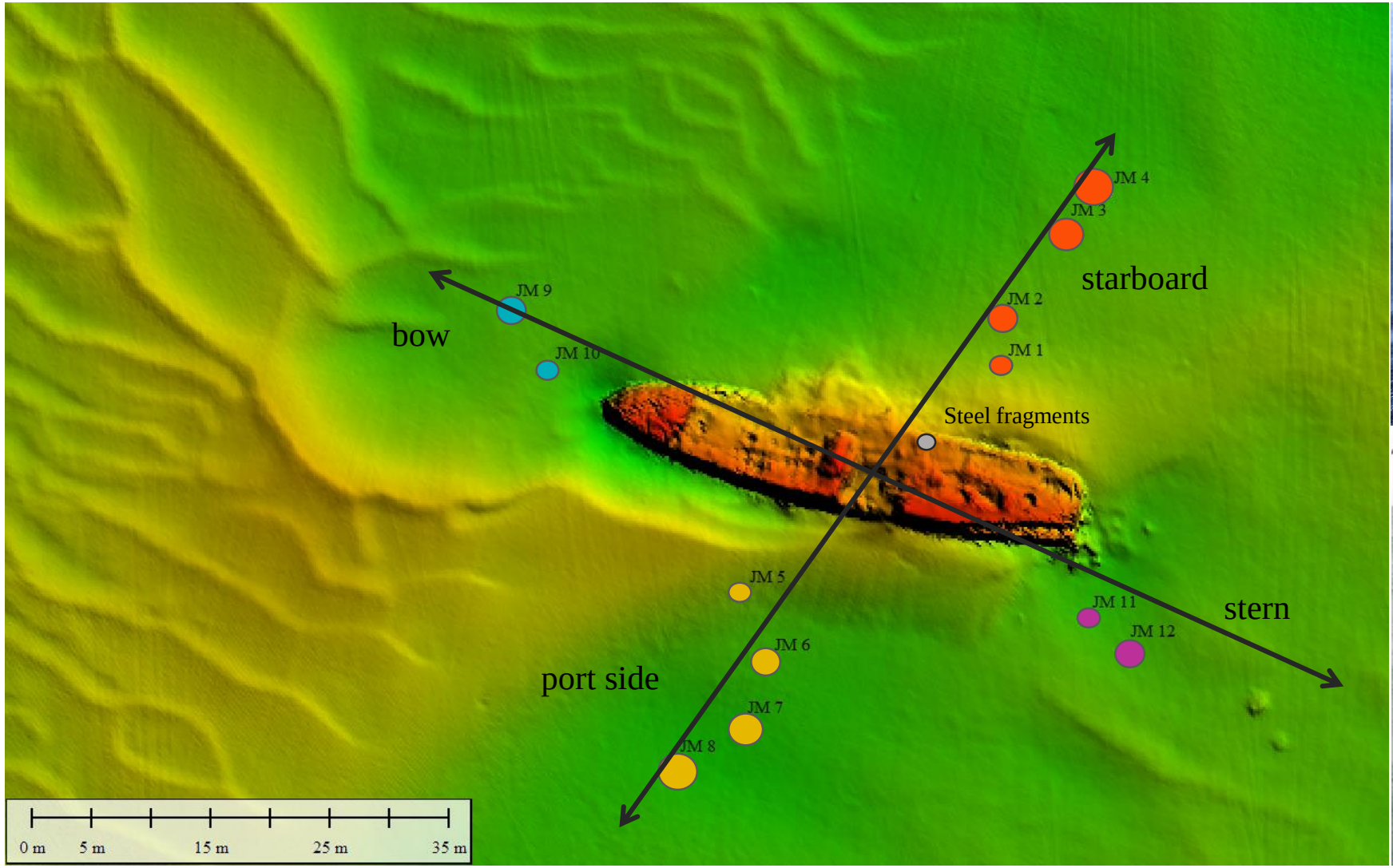
Sampling (2020)



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Sampling (2020)

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Processing

12x ±250gr.

200 gr.

Accelerated solvent extractor

GC-MS (Thermo TSQ8000)

PAH analysis (23 compounds)

Explosives (TNT; 1,3-DNB)

3-4 gr.

Acid digestion

ICP-OES (Thermo TSQ8000)

Trace metal analysis

Fe, Zn, Pb, Ni, Cu, Cr, As

1 gr.

Cell counts

Flowcytometry (Attune NXT)

DNA sequencing (Illumina miseq)

