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Microplastics in the Arctic – with potential implications for key zooplankton species

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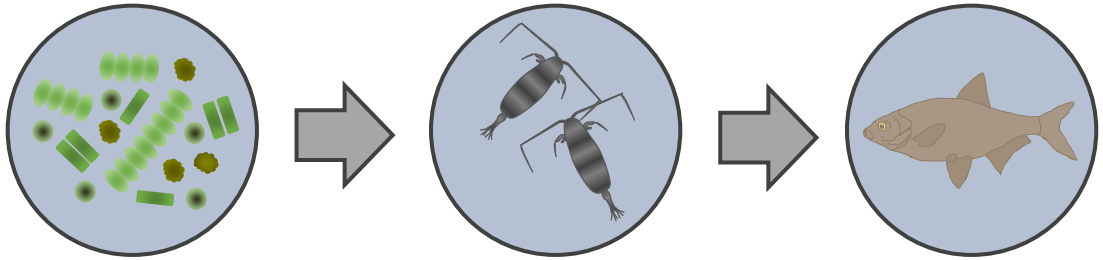
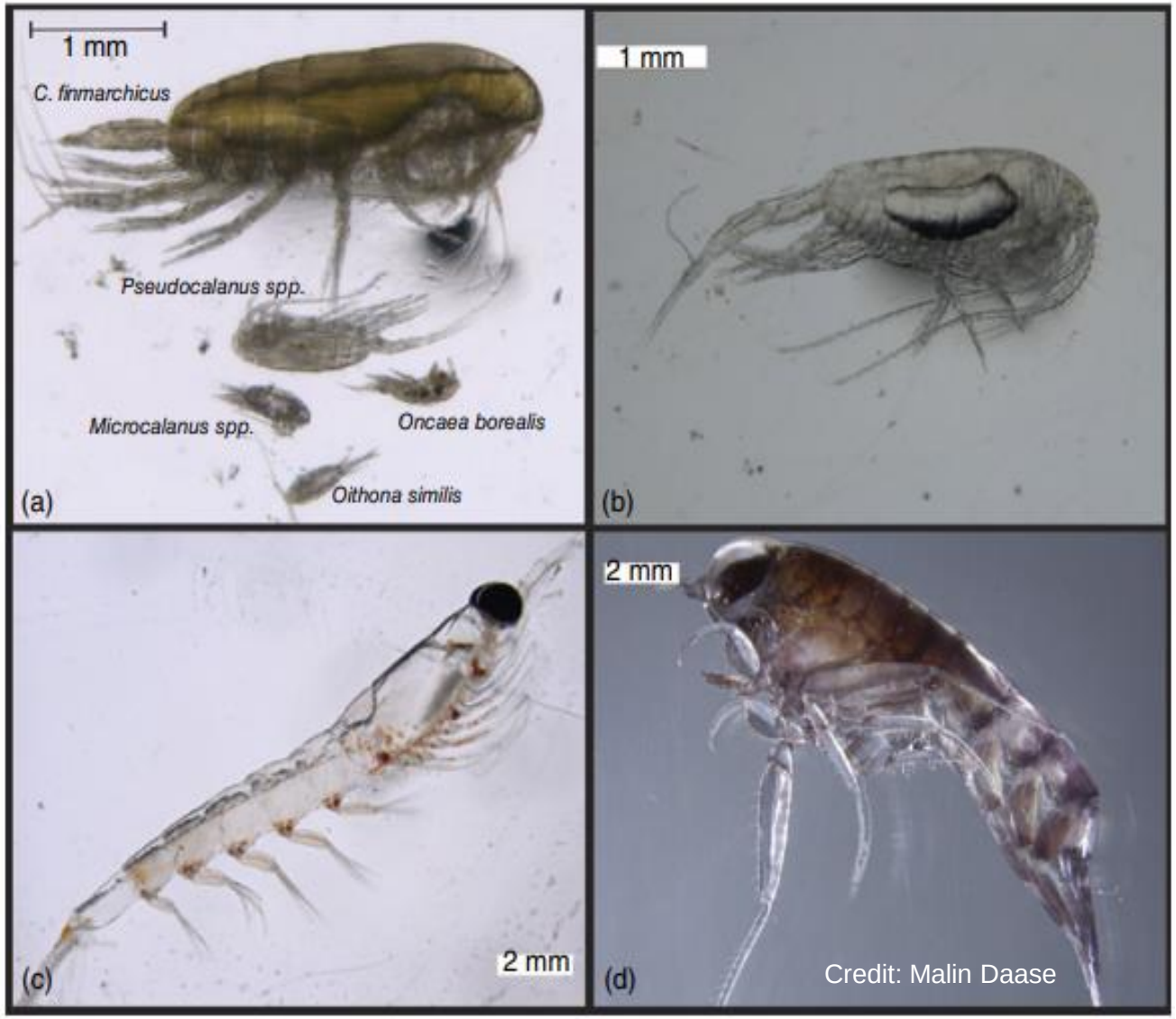
Anthropogenic Particles - Microplastics

