Water and sanitation – impacts on industrial production of foods in the Arctic

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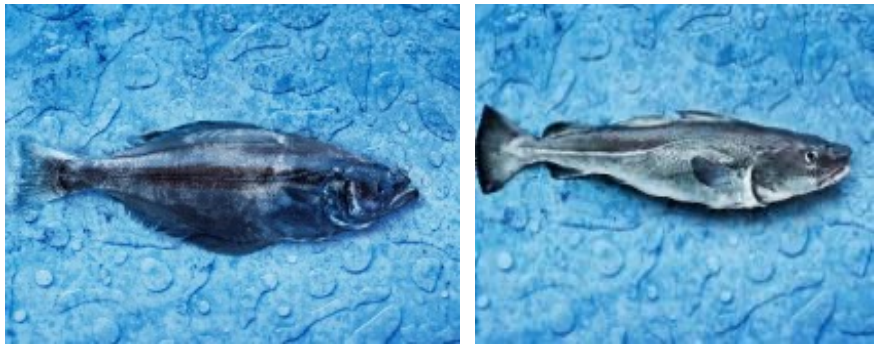
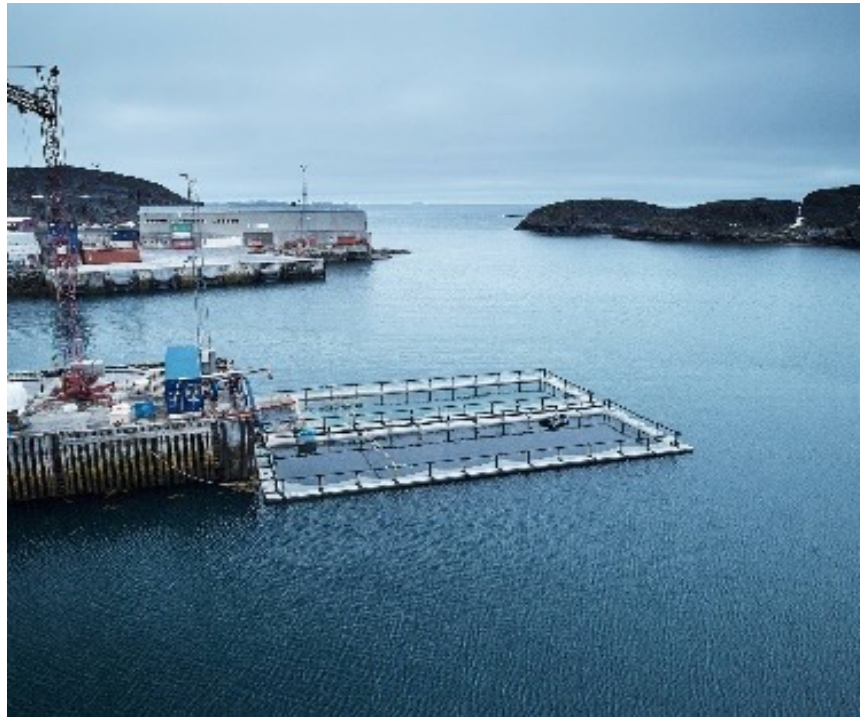
Opportunity

- **Greenland is surrounded by pristine water and has 44000 km of coastline**
- **Resources from the ocean that can be harvested**

