

Epifaunal habitat associations on mixed and hard bottom substrates in coastal waters of northern Norway.

Kathrine Dunlop (IMR), Astrid Harendza (APN) , Liv Plassen (NGU), Nigel Keeley (IMR)



Work Package 1

Broad scale surveys and environmental mapping of salmon farms in Northern Norway

WP leader: Astrid Harendza (APN)

Objective

- Increase knowledge on the structure of hard and mixed bottom habitats and diversity of associated epibenthic assemblages in Northern Norway



Study area



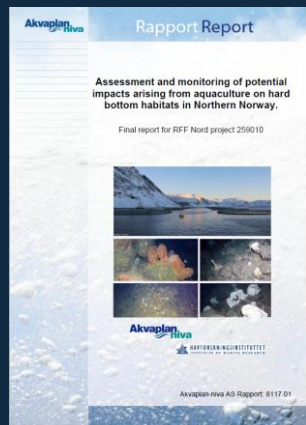
Study area



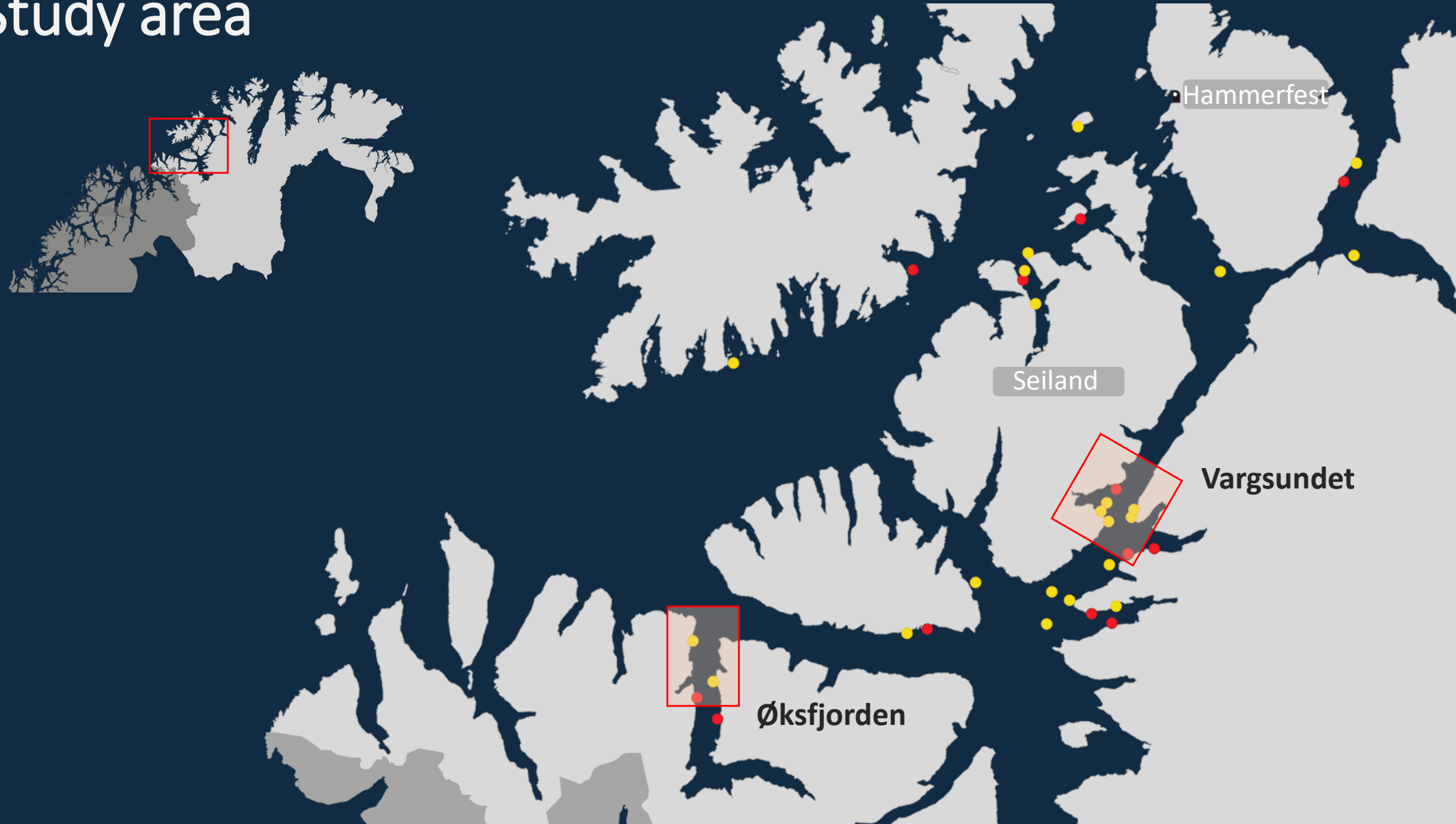
Study area



- Farm locations (12)
- Reference sites (22)