- Man-made particles and fibres (0.1 µm – 5 mm) comprising: Plastics, Semi-Synthetics, Bioplastics, Cotton, Tyre Particles, Antifouling Paint Particles
- These are prolific environmental contaminants, found across all environments including ‘pristine’ Arctic
- Small size means can be ingested by smallest to largest marine organisms
- Evidence of harm to wide range of organisms, including zooplankton

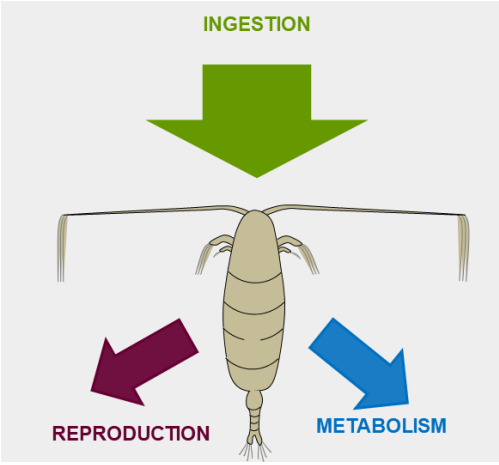
Zooplankton

- Zooplankton are common to marine ecosystems across the globe
- Provide a key link in the marine food web and play vital roles in marine processes
- Copepods lipid rich - underpin entire Arctic food web
- Copepods play an important role in regulating Earth's climate





