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ECO-REGION IV: a field study towards understanding the main drivers of changes in REGION IV offshore seafloor functioning.

OVERALL AIM:

Offshore sediment monitoring is an important and extensive effort to safe-guard the marine environment by monitoring changes in seafloor functioning and can be optimized:

- 1) With minor expansion and refinement of the current methods, the sensitivity and ecological relevance of regular sediment monitoring can be significantly increased.
- 2) This will simultaneously fill fundamental knowledge gaps and increase understanding of the drivers of changes in offshore seafloor functioning.

Emphasize that this is a co-production or a co-creation!
Contribution from different institutes and stakeholders in
the design, execution and analysis of the work:

AKVAPLAN-NIVA (Hans Petter Mannvik, Rune Palerud and their team on board the Ocean Response)

Royal Netherlands Institute for Sea Research (NIOZ- Peter van Breugel & Eric Epping)

EQUINOR SUS Env Tech (Rolf Christian Sundt & Linn Pedersen Hocking)

NORCE (Alessio Gomeiro and Leon Moodley)

ECO-REGION IV was a case study as part of the regional monitoring program in REGION IV on board the Ocean Response
in May 2023.

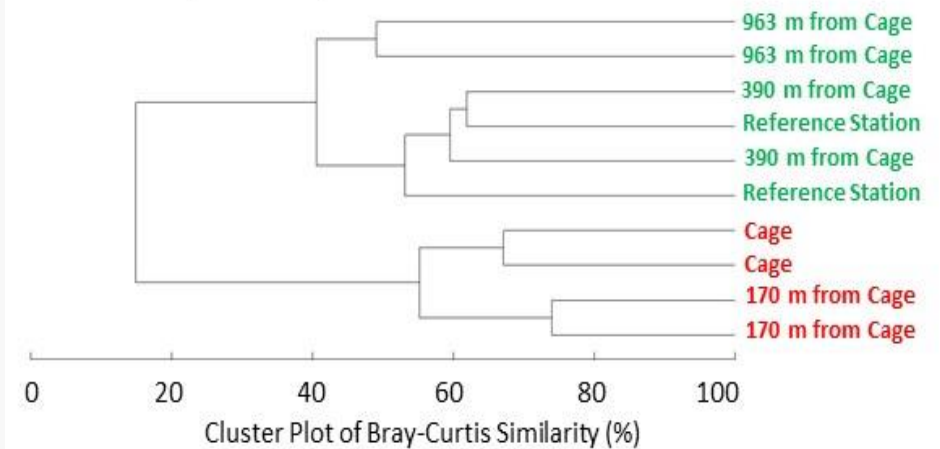
Macrofauna biodiversity is a key parameter used to detect anthropogenic changes in seafloor functioning

e.g. Transect on impact of aquaculture derived matter on seafloor biodiversity

Characteristics of a macrofauna community analyzed in the upper 2 cm along a transect in a fjord salmon fish farm

	# Species	# individuals.m ⁻²	Shannon (log2)	Margalef
Reference Station	20 (1)	226 (91)	2.82 (0.13)	4.06 (0.05)
963 m from cage	33 (2)	241 (61)	4.34 (0.15)	6.62 (0.80)
390 m from cage	26 (4)	368 (74)	3.45 (0.37)	4.79 (0.63)
170 m from cage	17 (1)	1180 (294)	1.63 (0)	2.52 (0.32)
Cage	4 (1)	1303 (847)	0.27 (0.21)	0.46 (0.17)

Macrofauna Species composition



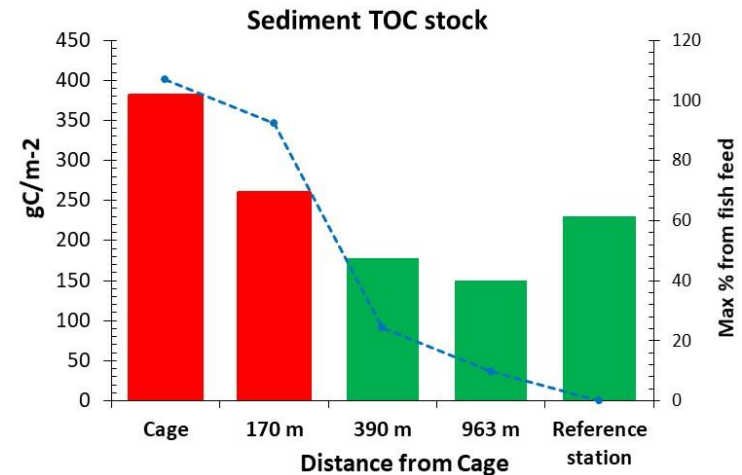
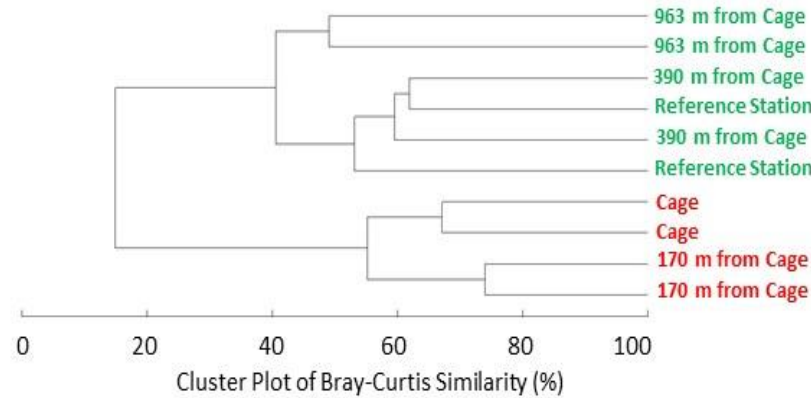
A common impact of aquaculture derived organic matter is a drastic drop in biodiversity under and close to cages. Low diversity macrofauna often dominated by *Capitella* (polychaete), an indicator species of high bioavailable organic matter content.