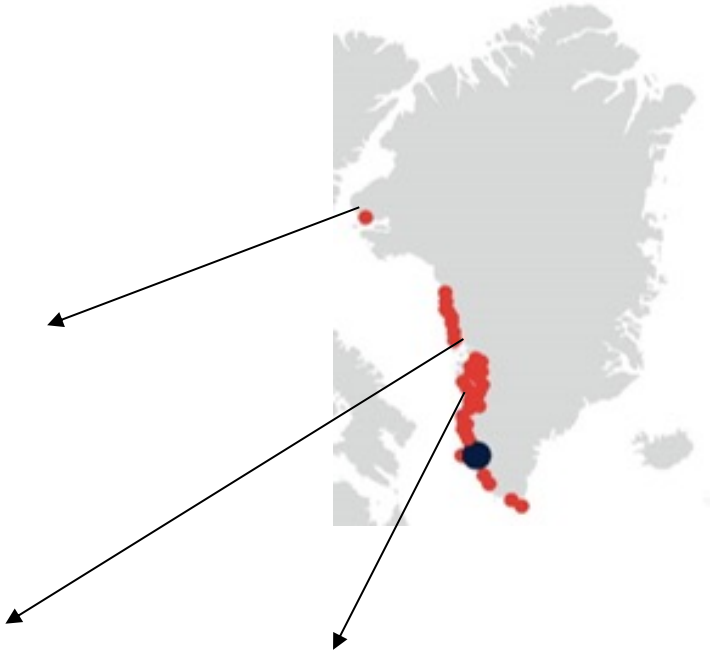




Problems

- **Drinking water supply**
  - Quantity
  - Supply
- **Wastewater**
  - Emission to the recipient
- **Waste**
  - Handling of solid waste

Qaanaq



Uummannaq

Sisimiut

Case 1: Quality and sufficiency of drinking water for processing

Drinking water and hygiene regulations - Greenland and EU (export)

- **Sisimiut:**
  - Ready-to-eat shrimp products
  - High risk since consumers eat as is
  - Water consumption – about 75% of ALL drinking water in Sisimiut
  - Quality in the spring (ice melt) – issues with microbiology
  - Rejection and products on hold!

Case 2: Quality and sufficiency of drinking water for processing

Drinking water and hygiene regulations - Greenland and the EU (for export)

- **Qaanaq:**
  - Halibut – frozen whole, gutted
  - Drinking water supplies limited (lack of source water)
  - Microbiology quality is rarely tested – difficult to get to an accredited lab within 24 h
  - Therefore, no processing – just freezing

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Water quality in rural Greenland - acceptability and safety

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Case 3: Processing wastewater in Sisimiut

Case 3: Solutions to process wastewater

Reduce the water consumption – less wastewater due to recycling of water, or processes with less water use

Separate waste –shrimp meal, extract valuables from shells, guts, etc., incineration for energy

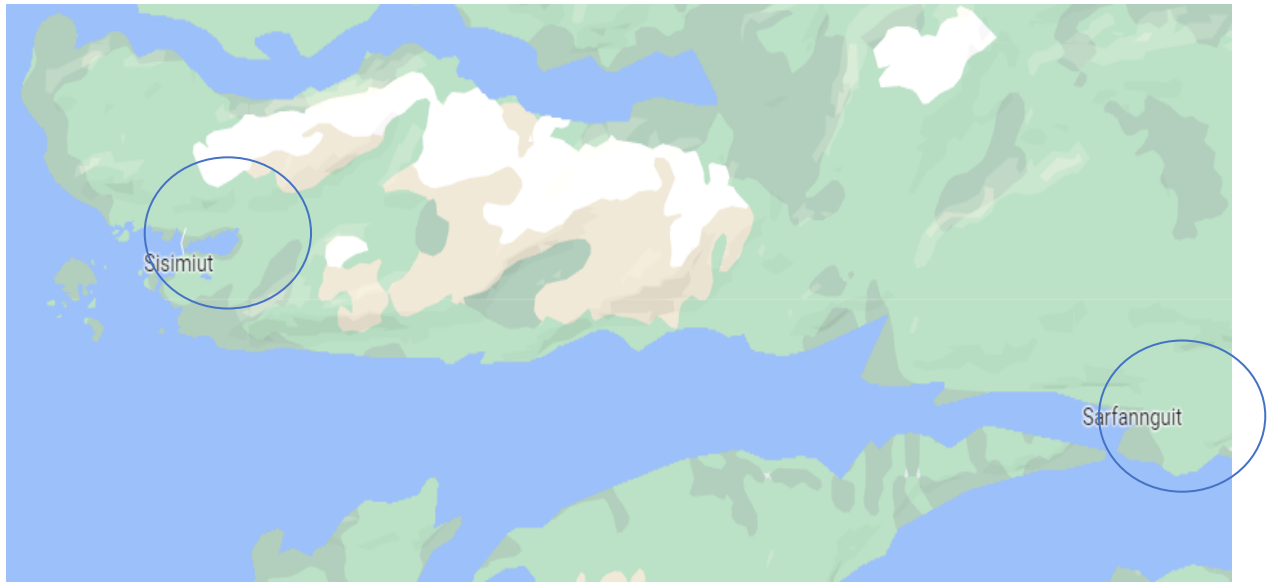
Treat wastewater before emission – filter screen, sedimentation