Zooplankton and microplastic - Impacts

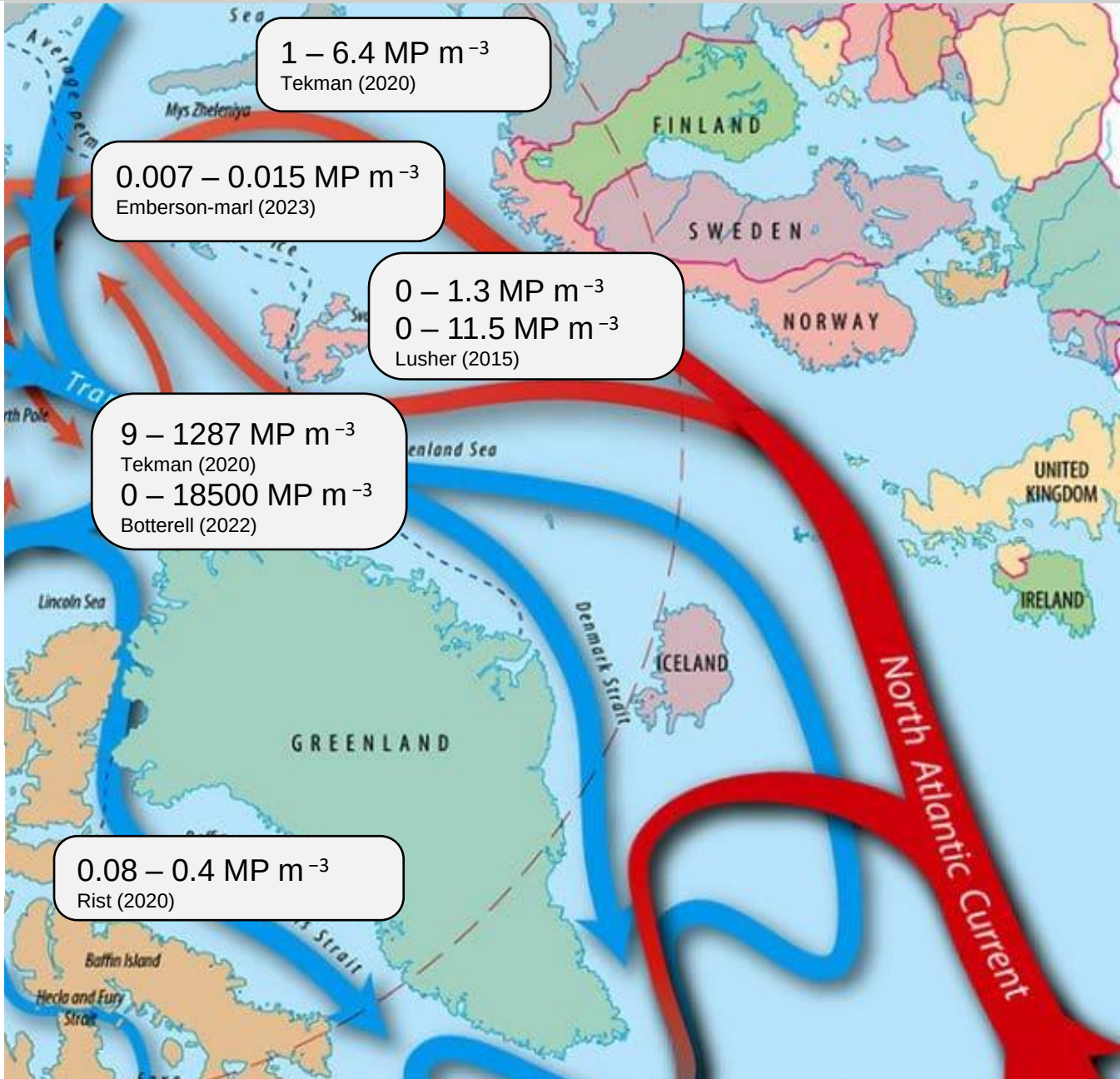


Copepods spend more energy than they consume: ENERGETIC SHORTFALL.

- Zooplankton have the capacity to ingest microplastics
- Lab based studies have shown: Reduced feeding capacity, decline in energy reserves, lower reproductive output
- Chemical profile of microplastic ingested may act as endocrine disruptors and impact moulting
- MPs are egested in faecal pellets, alter the properties and sinking rates
- MPs have been shown to be consumed by zooplankton in the natural environment – largely limited to warmer waters