16S rRNA gene sequencing

Bacterial diversity

Chloroplast/mitochondria

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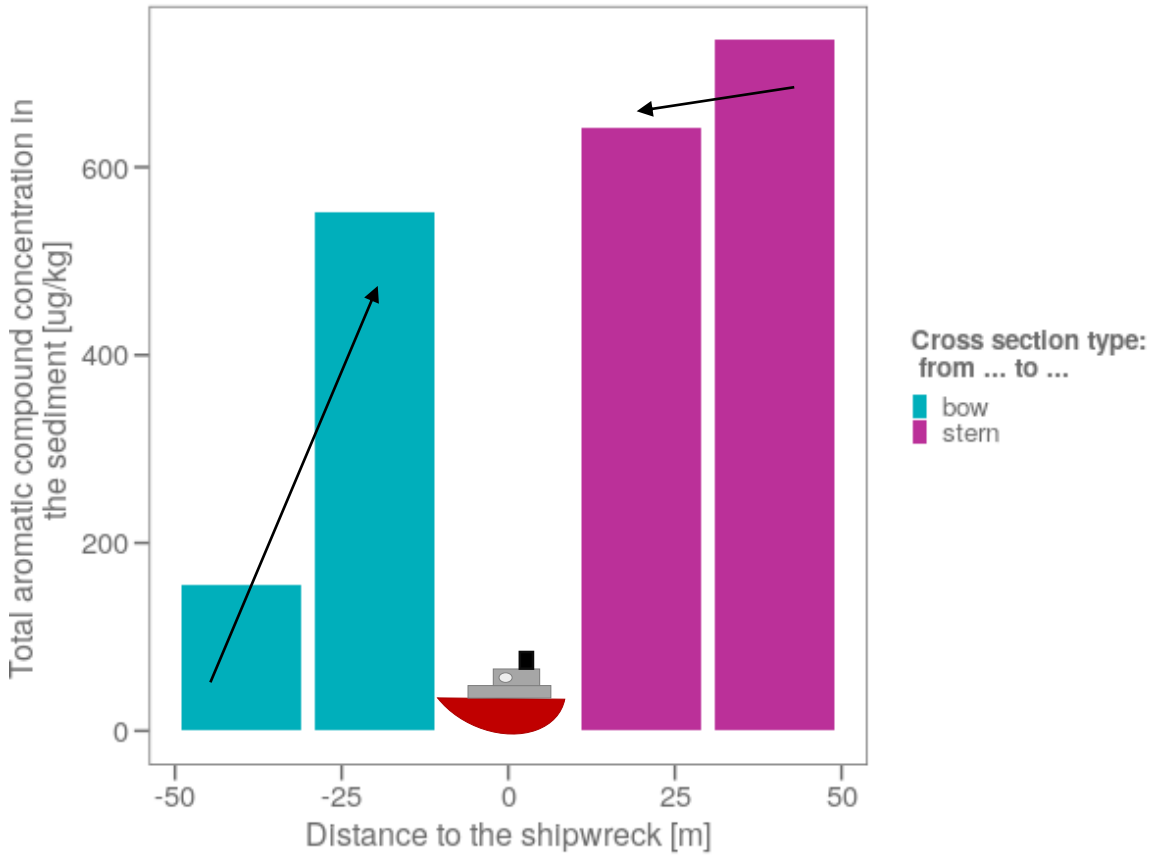
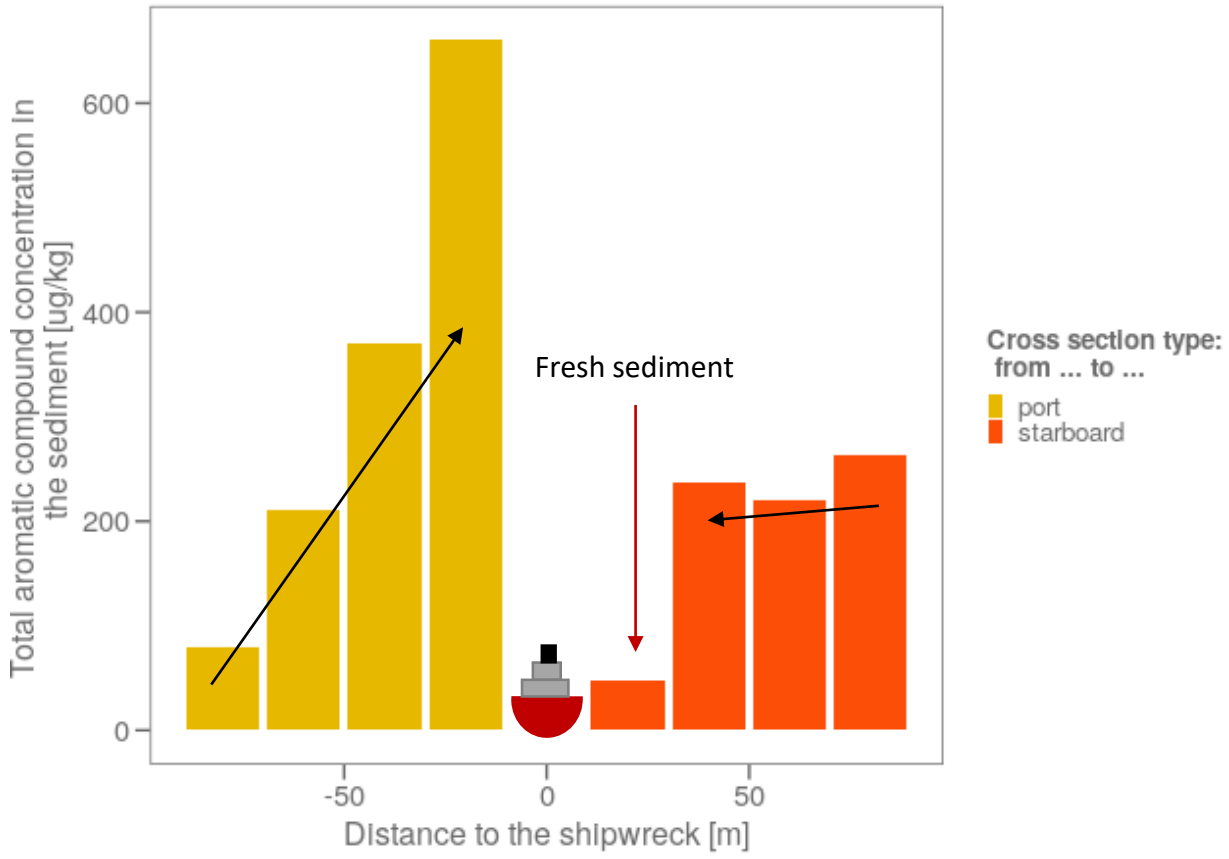
Polycyclic aromatic hydrocarbons (PAH) – coal bunker still leaching