Case 4: Harvest of resources in places impacted by wastewater emissions

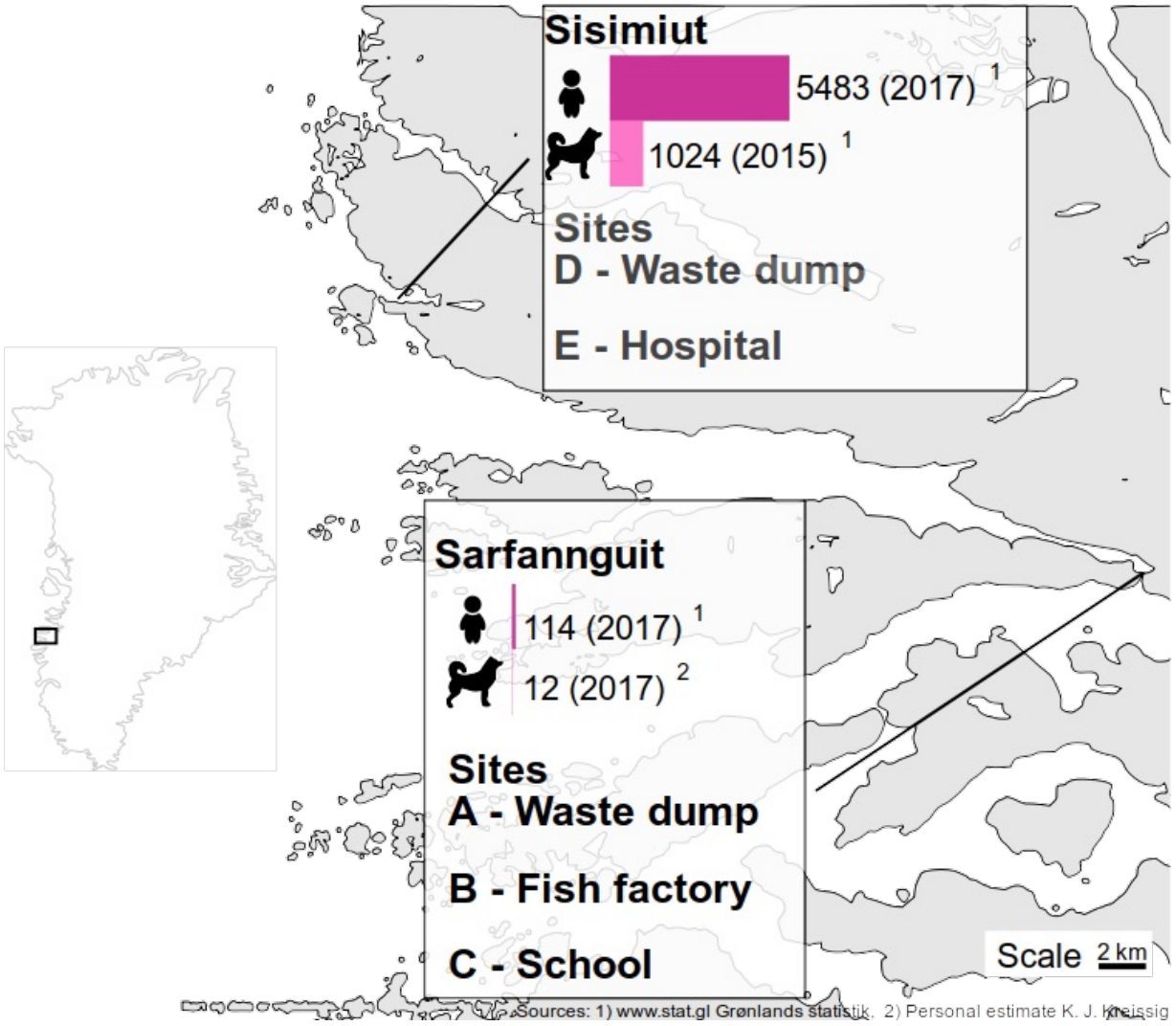
- **Objectives:**
  - To examine the effect of wastewater emission on the microbiology of wild bladderwrack (*Fucus* sp.) from the tidal zone
  - To create background knowledge that can be used to establish best practice for selection of sites for cultivation or harvest of seaweed

What did we do?