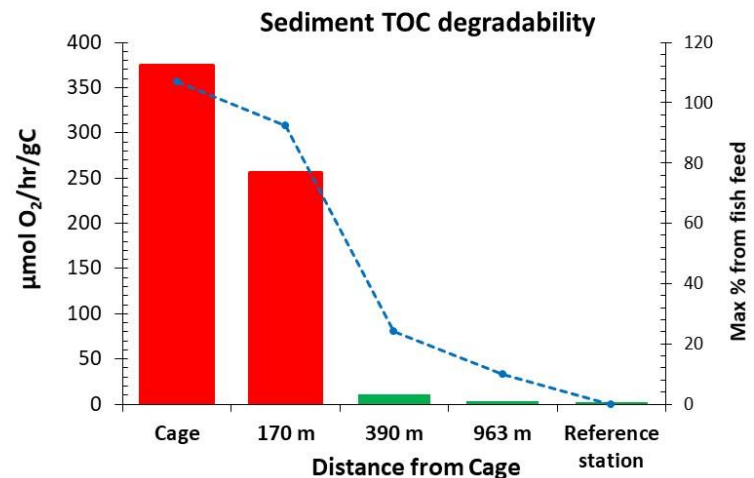
Strong dominance of *Capitella* under high supply of aquaculture derived organic carbon



Macrofauna Species composition



Drop in biodiversity associated with high organic carbon content (left Y-axis) due to higher contribution of aquaculture derived organic carbon (right Y-axis)

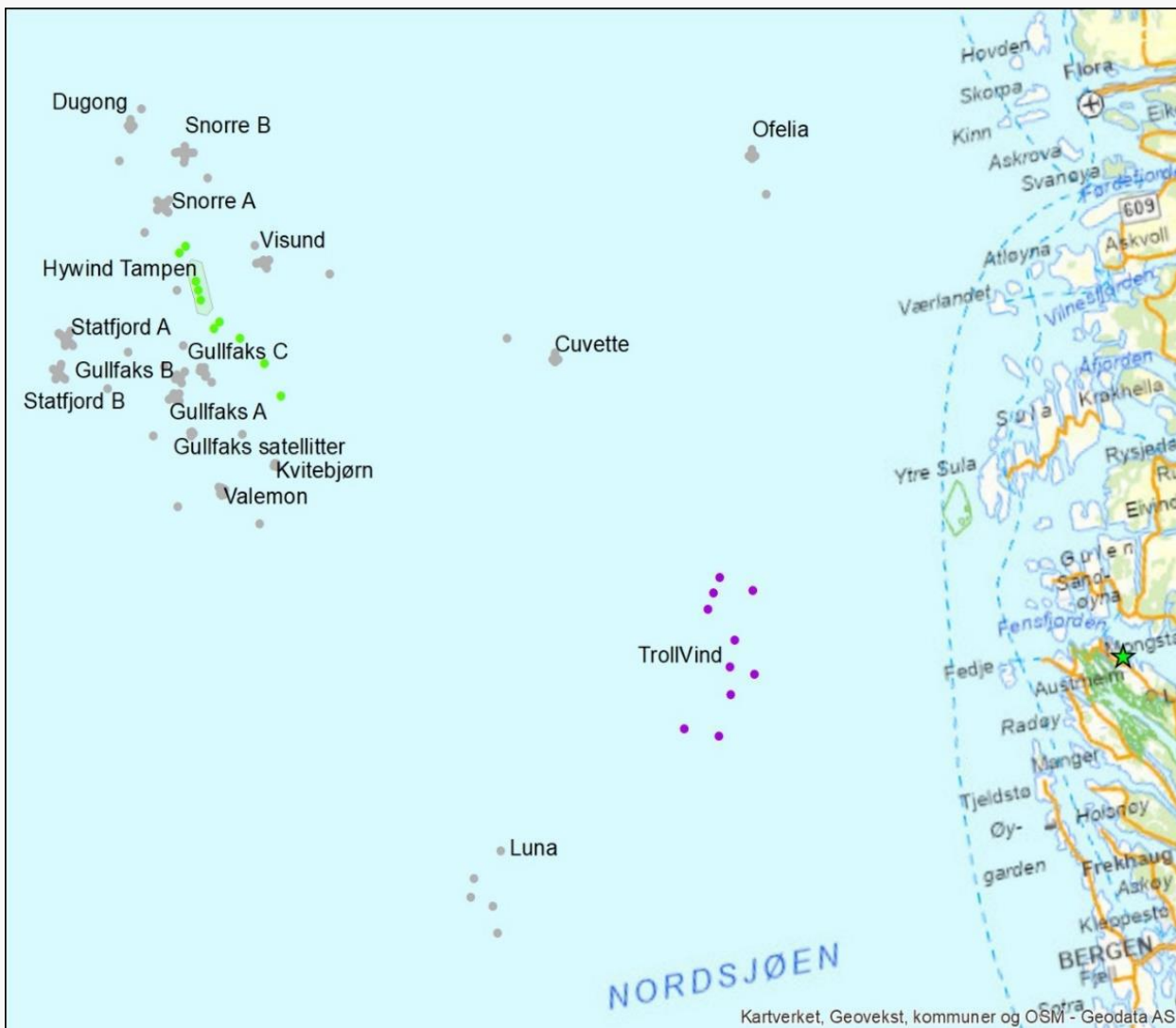


Higher biodegradability of organic carbon in sediment close to cages (left Y-axis) due to a larger fraction of aquaculture derived organic carbon (right Y-axis)

Interestingly, in cases of a drastic drop in biodiversity of macrofauna in offshore sediments attributed to petroleum activity, a strong dominance of the polychaete *Capitella* is also reported.



This suggest that organic enrichment may be a main driver of changes encountered under petroleum activity impacted seafloor but observations on organic carbon stock, provenance and biodegradability is limited!



Overview of Region IV O&G fields (from Mannvik, 2023).

ECO-REGION IV was a case study that visited regional (reference) stations and sites at different distances from different oil fields in REGION-IV on the NCS.

3 Aspects

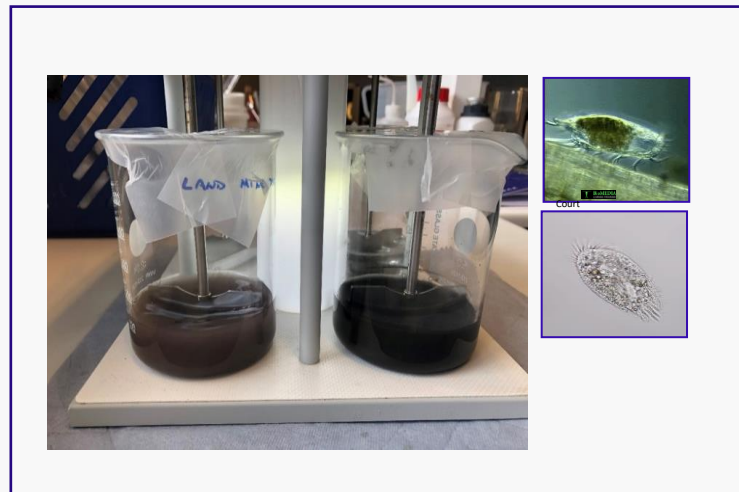
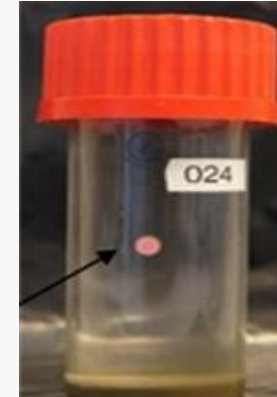
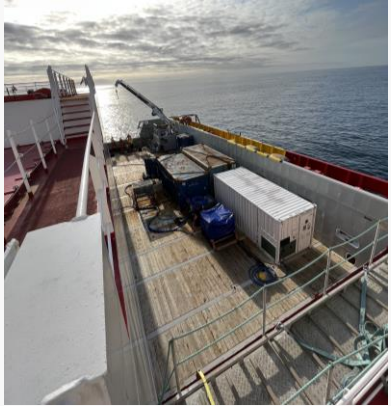
1. Sediment carbon stock, provenance and biodegradability as measure of sediment metabolism