Also low levels of TNT and 1,3-DNB

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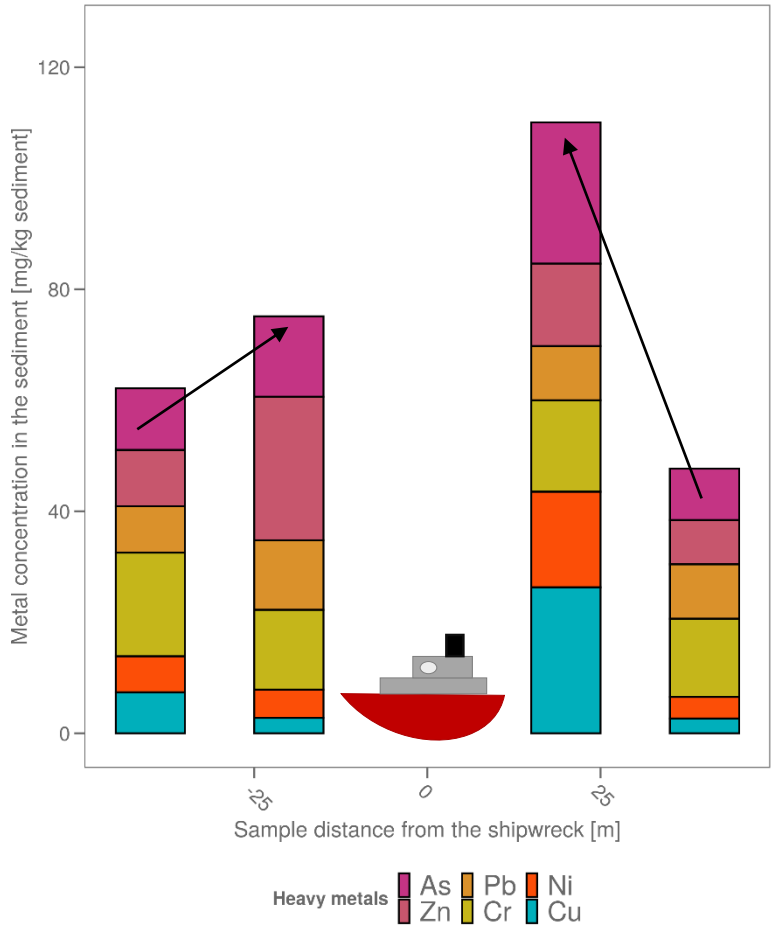
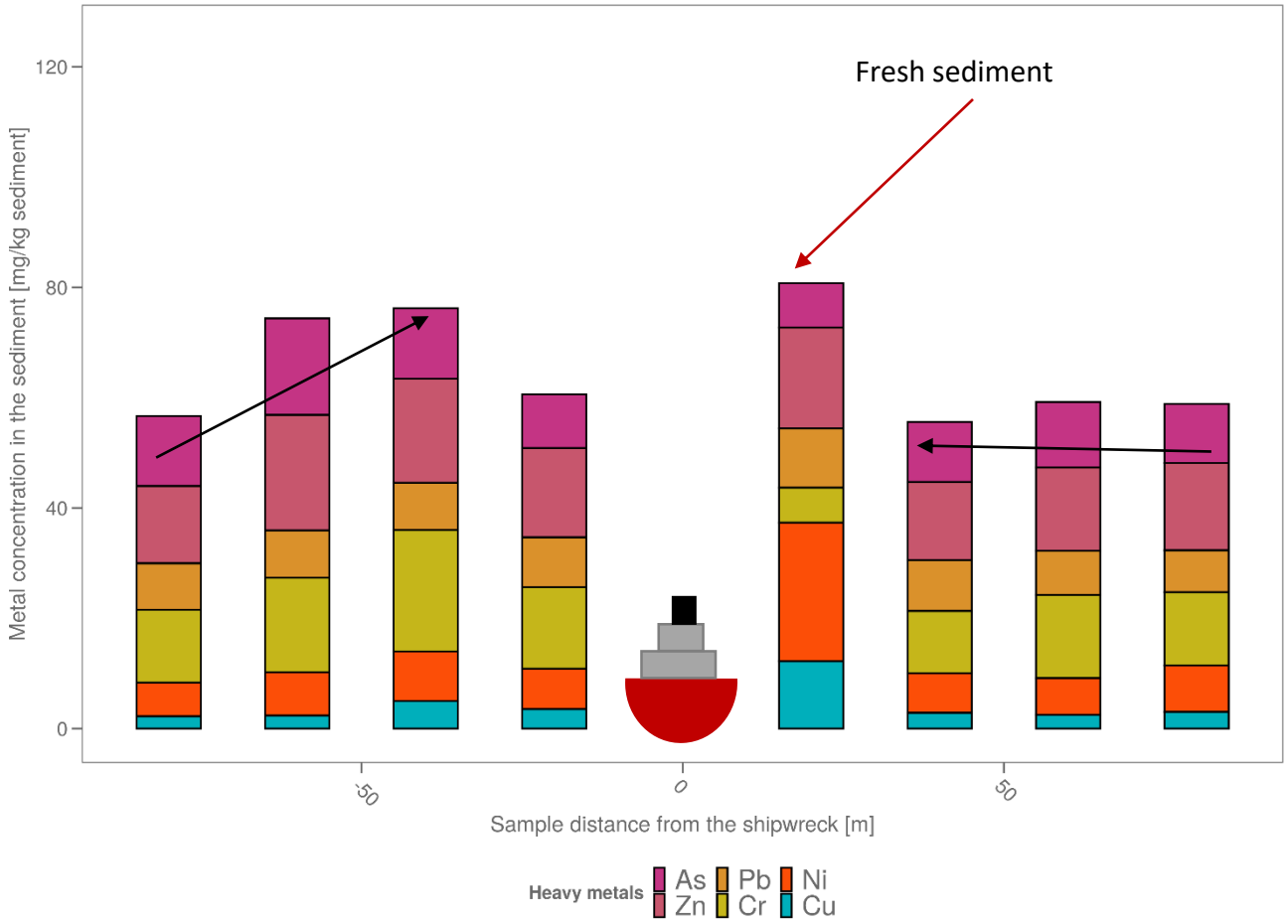
Heavy metals – Ni & Cu starboard side





