BENTHIC ORGANISMS IN ARCTIC ECOSYSTEMS

PRESENCE AND EFFECTS OF NANOPARTICLES IN THE CONTEXT OF SINGLE AND MULTIPLE STRESSORS

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INTERNATIONAL SYMPOSIUM ON PLASTIC IN THE ARCTIC AND SUB-ARCTIC REGION

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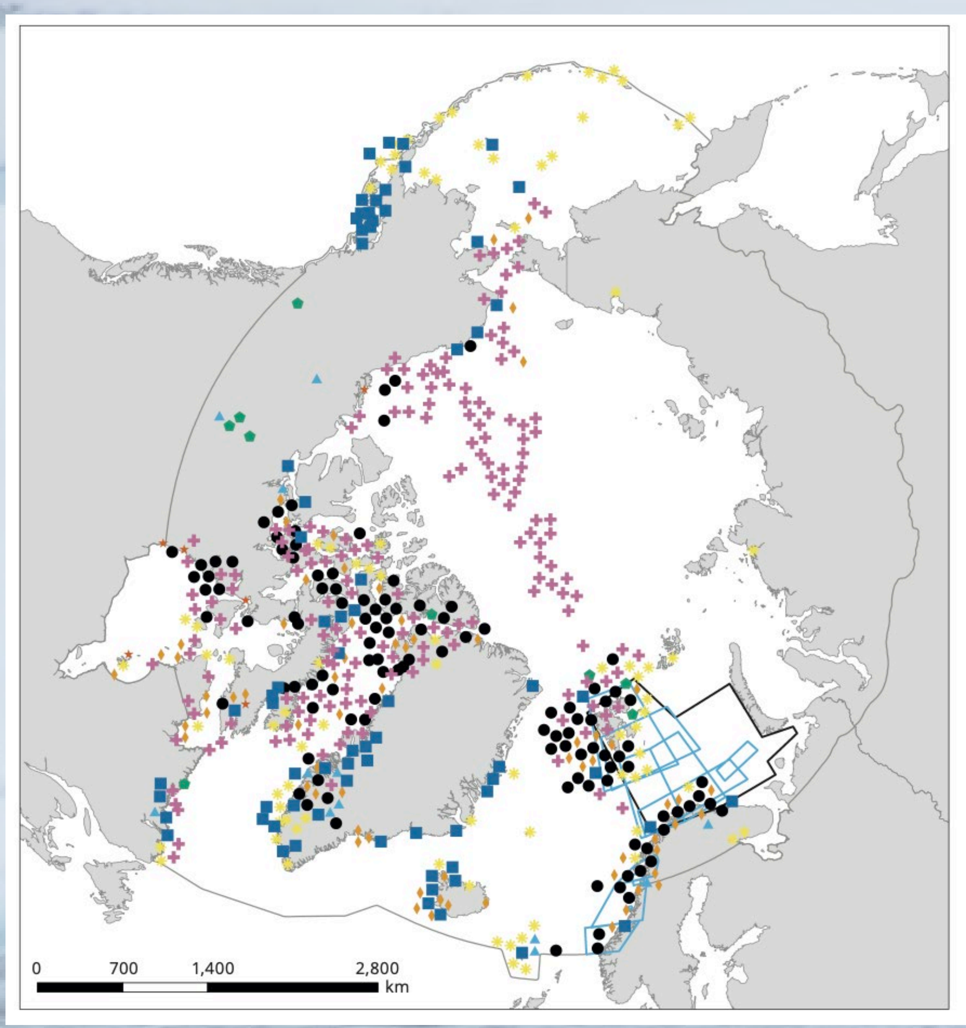
PLASTIC IN THE ARCTIC



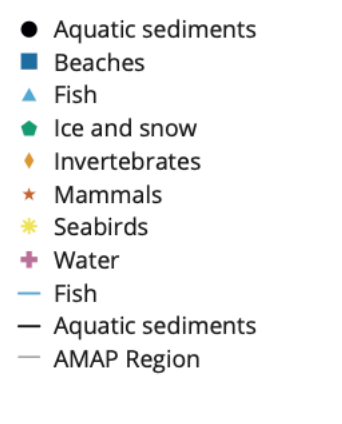


Figure 1. Sub-set of the distribution of the types and locations of existing data on litter and microplastics in the AMAP region (AMAP, 2021; Provencher et al. 2022)

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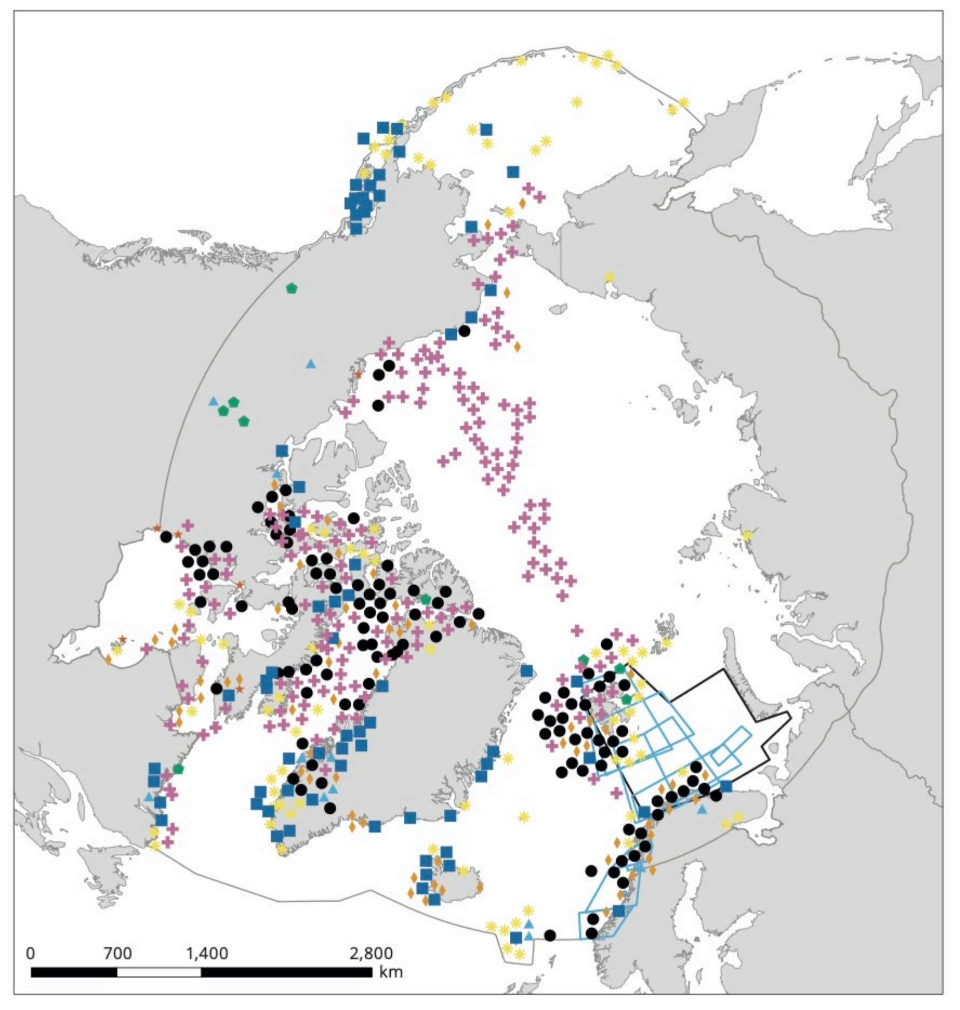