2. Seafloor metabolism examined with microsensor down-core sediment profiling (O_2 , redox, H_2S and pH).

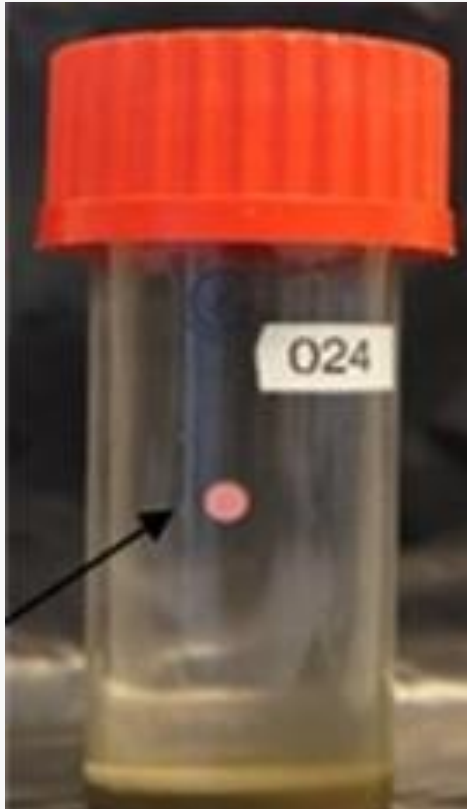
3. Toxicity was examined by determining the effect of elutriates prepared from different sediments on the mortality and replication rates of a model benthic protozoan.

General approach

All experiments conducted at bottom in situ temperature of 8°C in NIOZ thermoregulated container

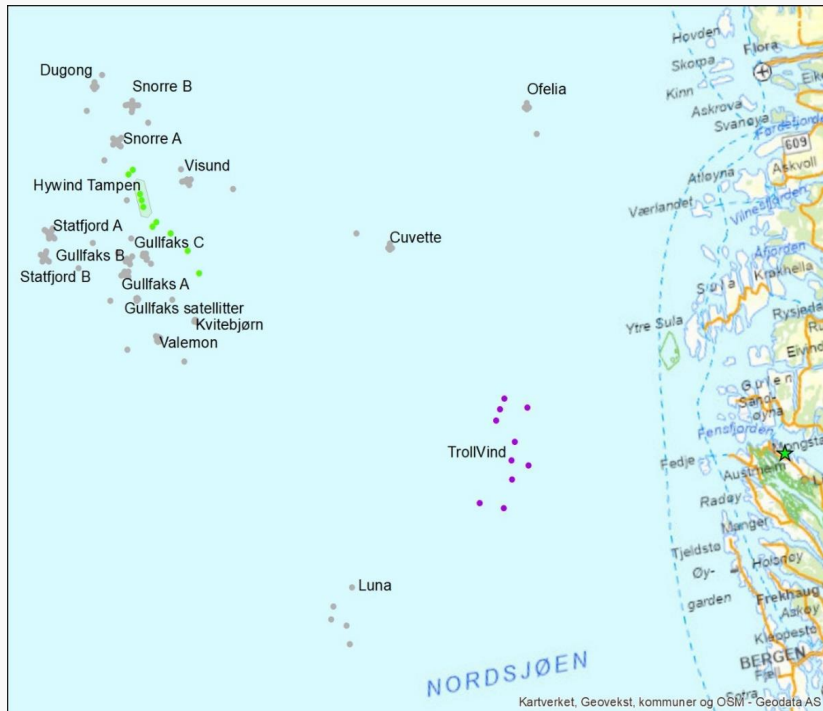


+ Sediment organic carbon content and stable carbon isotope signatures.