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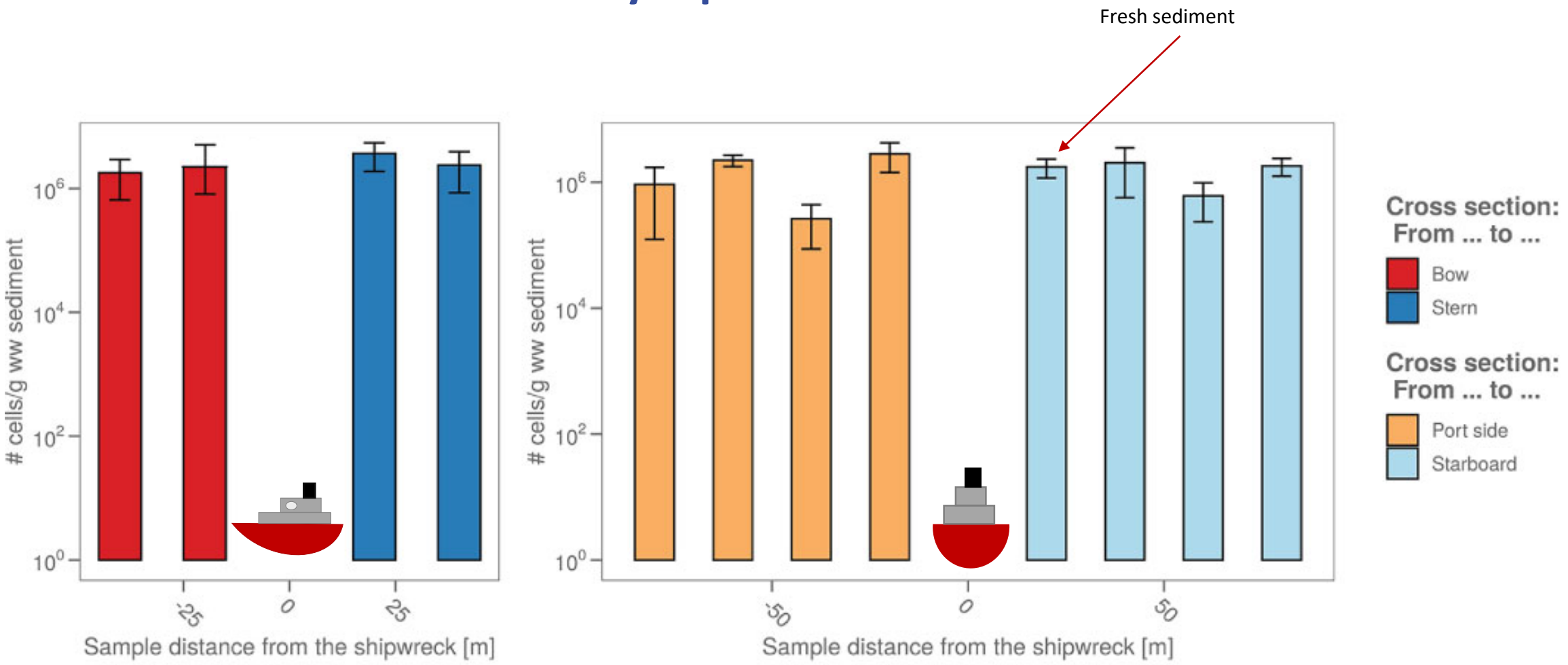
Bacterial abundance – mostly equal



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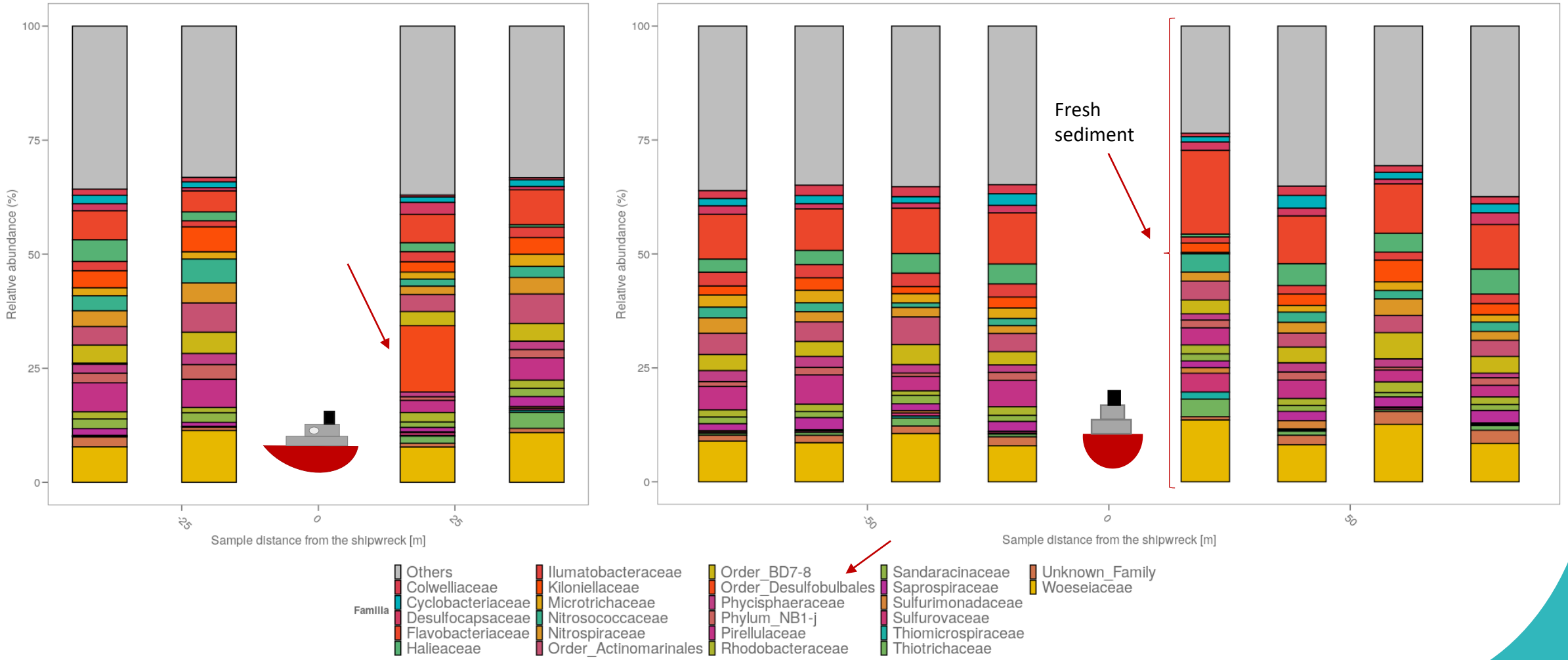
Bacterial community composition – small differences