Study area



Study sites

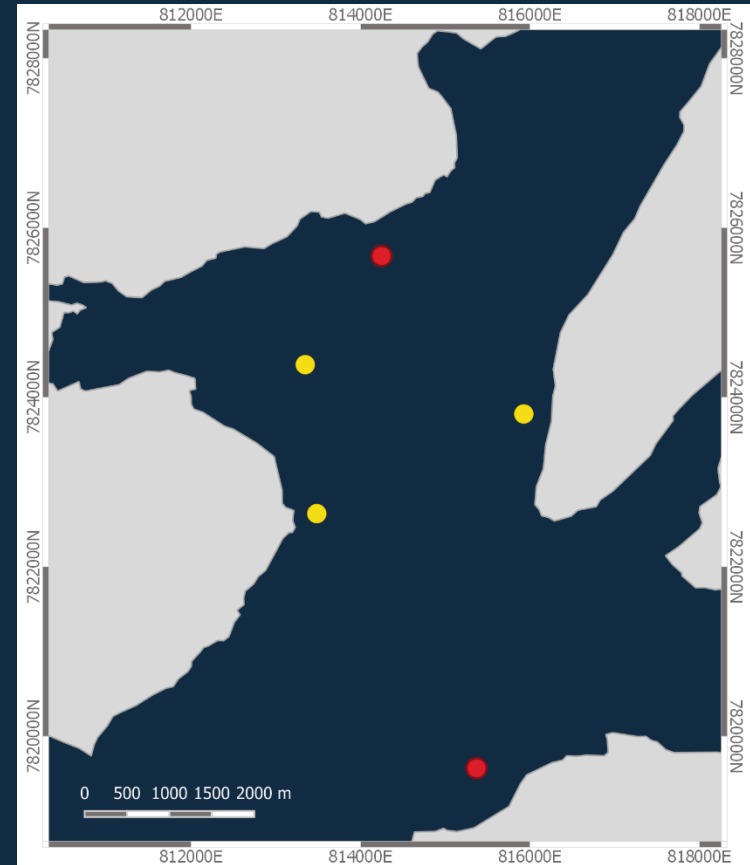


- Farm locations (3)
- Reference sites (5)