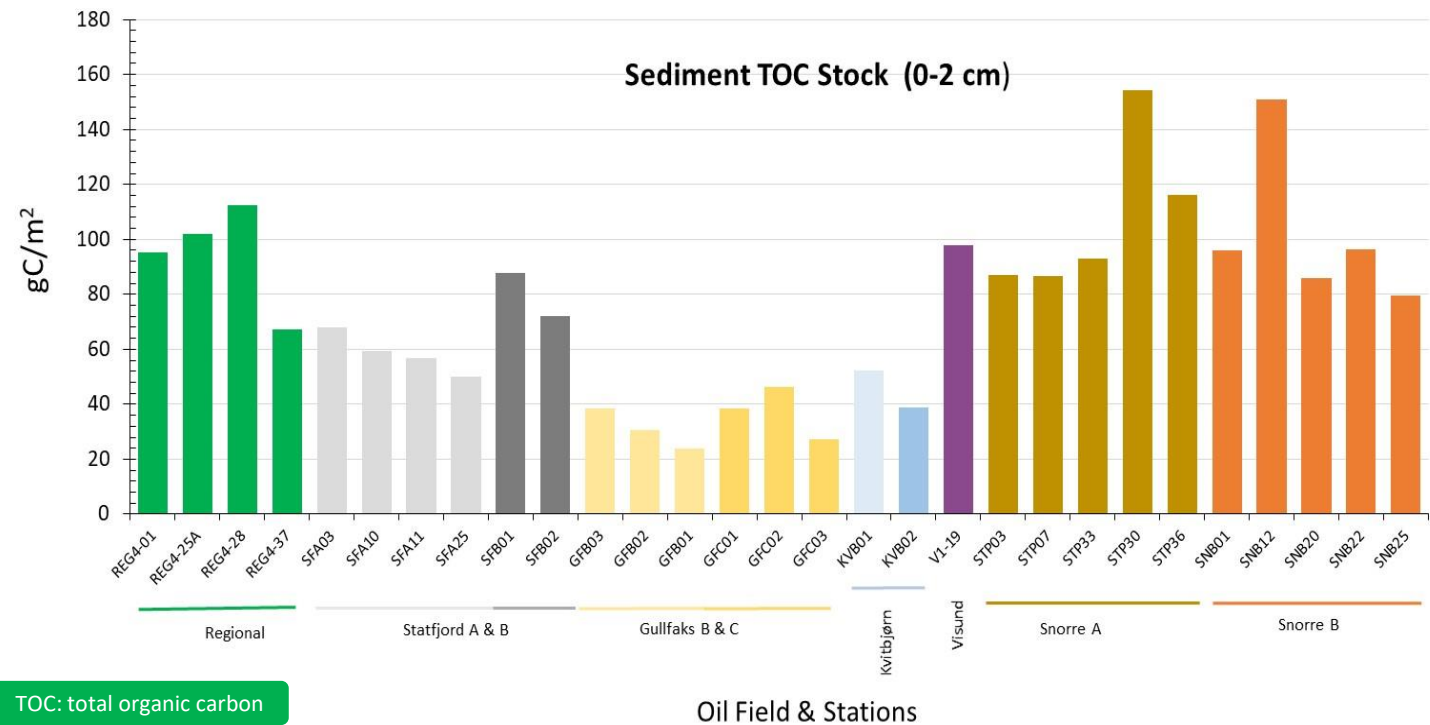


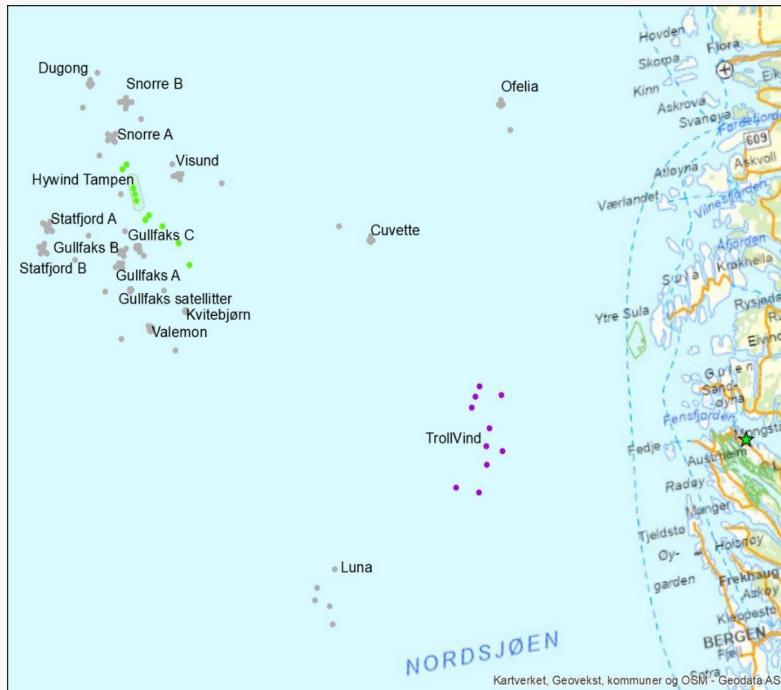
MICRO-RESPIROMETER. Small Bottle sediment-water slurry incubations: non-invasive O_2 consumption measurements

Because anthropogenic sources of organic carbon (e.g. aquaculture derived organic carbon and drilling mud) have atypical isotope signatures, carbon source isotope mixing model can be used estimate maximum contribution to sediment organic carbon



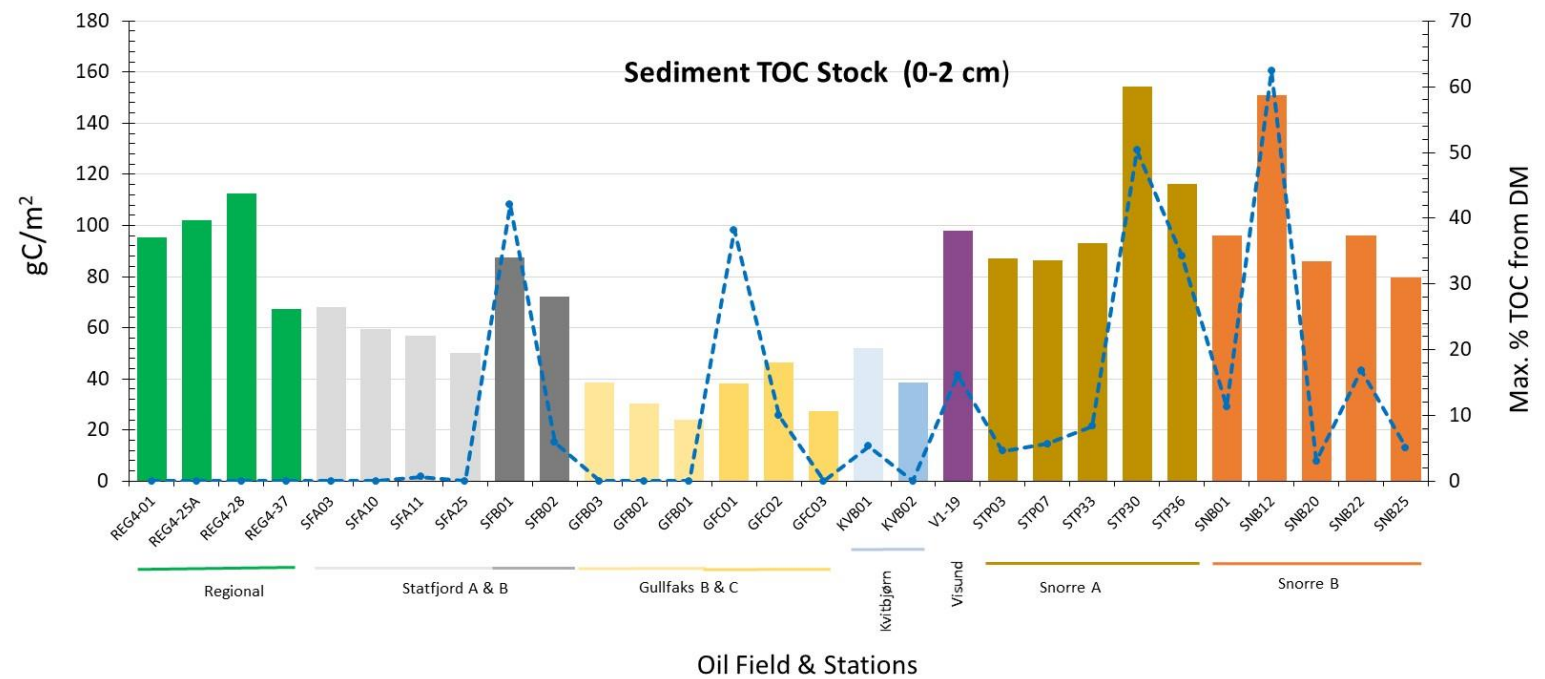
Overview of Region IV O&G fields (from Mannvik, 2023).