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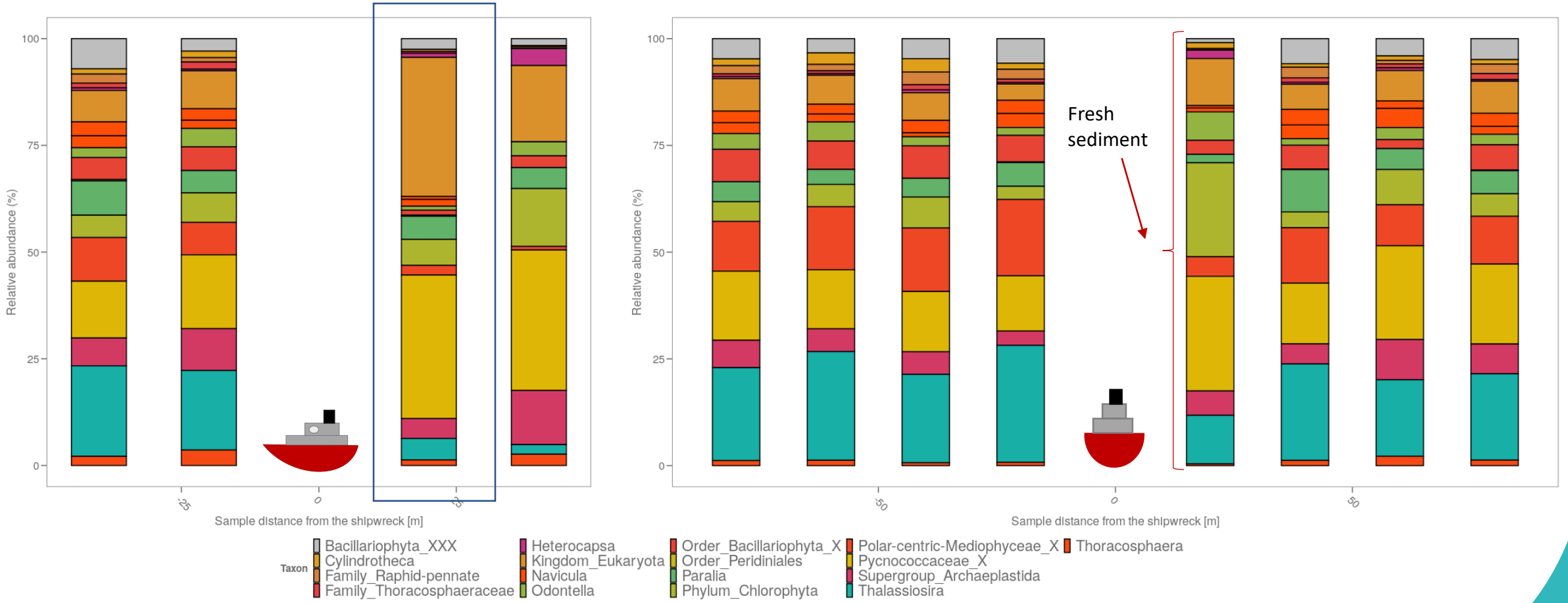
Phytoplankton community composition – minor changes