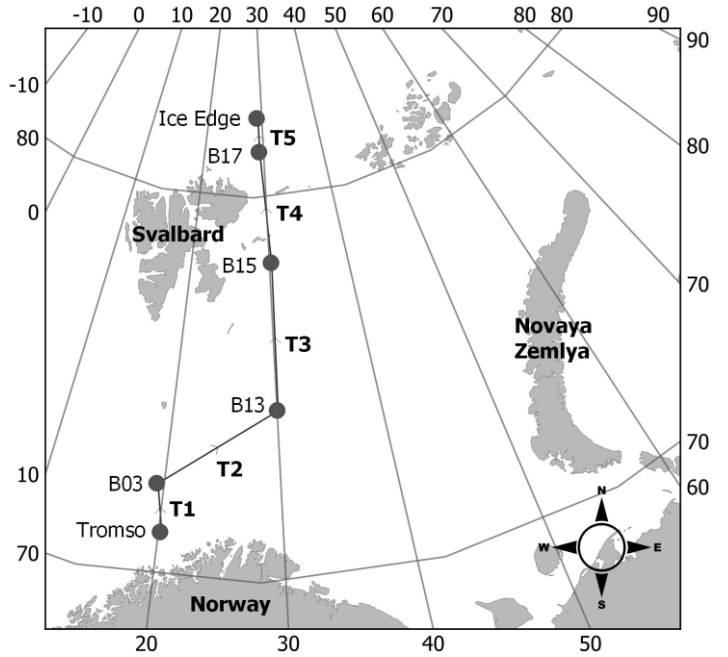
Microplastics in the Arctic

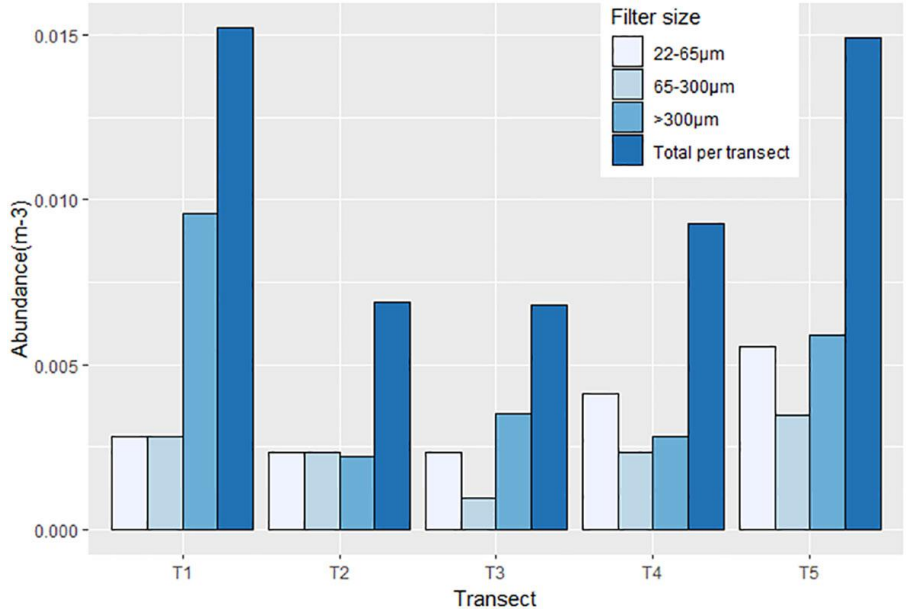
- Transported via currents, atmospheric deposition and local input (fishing, tourism)
- MPs found in all compartments
- MP abundance highly variable, often by several orders of magnitude
- Different methods make it difficult to compare across studies



Barents Sea

- Transect through eastern Barents Sea
- Low abundance compared to other work – underway pump 6m below surface + high volumes sampled
- Found higher MP concentrations towards ice edge and land mass
- Suggests from ice melt and land based sources