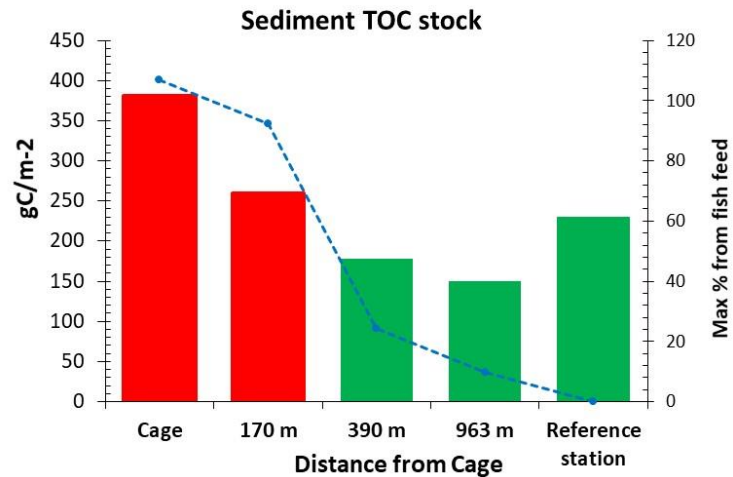
Overview of Region IV O&G fields (from Mannvik, 2023).