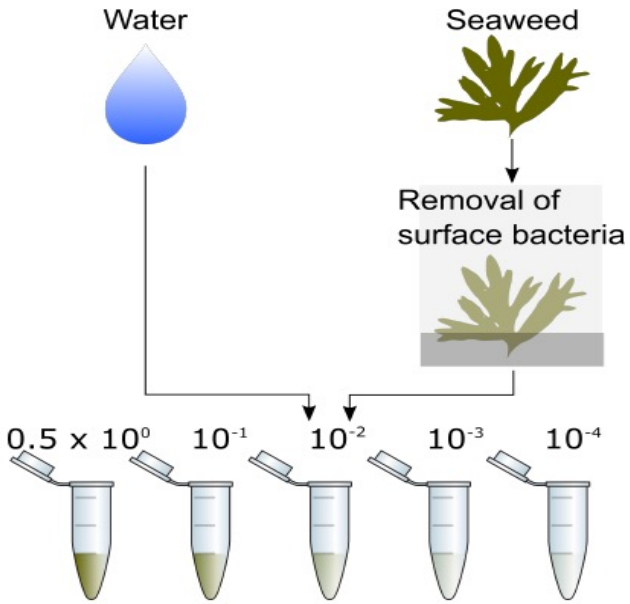
- **Sampes of seawater and *Fucus* sp.:**
  - Sarfannguit (SA), *ca*. 110 inhabitants
  - Sisimiut (SI), *ca*. 5500 inhabitants
- **Sampling in 2017 and 2018**
- **Samples from:**
  - Wastewater impacted sites (SA & SI)
  - No wastewater (SA, control site)