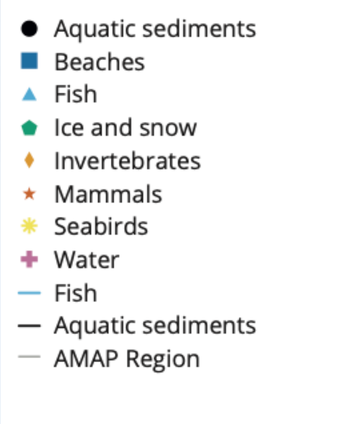

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Environmental compartment	Particles > 1 mm	Particles < 1 mm
Beaches/shorelines	X	
Water	X	X
Sediments	X	X
Seabirds	X	
Atmospheric deposition		X
Seabed	X	
Invertebrates		X
Fish		X
Snow/ice		X
Terrestrial soil		X
Mammals	X	X

Table 1. Size classes of plastic particles reported in Arctic environmental compartments (AMAP, 2021)

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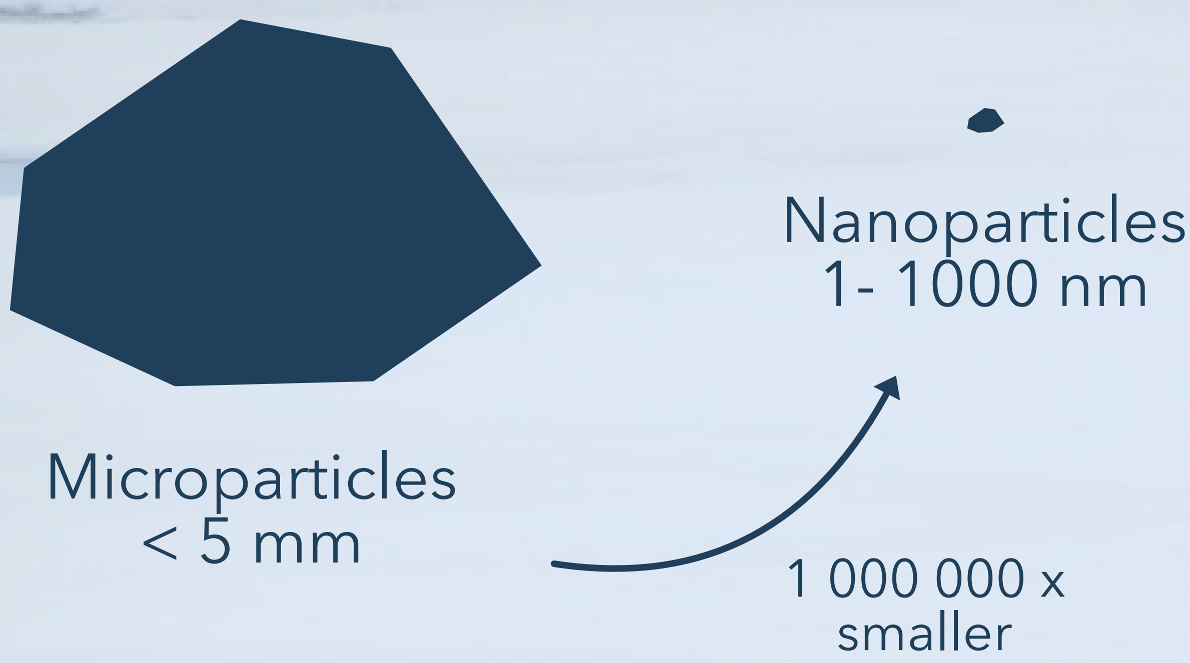

NPs are produced by the **degradation** and **fragmentation** of plastic objects and show colloidal behavior (Gigault et al. 2018).

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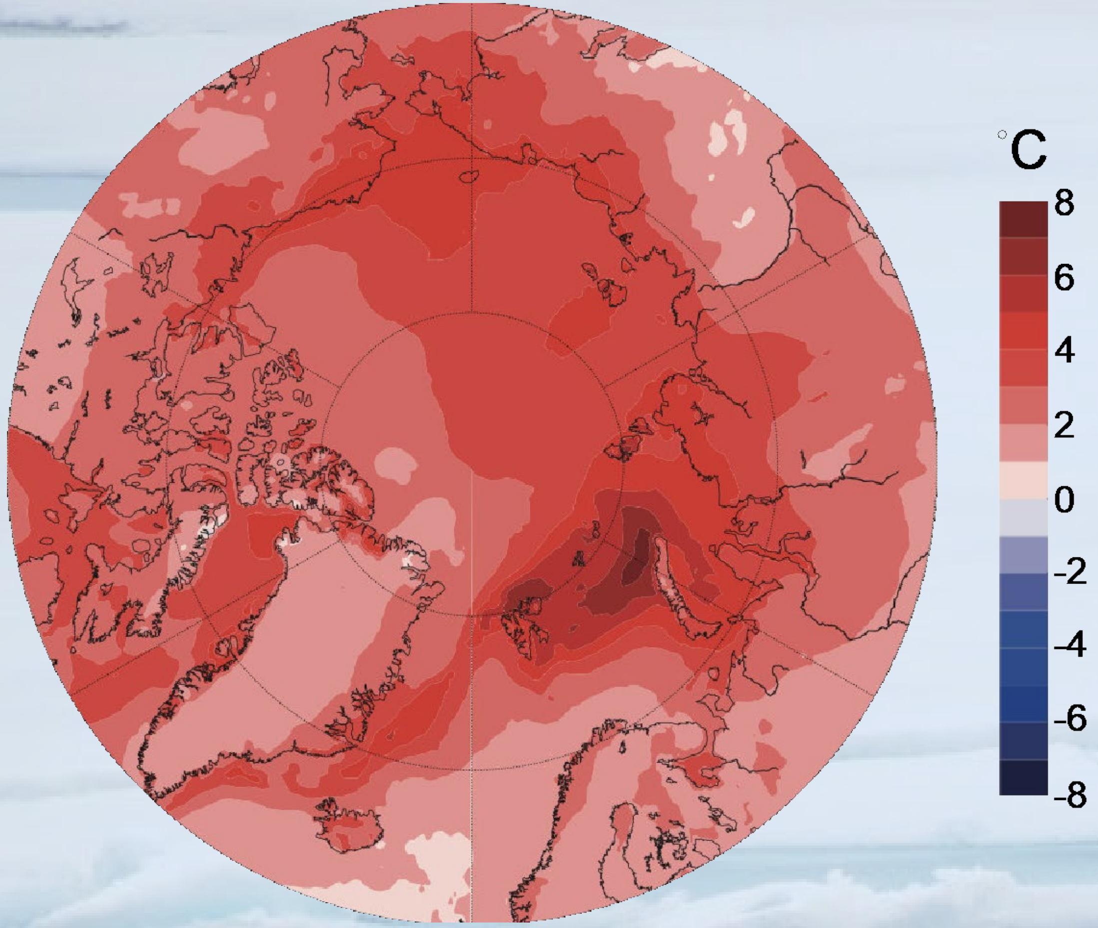