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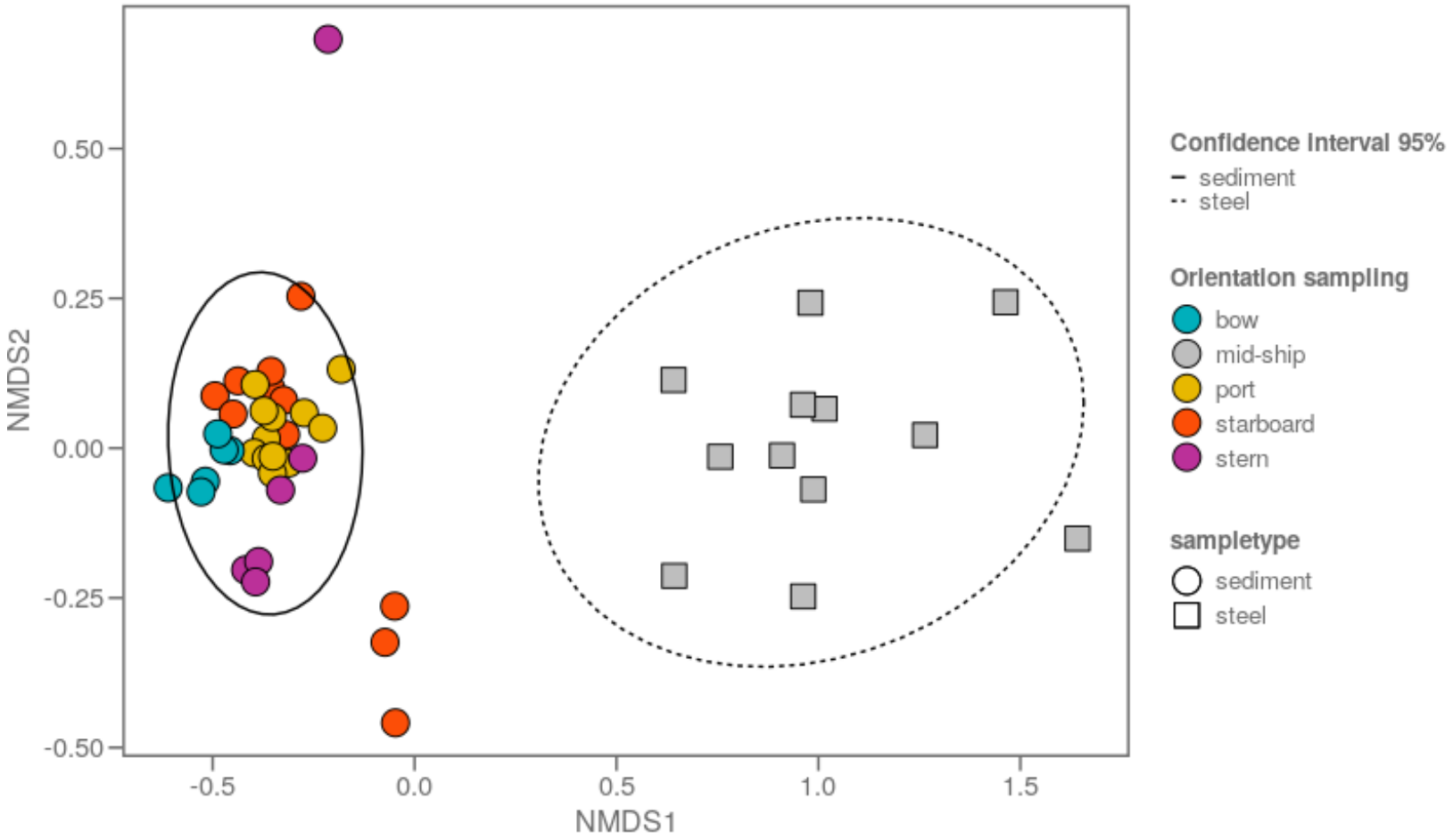
β-diversity 16S – steel vs. sand



Steel; a lot of Desulfobacterota (*Desulfobulbia* = sulfate-reducing bacteria linked to MIC)

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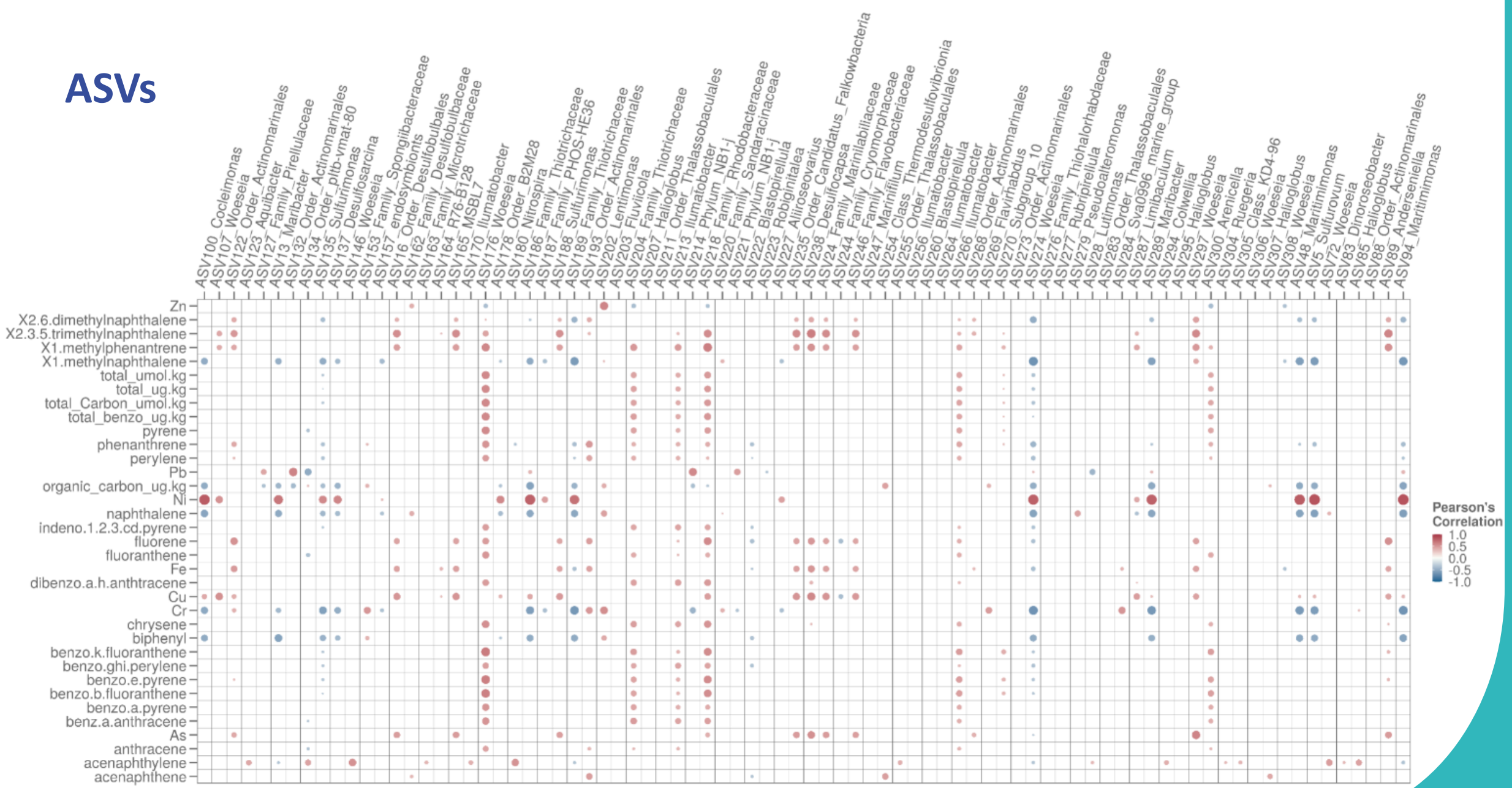
ASVs