Sampling sites



Microbiological analysis



qPCR detection of human fecal bacteria HF183

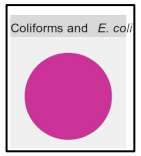
16S rRNA analysis of microbiota

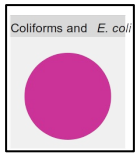
Incubation on petri films

Coliforme & *Escherichia coli*

Aerobic plate count
ID with Maldi-TOF

Fecal contamination of bladder wrack

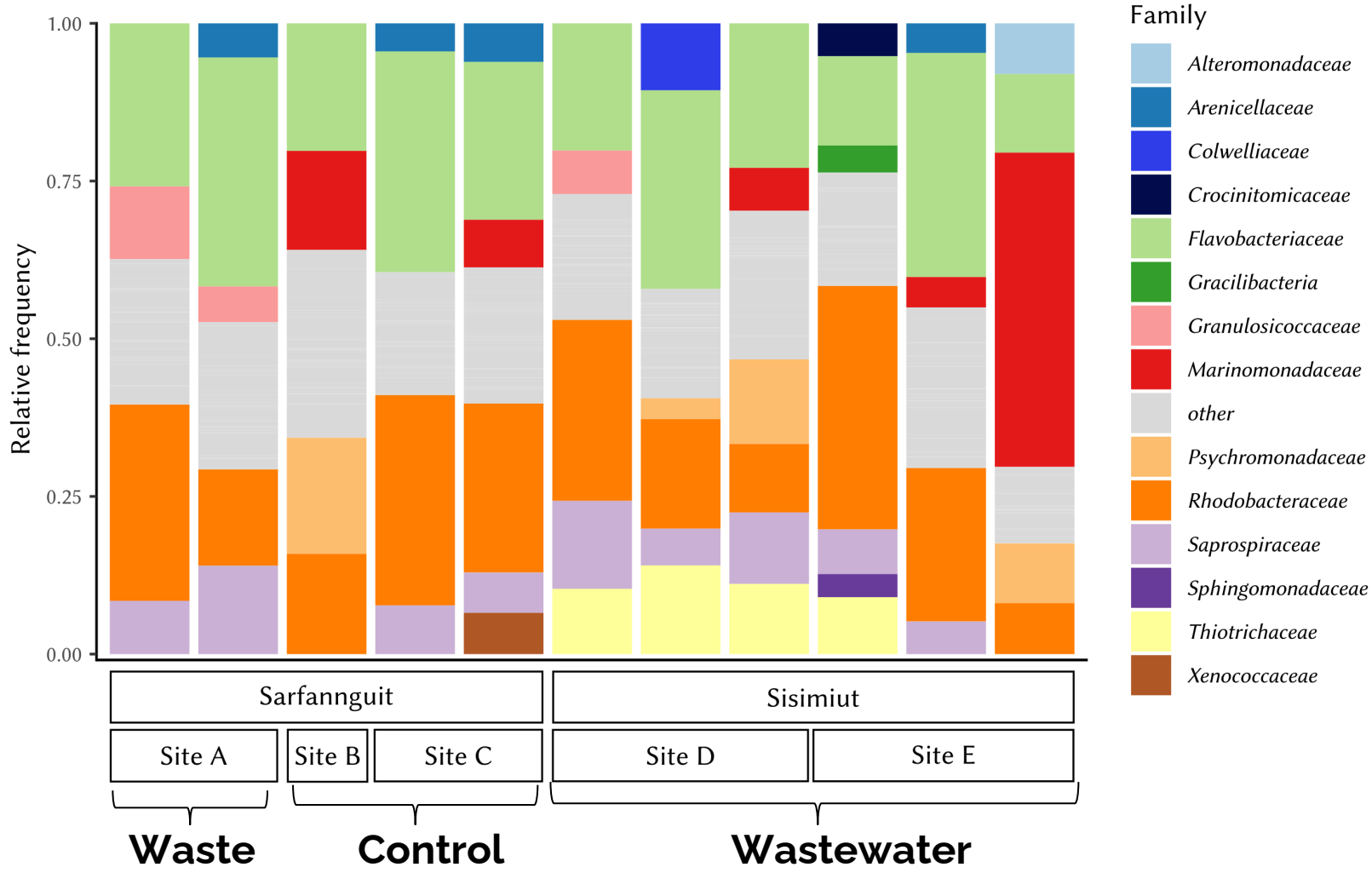




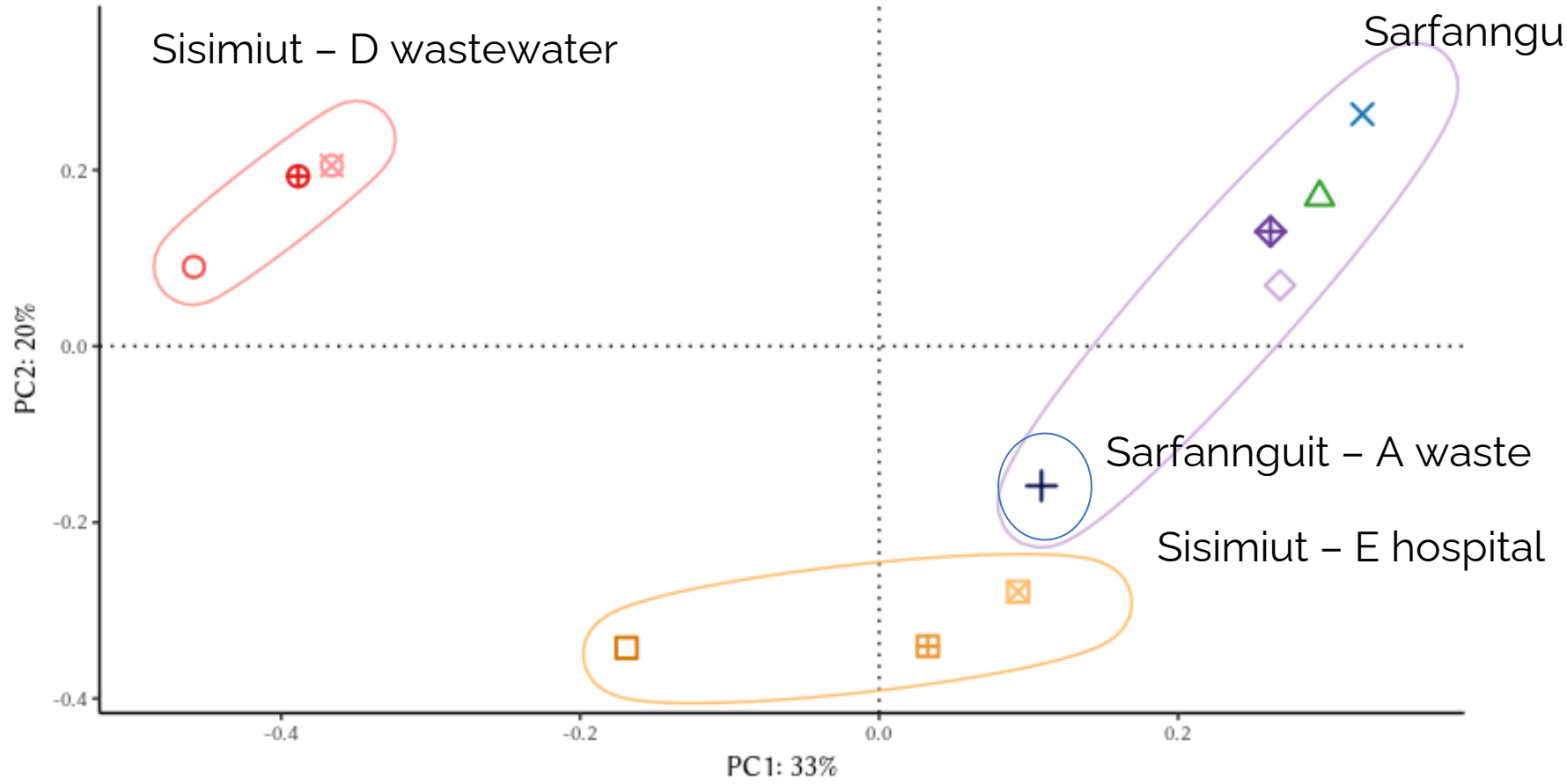
Sted		Coliforme (log CFU g^{-1} seaweed)	*E. coli* (log CFU g^{-1} seawater)	HF 183 (log gene copies g^{-1} seaweed)
Sarfannguit	A Waste	< LOD*	< LOD	< LOD
	B Fish plant	< LOD	< LOD	< LOD
	C Control	< LOD	< LOD	< LOD
Sisimiut	D Wastewater	7.7	5.3	3.5
	E Hospital	5.9	3.9	3.6

* LOD = Under detection limit

Sequencing results - microbiota on wrack – alpha-diversity



Sequencing results for *Fucus* sp. – differences among sites (beta-diversity)



Identification of bacteria cultured from the seaweed

- Human pathogens on exposed sites