Figure 2. Arctic annual surface temperature trend patterns, 1971-2019, based on combined observed and modeled data (AMAP 2021)

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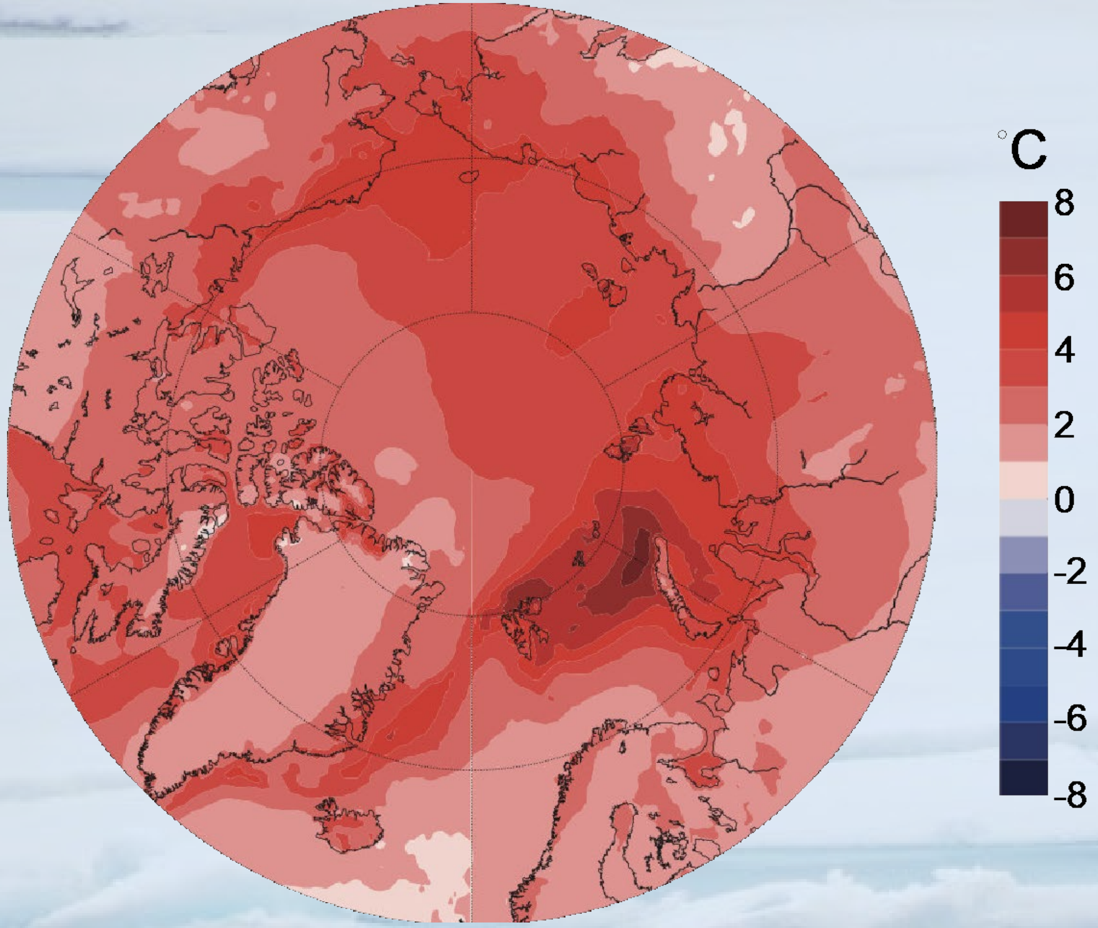

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ACIDIFICATION

SALINITY VARIATION

INVASIVE SPECIES

CONTAMINANTS

INVASIVE SPECIES

SEA ICE LOSS

NANOPARTICLES AND… MULTIPLE STRESSORS

STRESSOR INTERACTIONS AND ECOLOGICAL SURPRISES

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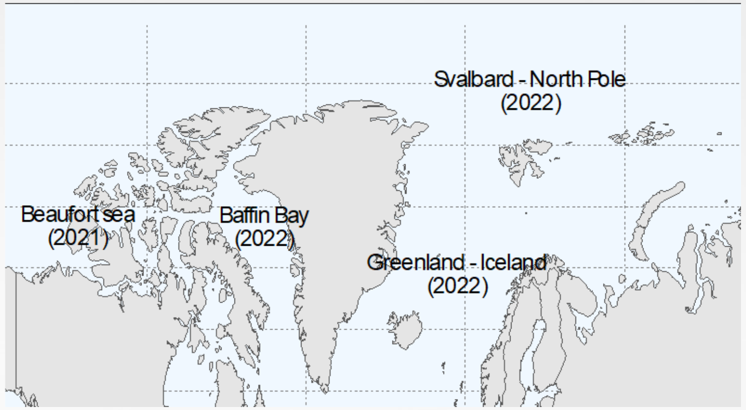
HOW TO ASSES THE EFFECT OF NPS IN THE ARCTIC



1. Characterization

- Global and local
- Multiple abiotic and biotic compartments

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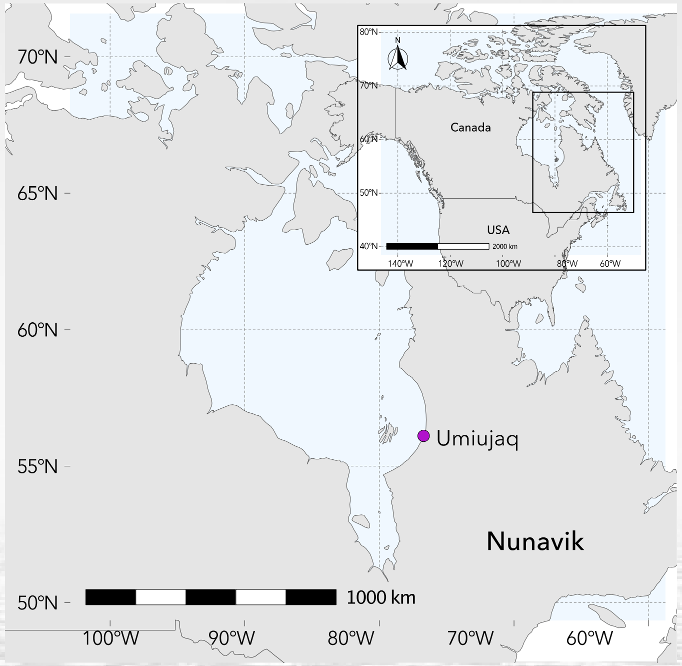