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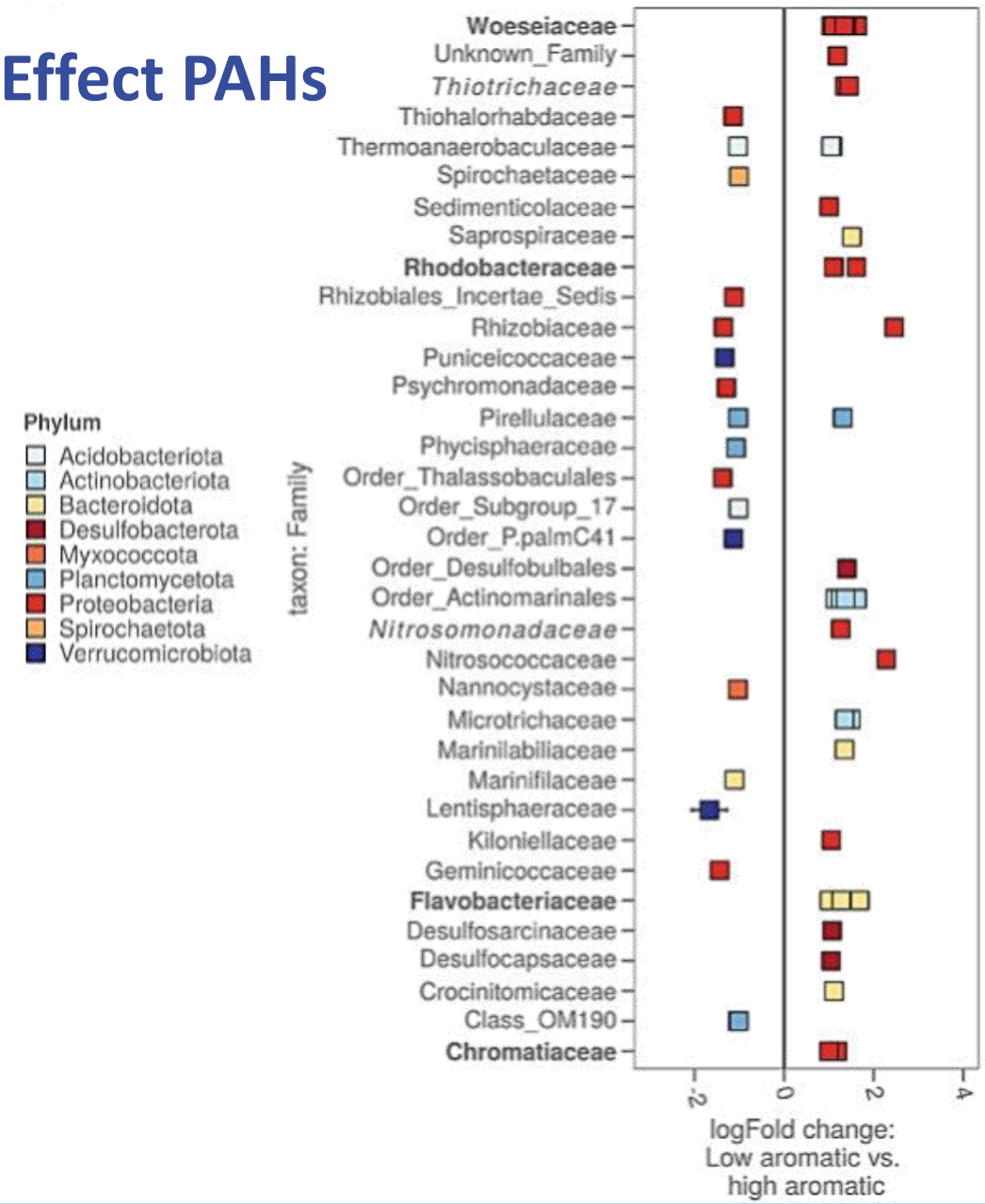
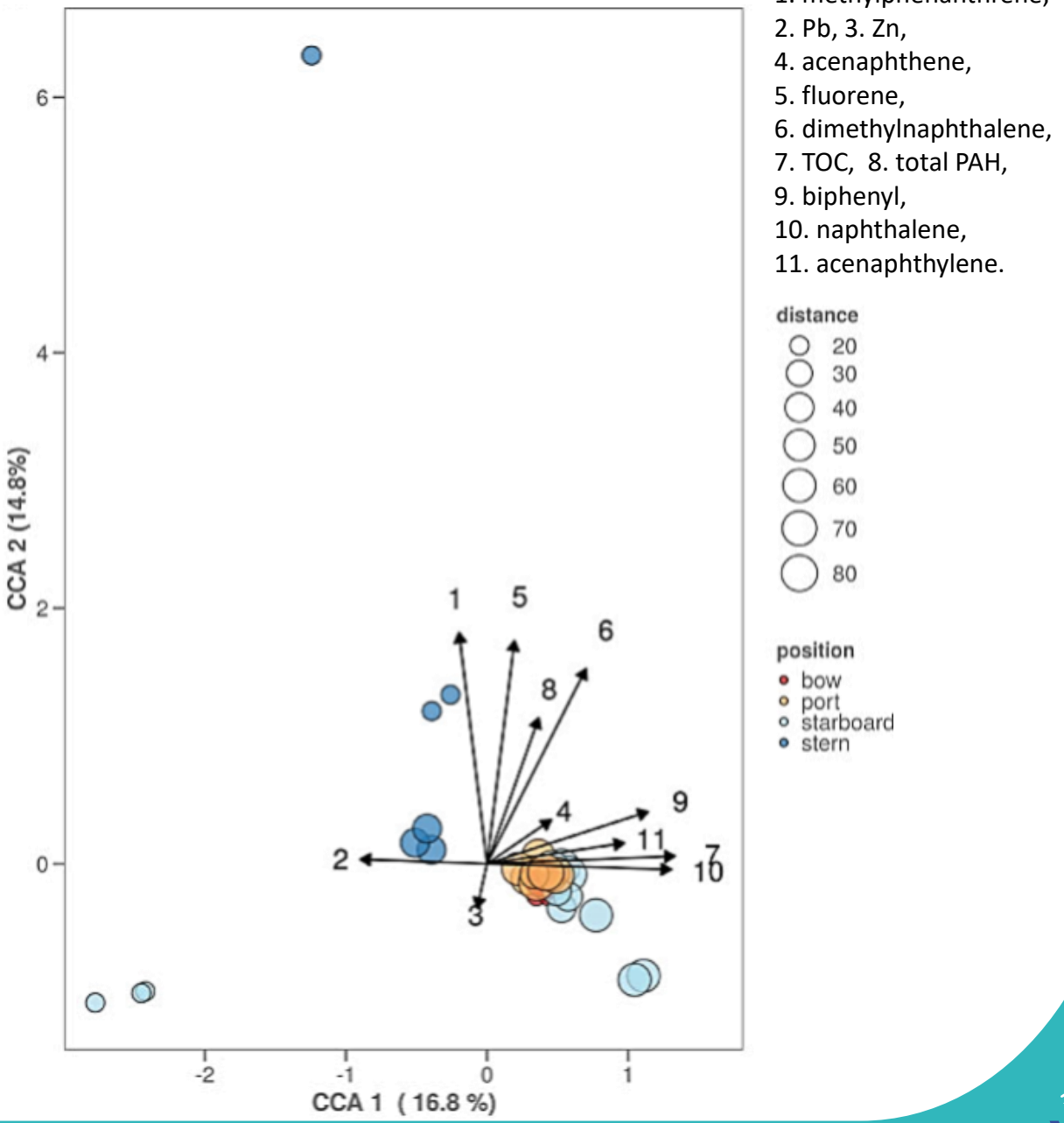
Effect PAHs