TOC stock and Provenance

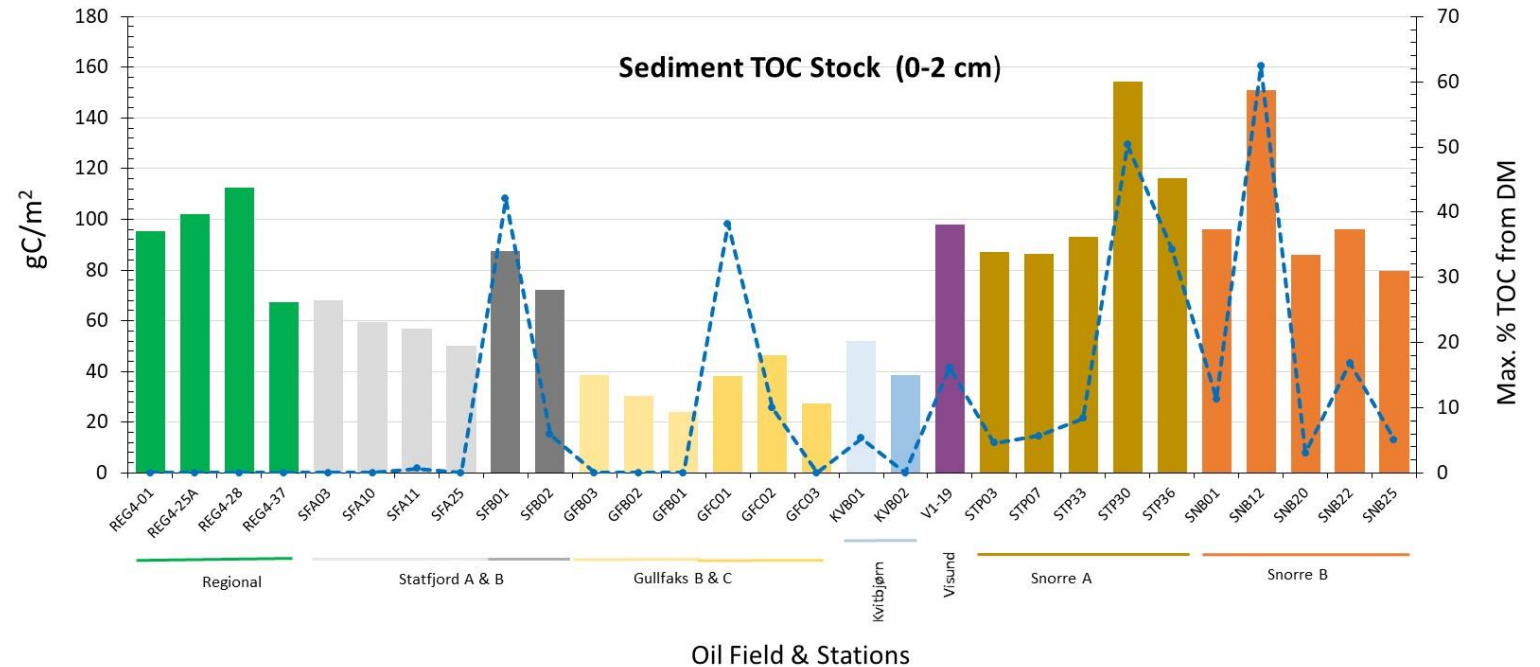


TOC: total organic carbon
DM: drilling mud

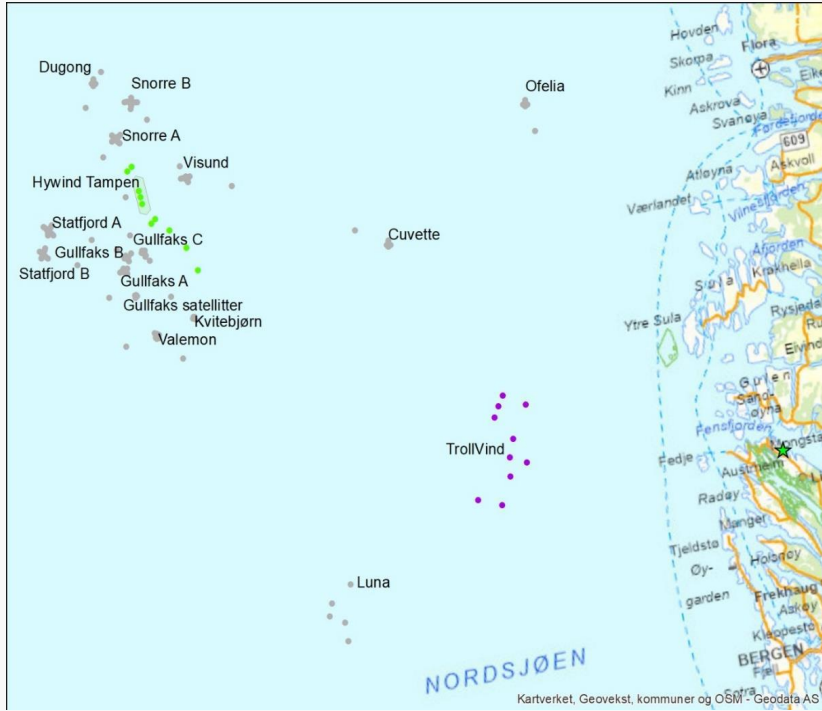
Fjord sediment



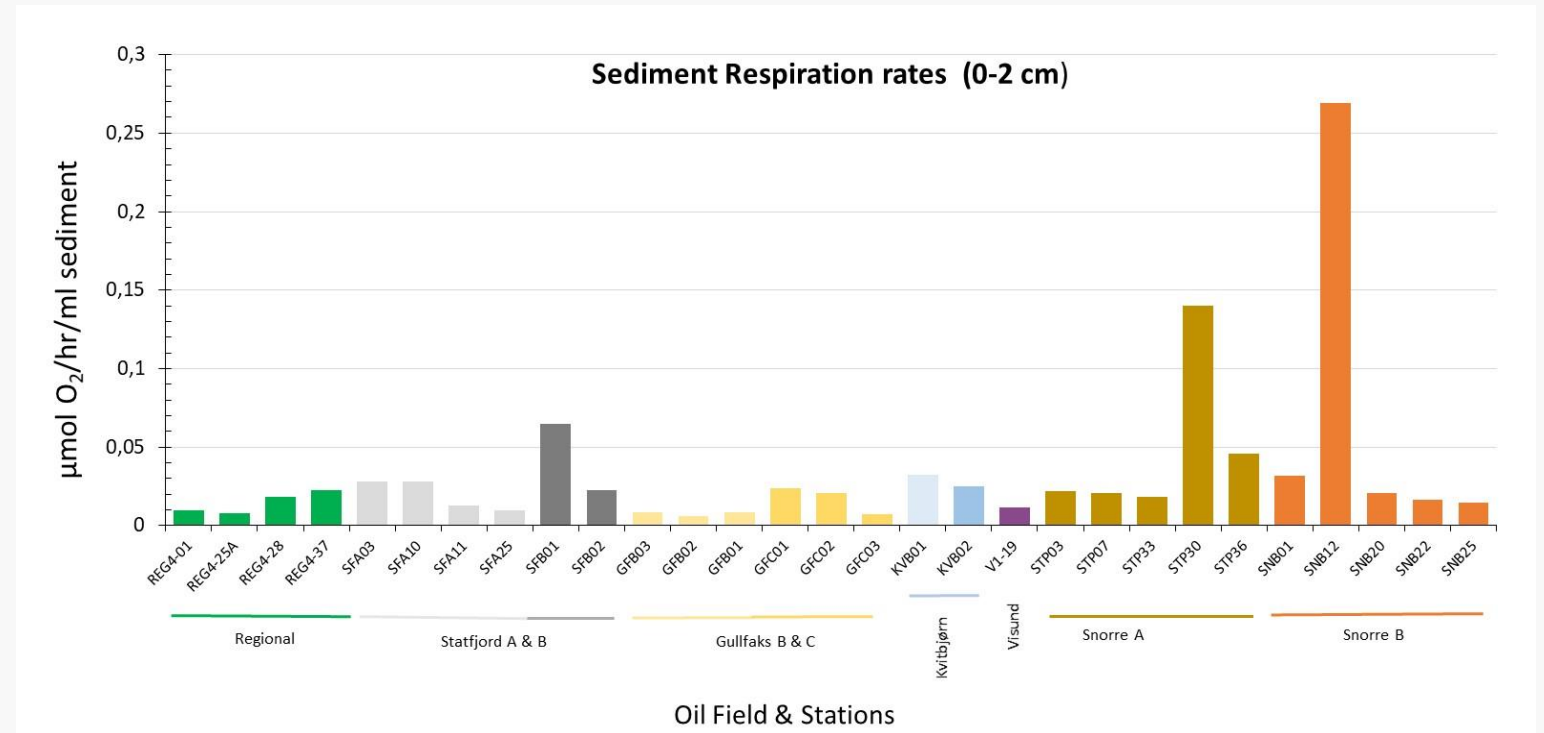
Offshore sediment

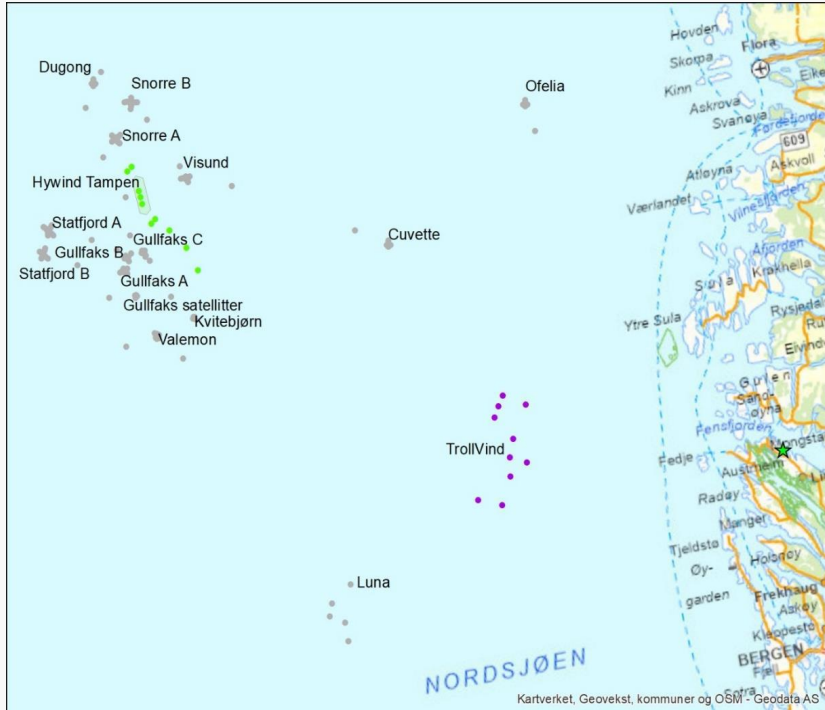


Organic matter stock measurements and stable carbon isotope signatures are very sensitive tools to monitor impact.