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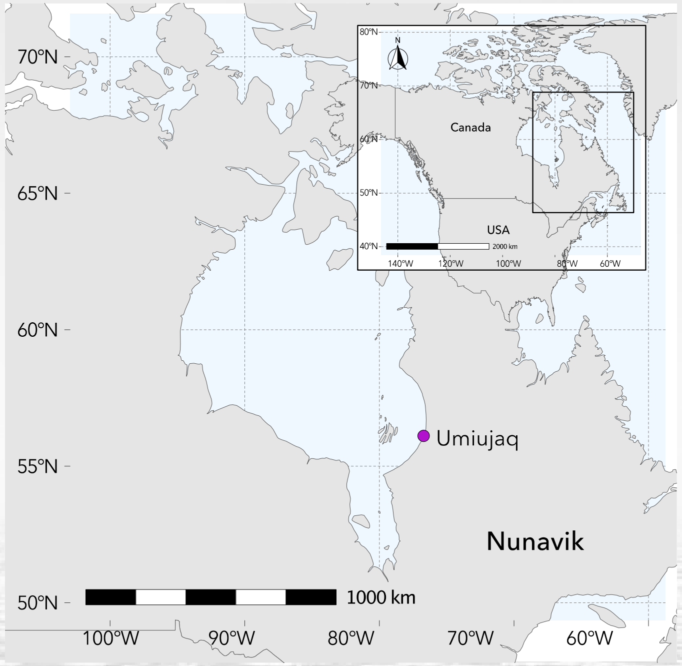

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- Effect of NPs on sentinel species or bioindicators

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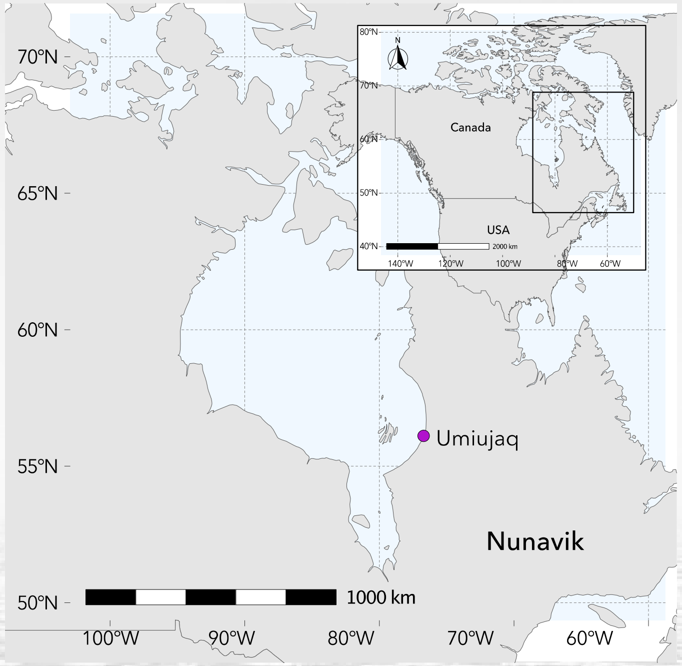

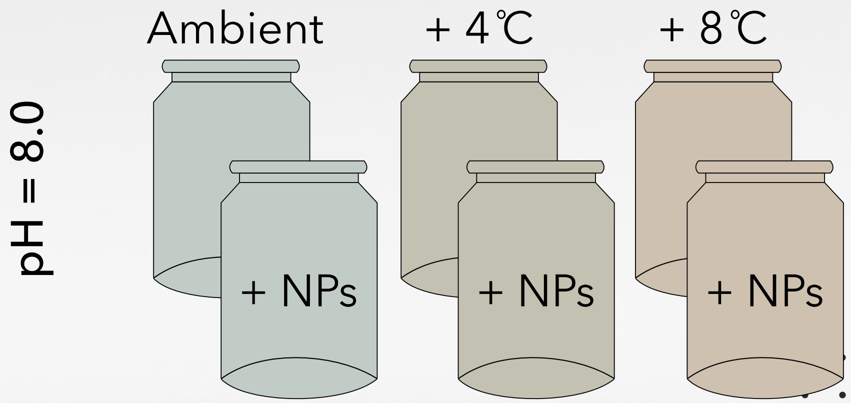

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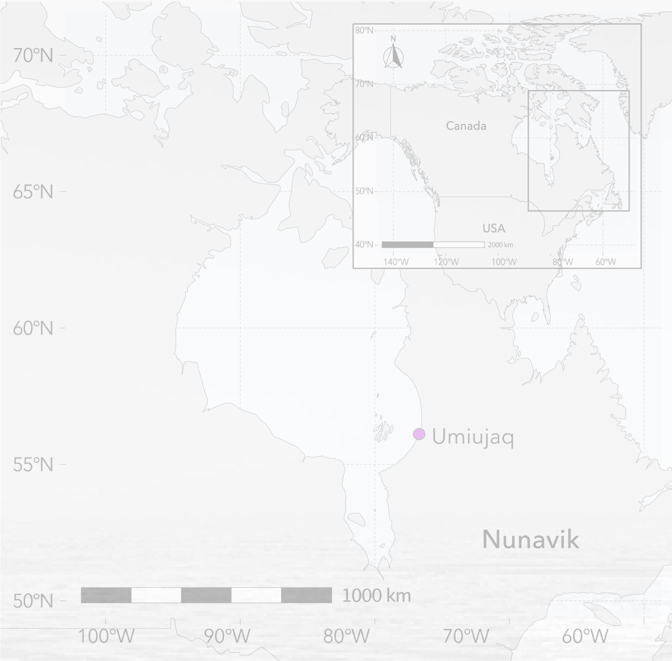

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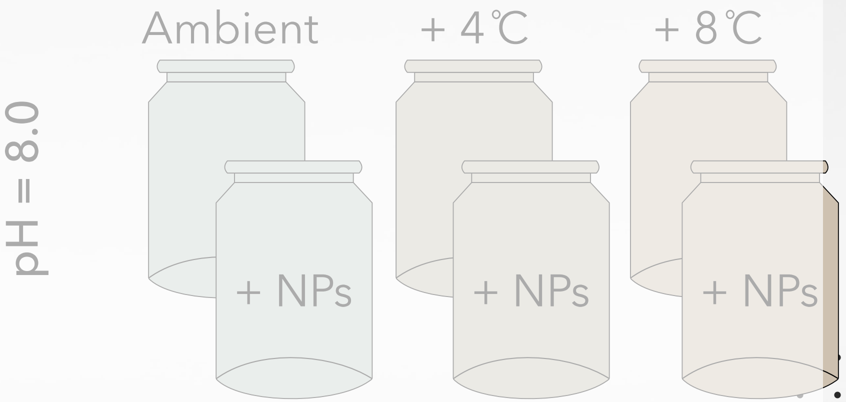