Emberson-Marl, Coppock *et al*., 2023. Frontiers in Marine Science

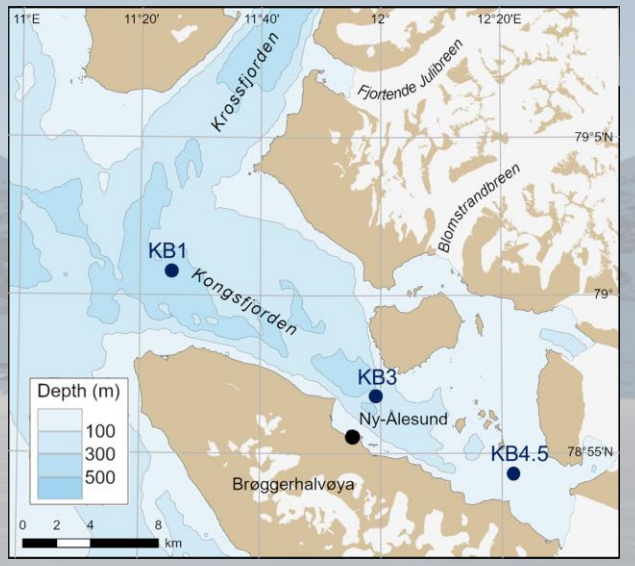
Fram Strait

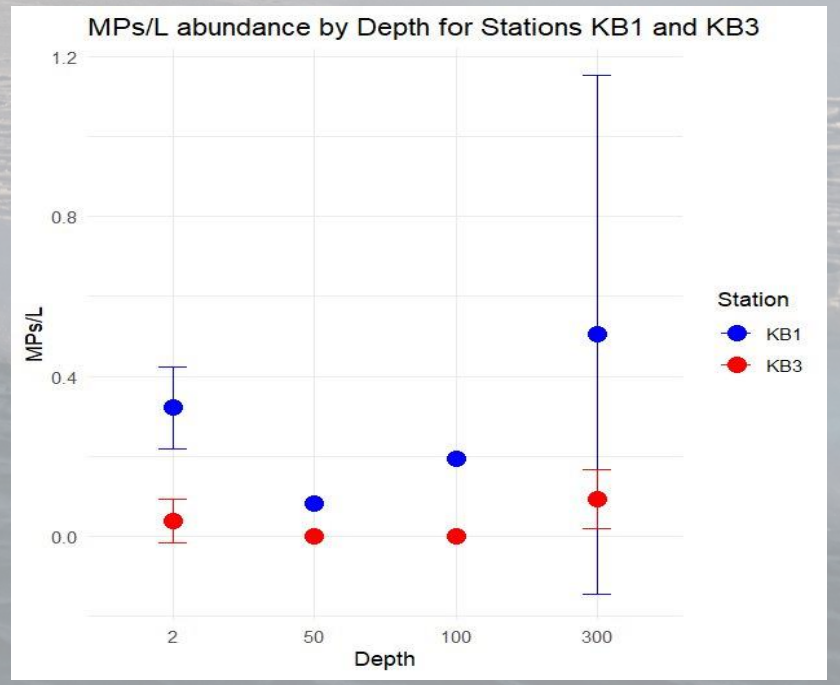
- High waterborne MP concentrations found in Fram Strait [0–18,500 MP m^{-3}]
- Evidence of ingestion by Arctic zooplankton - high MP loading in ice associated amphipods, fewer in copepods but high biomass
- All ingested particles were fragments & majority much smaller (≤50 µm) than found in surrounding water – selectivity

Botterell et al., 2022

High Arctic fjord

- Preliminary results – data not yet published
- Higher waterborne MPs in outer fjord, consistent with Atlantic being key contributor
- ~9% Krill ingested MPs (outer fjord)
- ~100% *C. hyperboreus* ingested MPs (mid fjord)