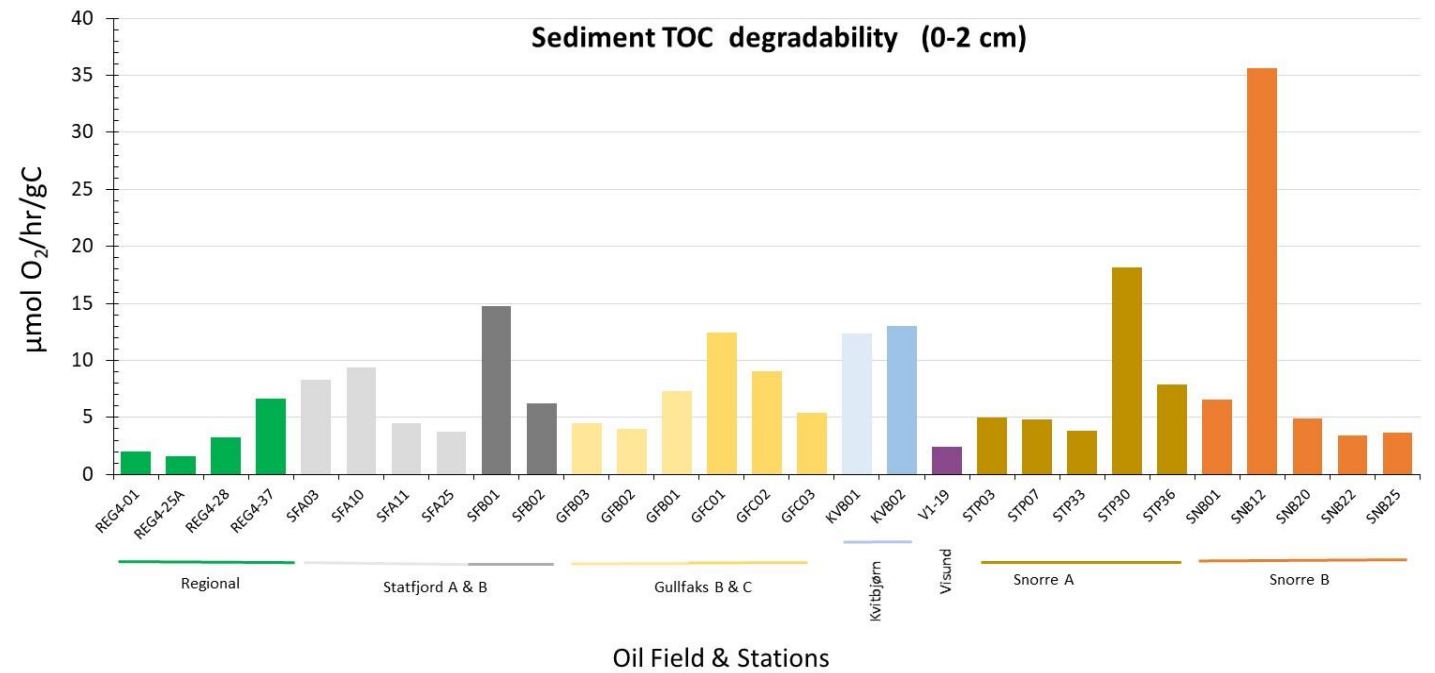


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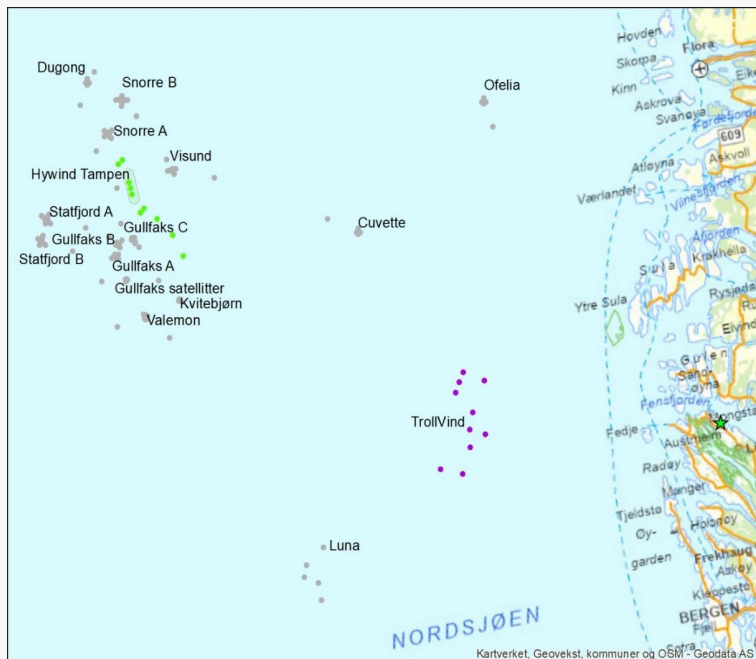




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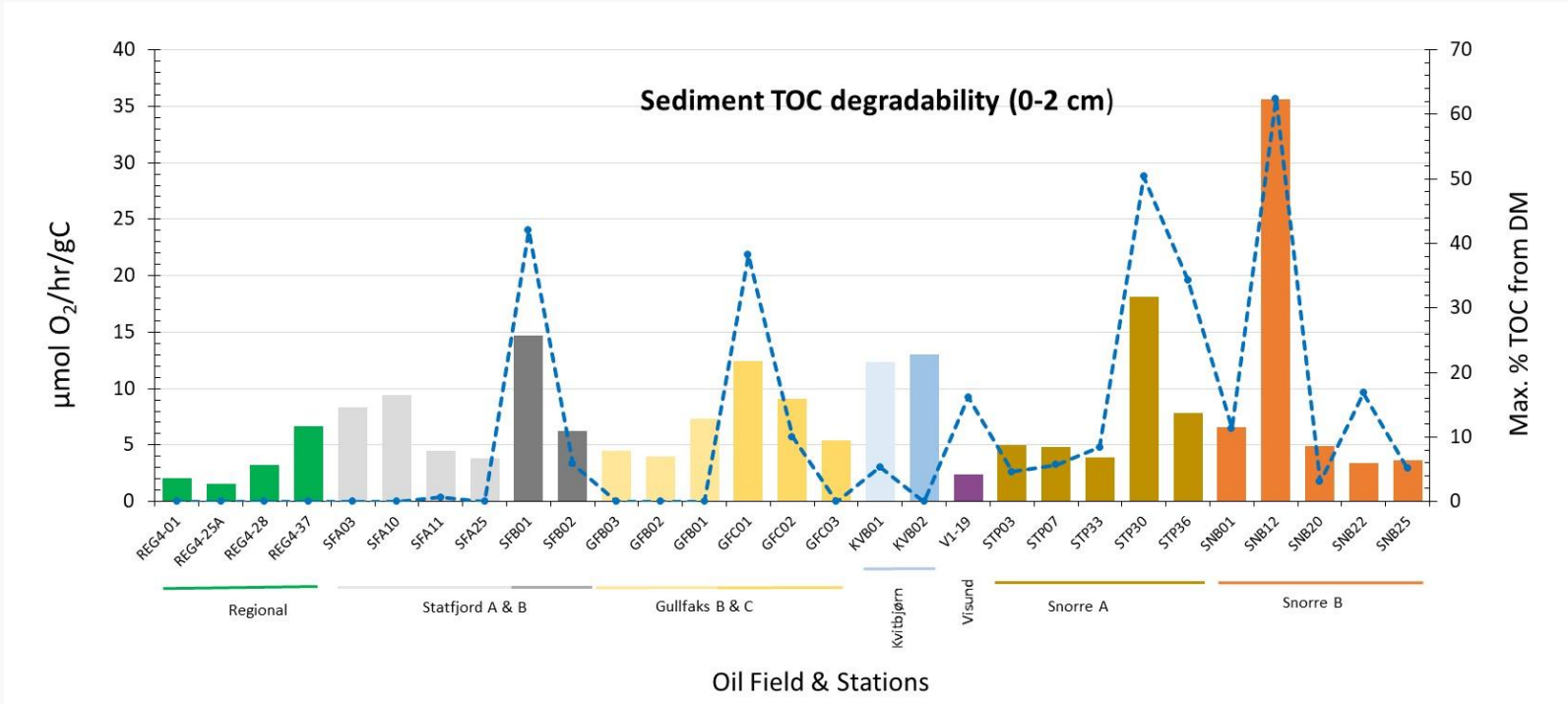