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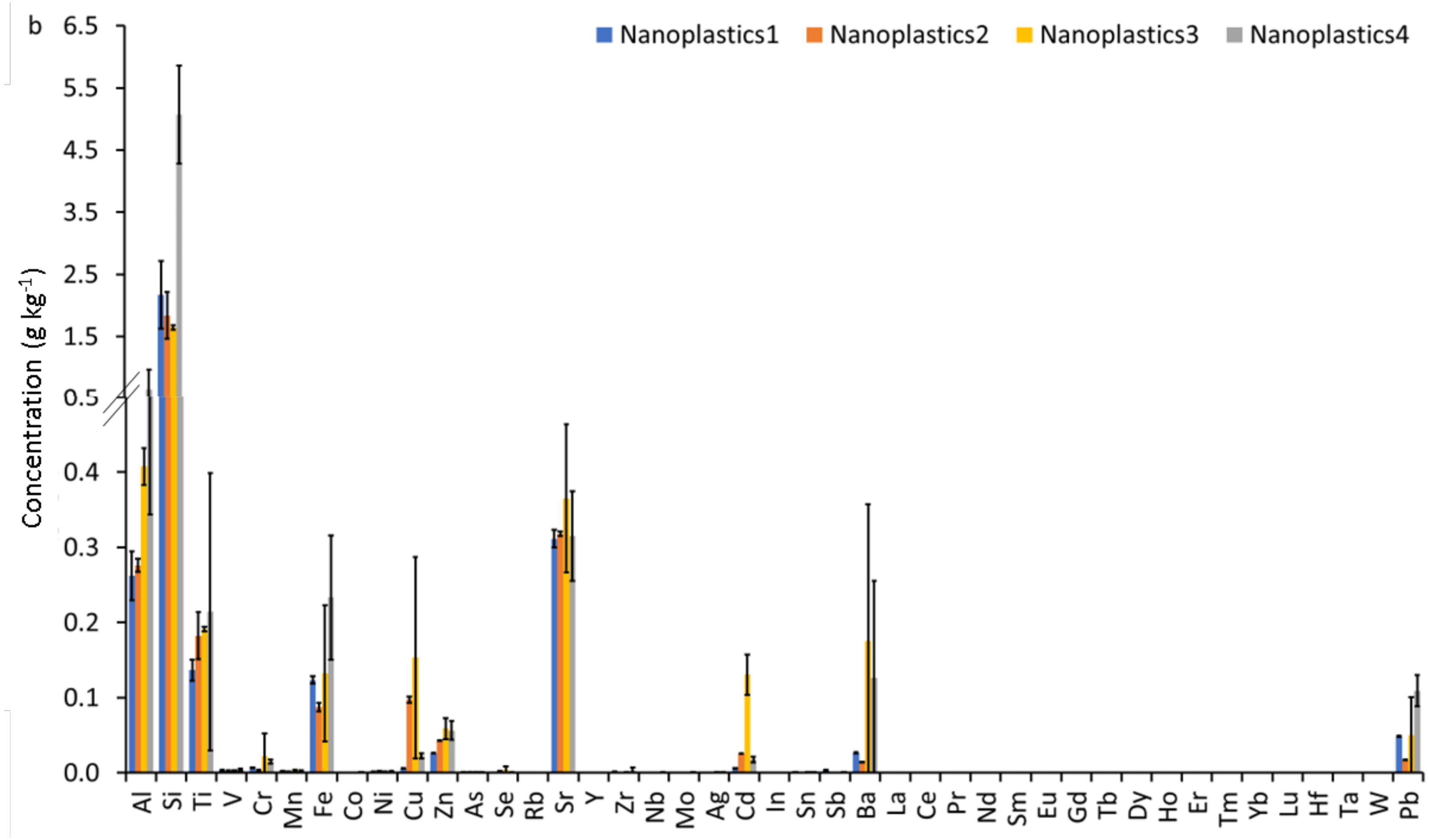
Why use benthic organisms as indicators ?

- Sessile species exposed to multiple environmental stressors
- Known ecology
- Important functional traits
- Important role in the food web
- Food resources used by local communities

BLUE MUSSEL AS SENTINEL ORGANISM

SINGLE STRESSOR EXPERIMENT



- Mix of 4 environmental nanoplastic solution
- Polyethylene
- Polypropylene
- Associated metallic nanoparticles
- 3 concentration (0, 500, 5000 µg L^{-1})
- 3 exposure time (6h, 48h and 6 days)