- No human pathogens on non-exposed sites
- Tidal seaweed to monitor water quality?

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Bacterial communities on *Fucus* sp. harvested in tidal zones with or without exposure to human sewage in Greenland

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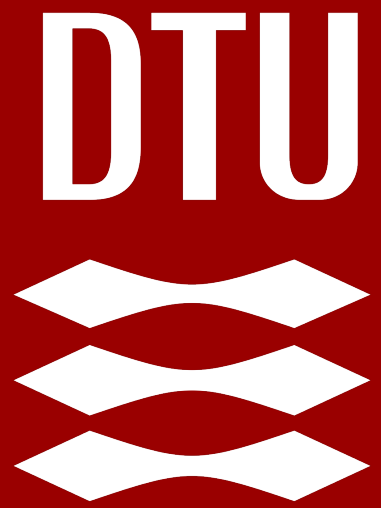
Conclusions

- **Drinking water availability and quality impacts the development of the seafood industry**
- **Export approvals rely on microbially safe drinking water – closest accredited laboratories in Nuuk (Iceland for the East!)**
- **Motivation to treat process wastewater – reduce drinking water consumption, extract valuables but impact the recipient?**
- **Wracks (*Fucus* sp.) from impacted tidal zones contain fecal indicator bacteria and pathogens**
- **Permissions to harvest/fish or cultivate should consider distance to wastewater sources and the number of inhabitants**

Thank you!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