TOC: total organic carbon



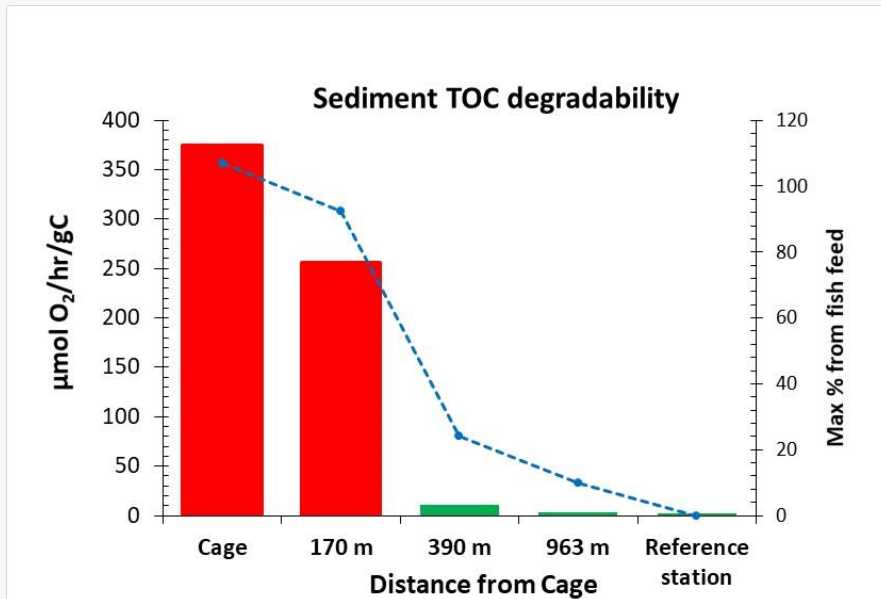
Overview of Region IV O&G fields (from Mannvik, 2023).

TOC degradability and Provenance

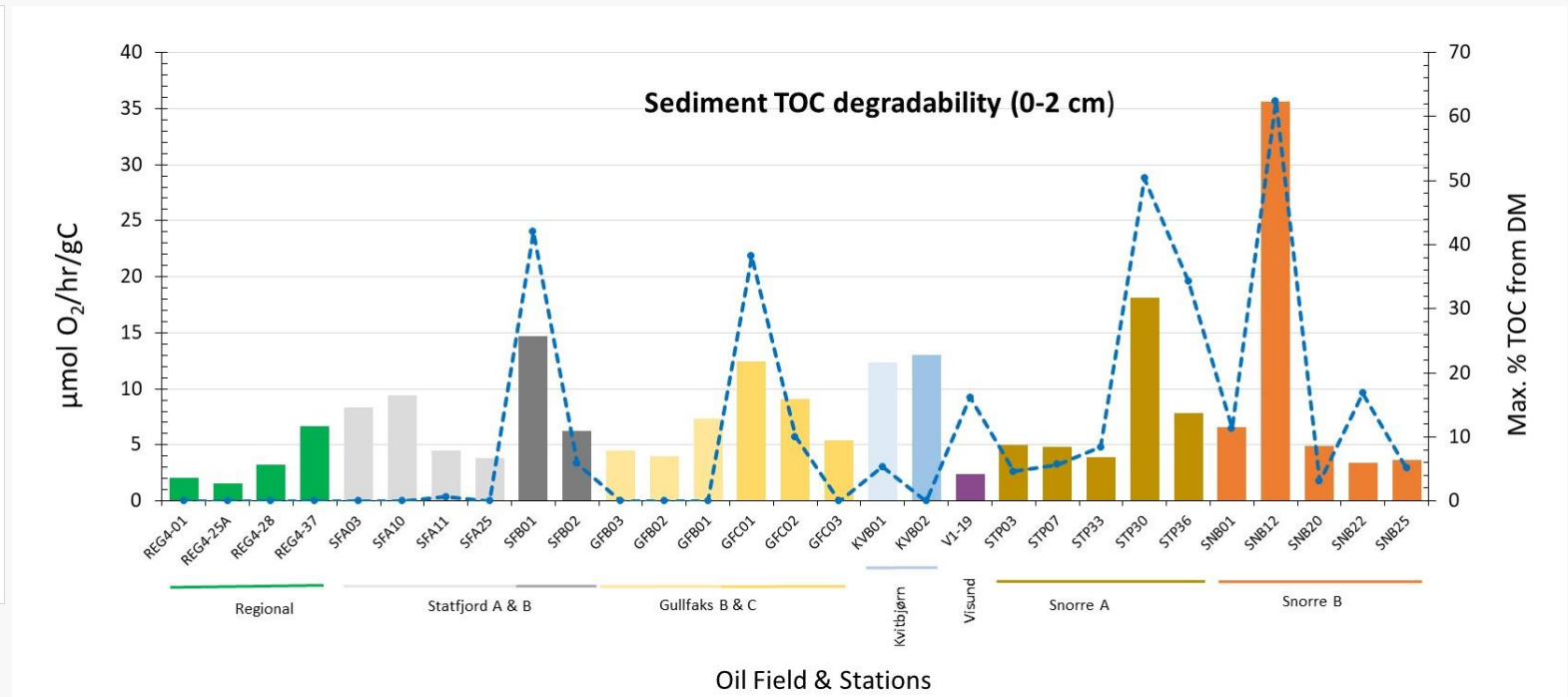


TOC: total organic carbon
DM: drilling mud

Fjord sediment



Offshore sediment



Direct measure of organic matter degradability and stable carbon isotope signatures are very sensitive tools to monitor and interpret impact of anthropogenic activity

Also for the upcoming offshore aquaculture

Tusen takk!

Thank you for your attention!

e.g. of altered benthic metabolism recorded with microsensors

A regional station versus the most highly impacted station Snorre B-SNB12