EFFECT OF CONCENTRATION AND EXPOSURE TIME

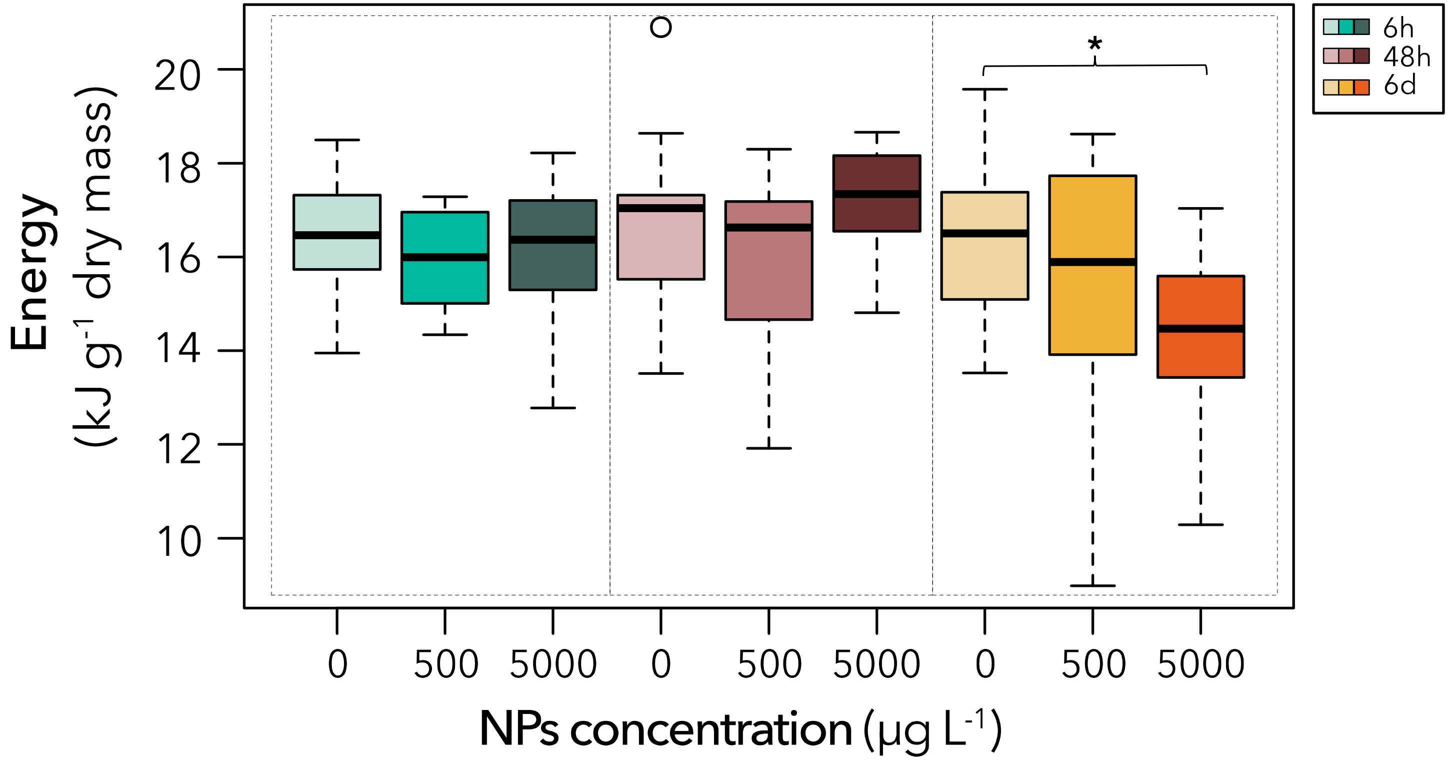
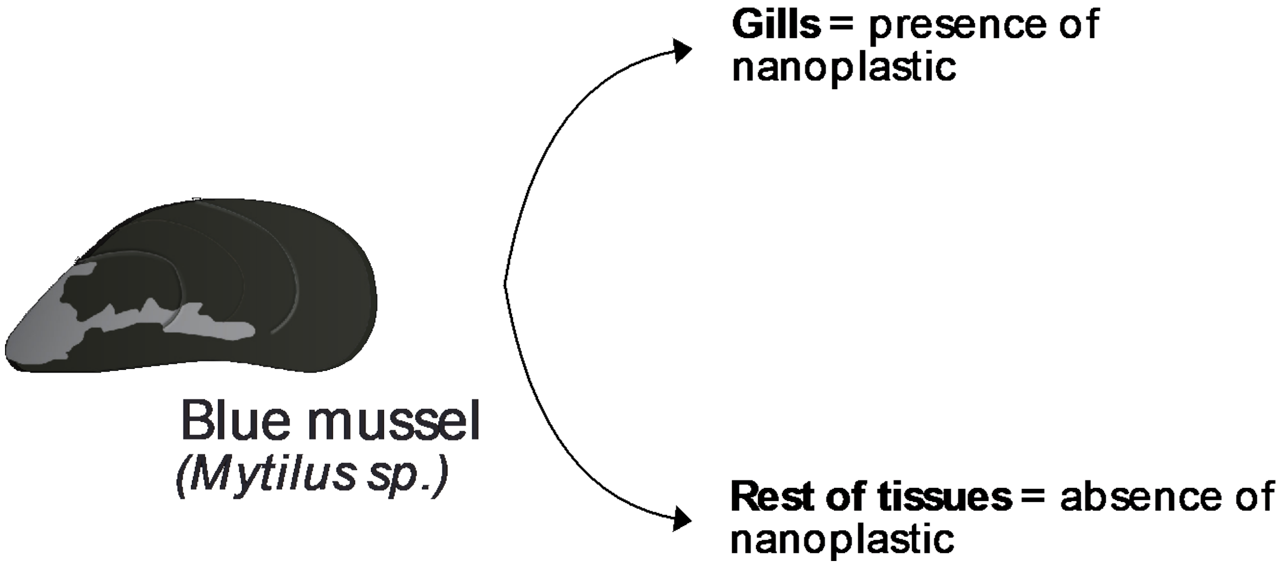


Figure 3. Effect of different concentration and time of exposure on energy content in Mytilus spp.

- After 6 days of exposure, higher NPs concentration (5000) decreases energy content in comparison to control conditions
- Increase variance
- Less energy → consequences for local communities and for energy flow through food web

NANOPARTICLES IN GILLS AND TISSUES



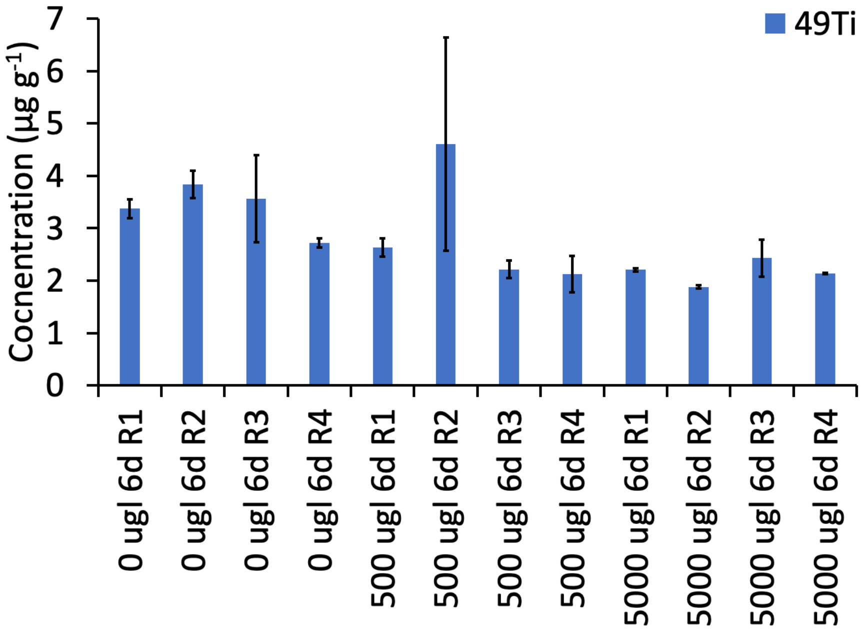
Quantification of NPs ongoing with Py-GC-MS-MS and sp-ICP-Q-ToF!

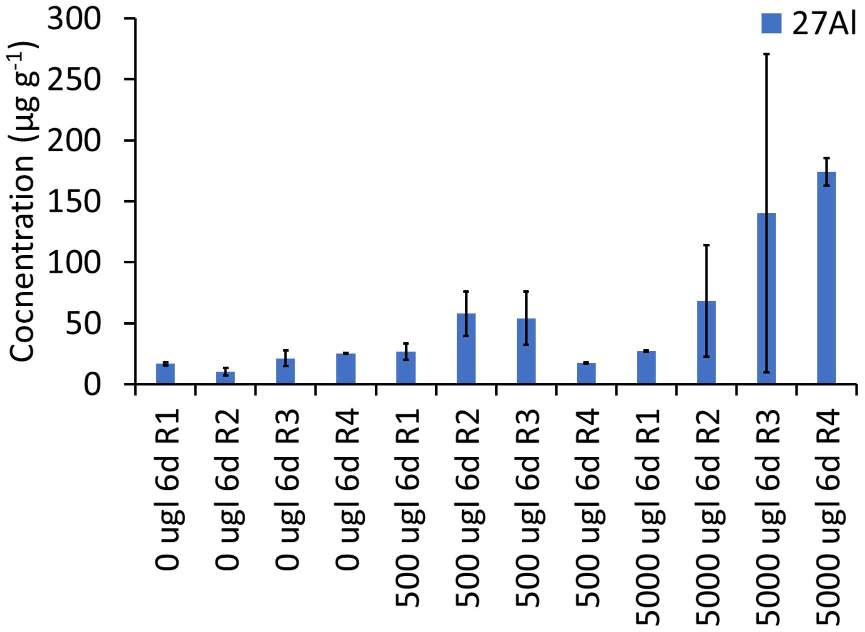
NANOPARTICLES IN GILLS AND TISSUES

Blue mussel
(Mytilus sp.)