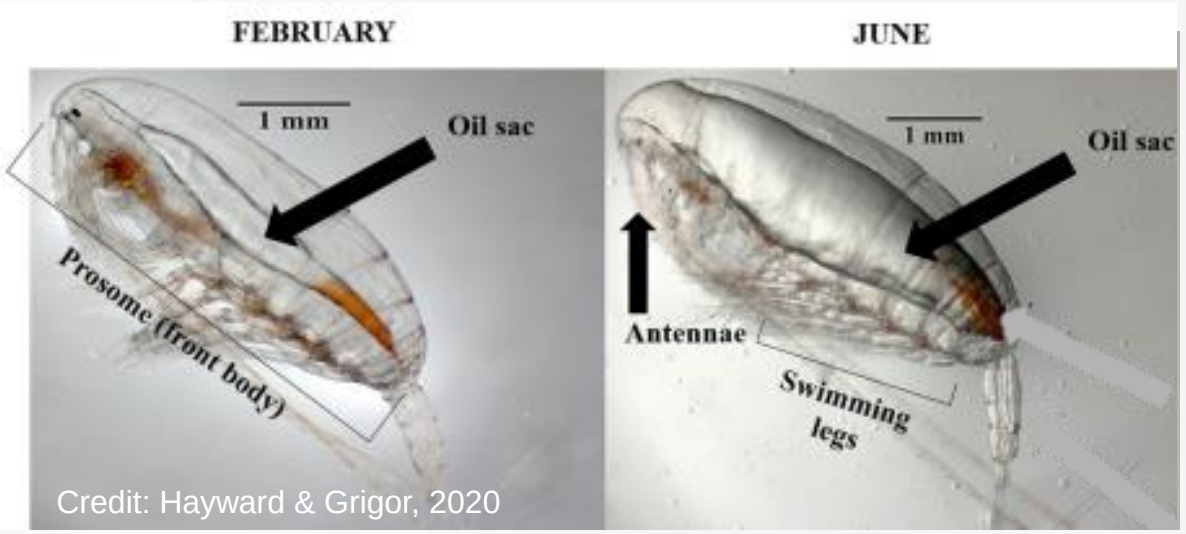




Coppock *et al.*, in prep

Implications for zooplankton

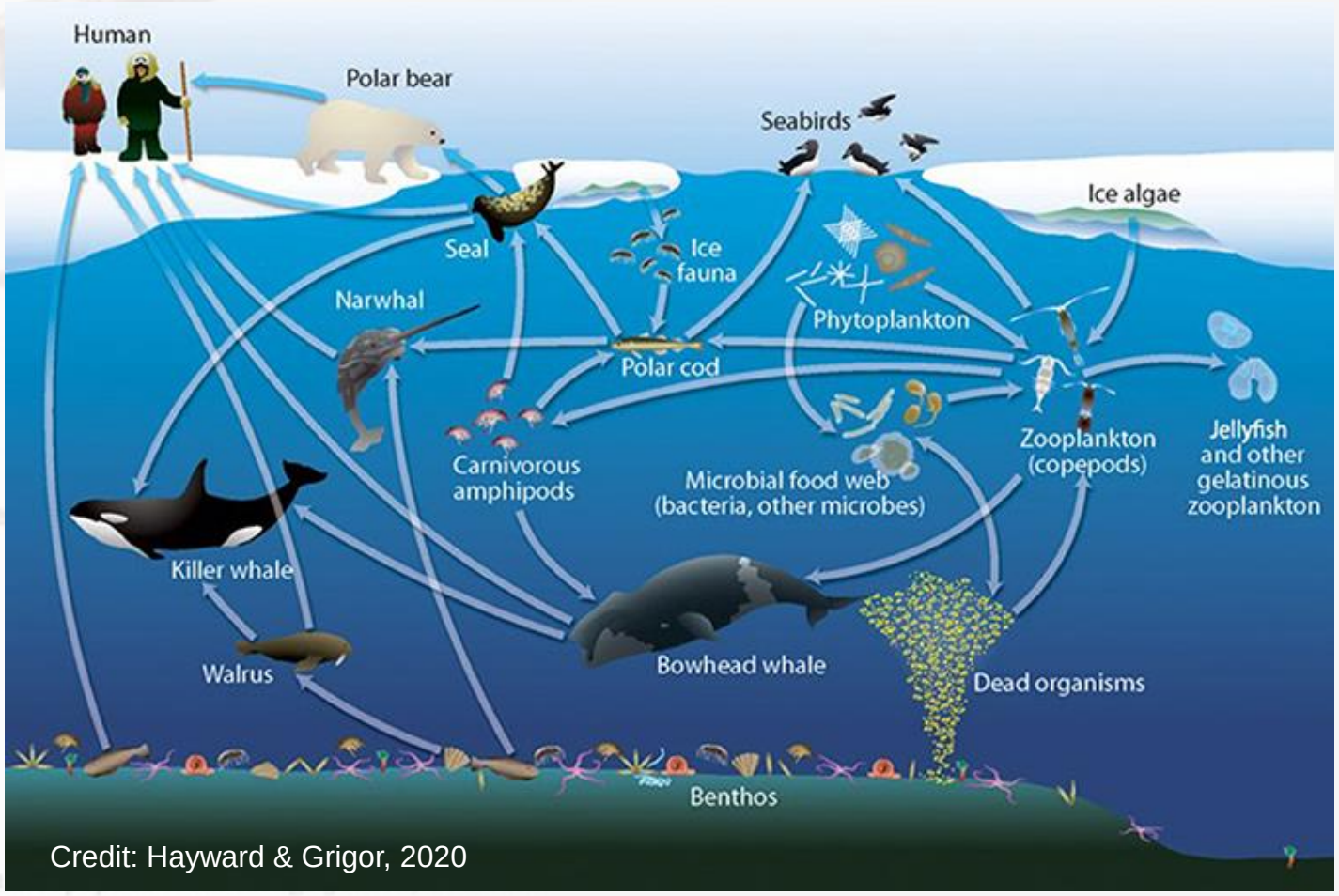
- Zooplankton are ingesting microplastics in the Arctic
- Microplastics pose a health risk to zooplankton populations
- Multi-stressor in addition to unprecedented climatic changes in the Arctic
- Mass release potential from melting ice, coinciding with phytoplankton bloom and vulnerable life stages
- Impacts to energy budgets could critically impair lipid storage



Credit: Hayward & Grigor, 2020

Implications for zooplankton….. and the entire Arctic food web

- Trophic transfer – abundant biomass of zooplankton key food source for megafauna
- Zooplankton underpin entire Arctic food web
- Potential impact to biological carbon pump
- Factors influencing MP bioavailability are complex – need lab **and** *in-situ* field assessments to tailor mitigation strategies



Credit: Hayward & Grigor, 2020

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Thank you

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