1. methylphenanthrene,
2. Pb, 3. Zn,
4. acenaphthene,
5. fluorene,
6. dimethylnaphthalene,
7. TOC, 8. total PAH,
9. biphenyl,
10. naphthalene,
11. acenaphthylene.

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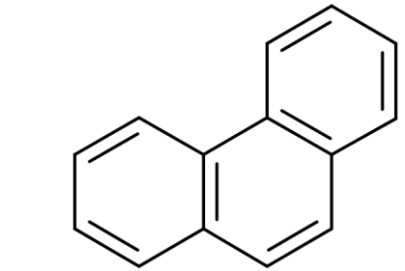
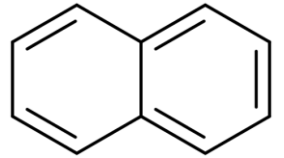
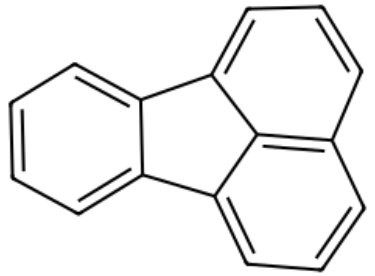
Biodegradation?

PAHs

- ✓ *Rhodobacteraceae* (phenanthrene-degraders)
- ✓ *Chromatiaceae* (naphthalene-degraders)
- ✓ *Flavobacteraceae* (fluoranthene-degraders)
- ✓ *Woeseiaceae* (generalists)
- ✗ *Alcanivoracaceae* (alkane-degraders)

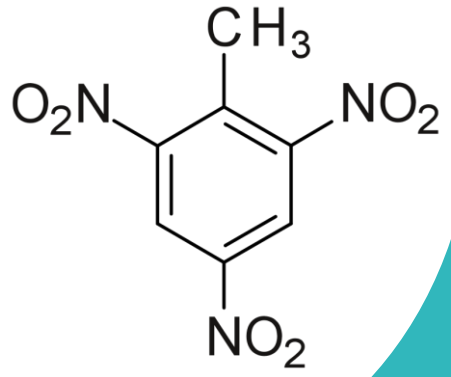






TNT

- ✓ *Enterobacterales* (TNT-degraders)
- ✓ *Colwelliaceae* (TNT-degraders, Paardemarkt)
- ✗ *Piscirickettsiaceae* (*Methylophaga*; Paardemarkt)
- ✗ *Thalassospiraceae* (*Thalassospira*; Paardemarkt)



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Conclusions

Are there residual pollutants components (organic aromatic compounds; heavy metals; explosives) present in the sediments surrounding an old shipwreck?

Yes, clearly.

Does the shipwreck (steel) and the residual pollutants influence the microbial composition and how far away can this influence be seen in the sediments?

Yes, especially PAH & metals (Pb, Zn).

Are there specific taxa that are clearly correlated with the aromatic compound?

Yes (*Rhodobacteraceae*, *Chromatiaceae + Flavobacteraceae* and *Woeseiaceae*)

Why are these species correlated; can it be linked to functionality?

Highly likely.

Biodegradation / Bioremediation-potential?

Plausible, more research needed.

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Thank you

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Center for Microbial Ecology and Technology

VLIZ

museum
Operational Directorate Natural Environment
OD Nature | OD Natuur | DO Nature

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Koen Parmentier
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Crew of RV Simon Stevin
Volunteer scientific divers

Interreg NS Region Programme

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