Gills = presence of nanoplastic

Rest of tissues = absence of nanoplastic





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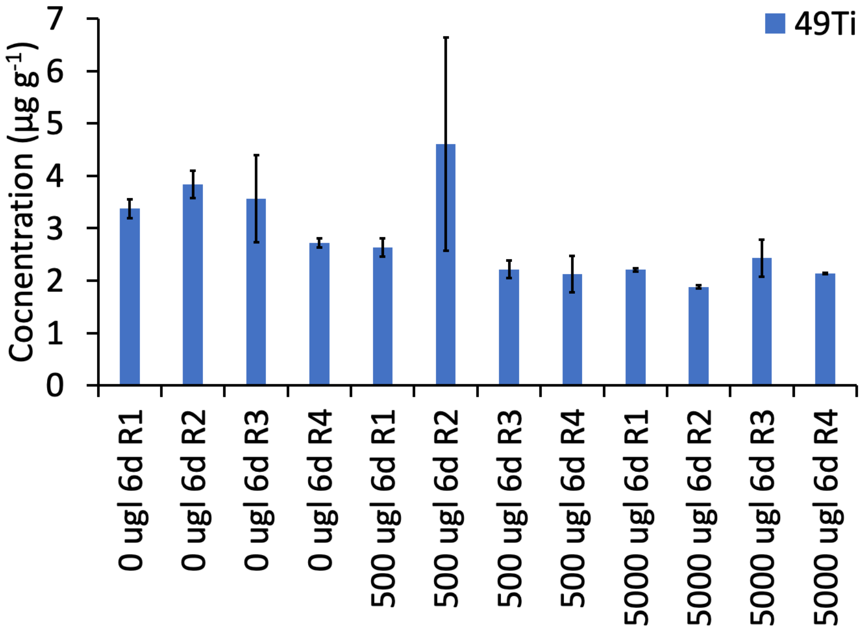
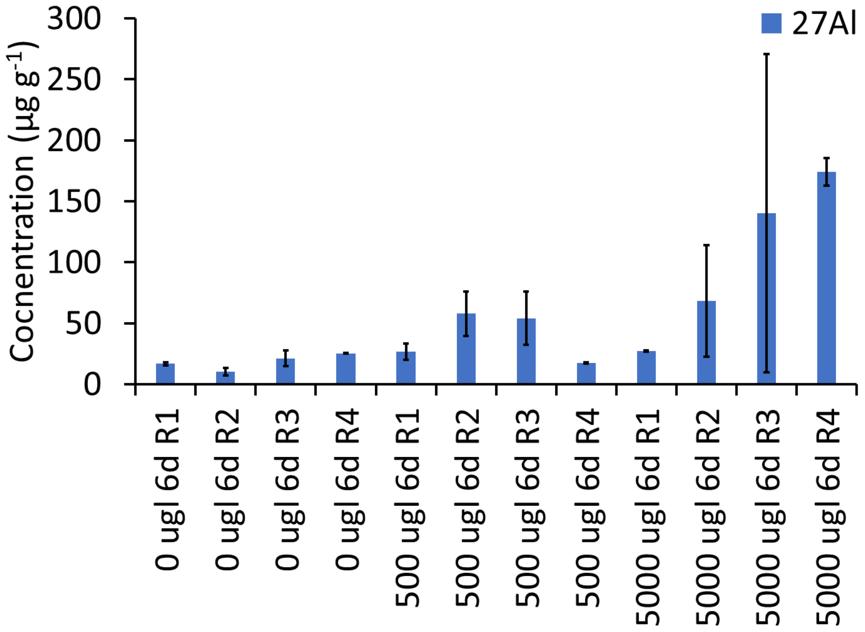
Work in collaboration with M. Baalousha (U. of North Carolina)

NANOPARTICLES IN GILLS AND TISSUES

- No accumulation of TiO2 in the tissue while we know the high concentration and the stability of the TiO2 in the plastic
- Accumulation of Aluminium in the tissues, stability of Al?
- Trojan horse property of nanoplastics?
- Selective assimilation of metals ?





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MULTI-STRESSOR EXPERIMENT

How do nanoparticles decrease the tolerance of benthic organisms to multiple environmental stressors ?

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7 days	1 month
Pre-exposure to nanoparticles	**Exposure to multiple stressors** Copper + Salinity variation + nutrient enrichment

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Pre-exposure to nanoparticles

Exposure to multiple stressors
Copper + Salinity variation + nutrient enrichment

Blue mussel
(Mytilus sp.)

- Multi-omics
- Energy content
- ATP production
- Filtration rates
- Oxygen consumption
- Ammonia excretion
- Mortality

Cellular, molecular, physiological responses

↓

Population and ecosystem functioning

Characterization

- What and where
- Best abiotic or biotic compartment
- Spatio-temporal variation

Nanoparticles experiment

- Mecanistic understanding
- Threshold effets
- Cellular, physiological, genetic effects

Multi-stressor experiments

- Layer of complexity
- Stressor interactions
- Realism

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- ARCTICNET AND MEOPAR

COLLABORATORS

- UNIVERSITY COLLEGE DUBLIN
- INRAE
- OHMI NUNAVIK
- MOHAMMED BAALOUSHA

THANK YOU TO THE ORGANIZING COMMITTEE

AND THANK YOU FOR YOUR ATTENTION

HOW TO CONTACT ME

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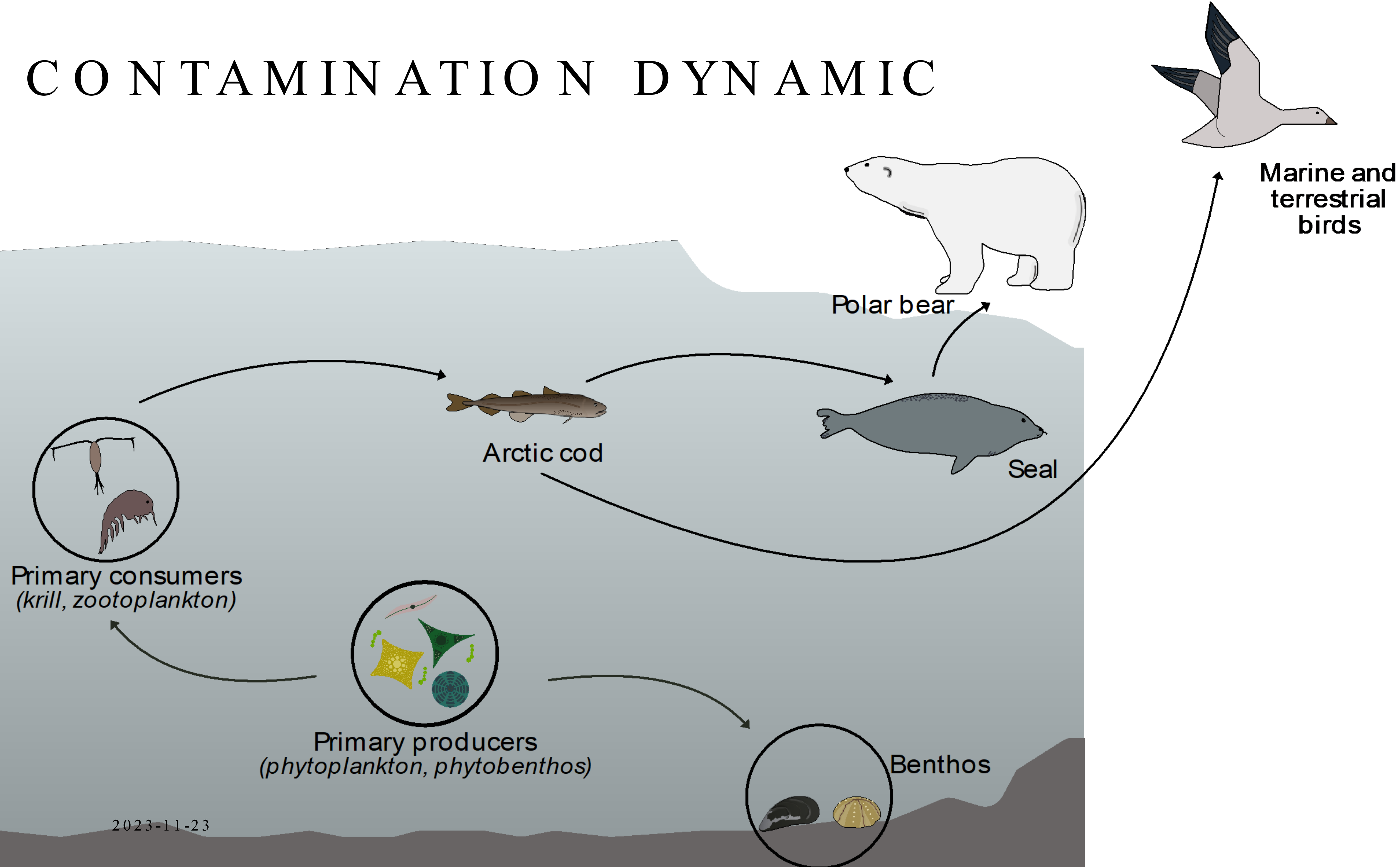
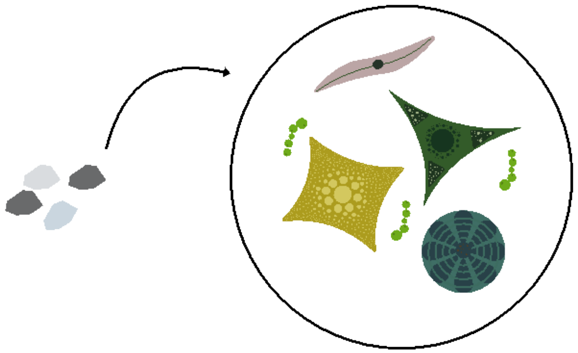
ResearchGate

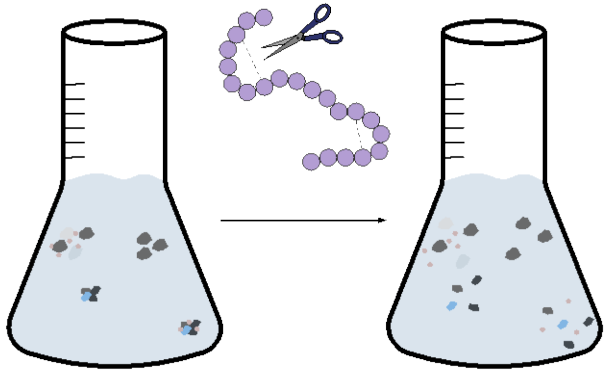
CONTAMINATION DYNAMIC



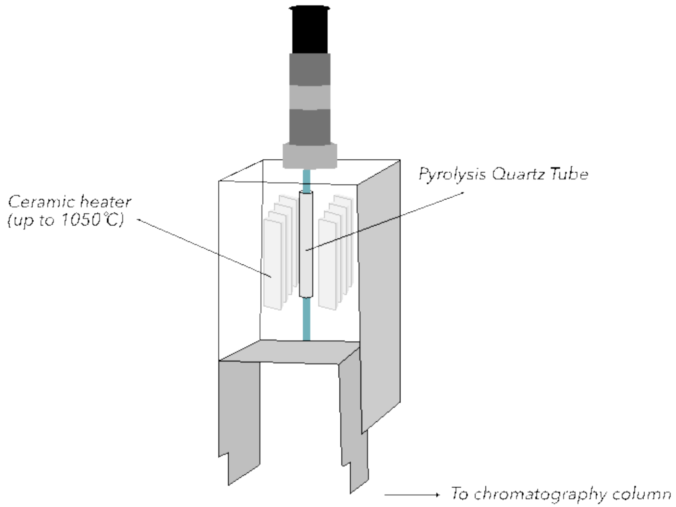
EXTRACTION METHOD



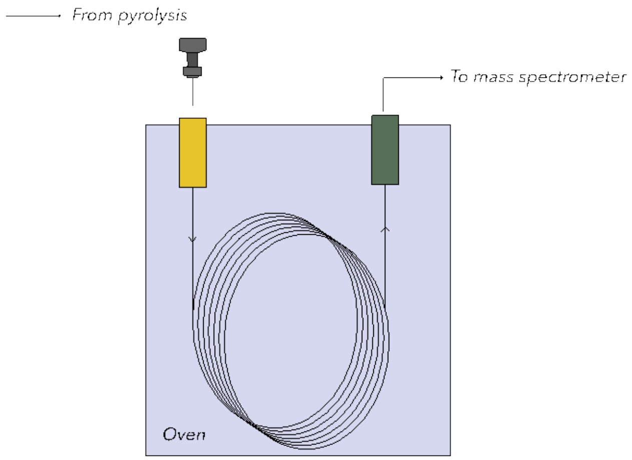
1. Remove organic matter
(peroxyde/UV)



2. Dissociate matter
(potassium hydroxyde)



3. Burst the matrix
(pyrolysis 600°C under helium flow)



4. Separate the different compounds
(chromatography column)