Oksfjorden



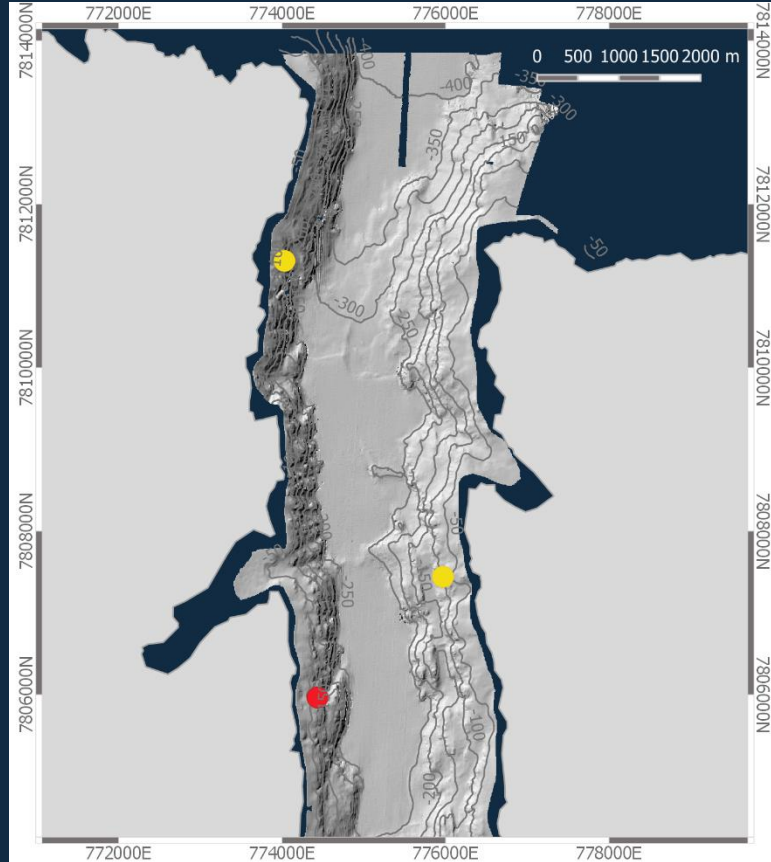
Vargsundet



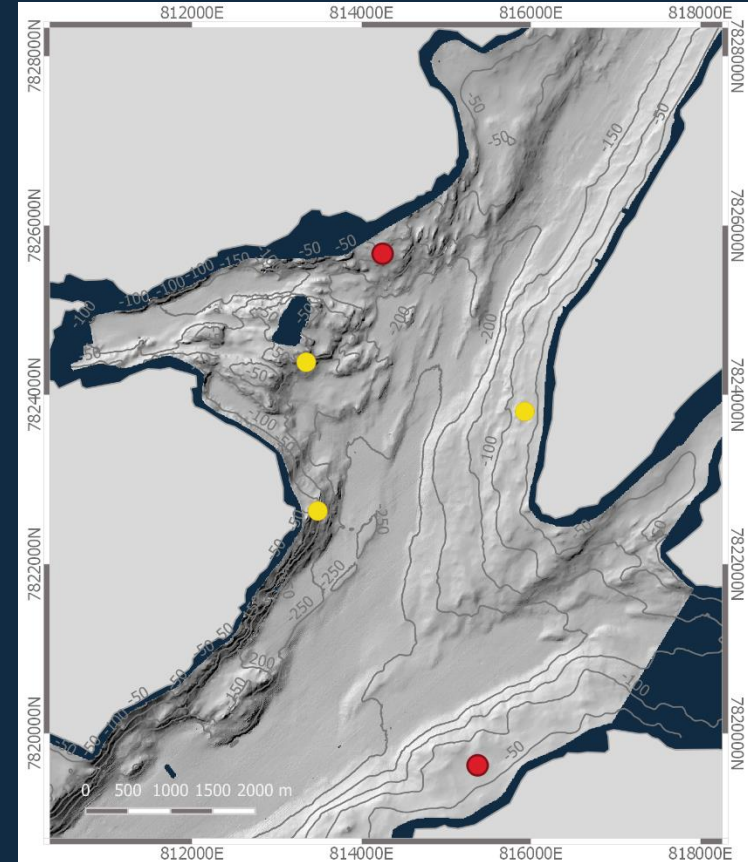
Study sites – bathymetry and substrate mapping



Oksfjorden



Vargsundet

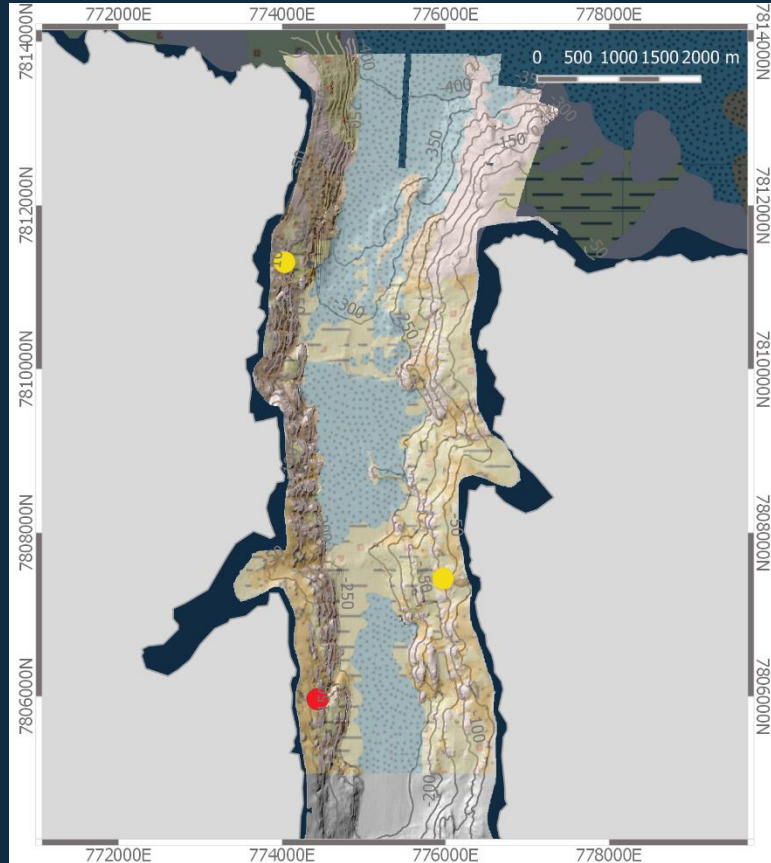


- Farm locations (3)
- Reference sites (5)

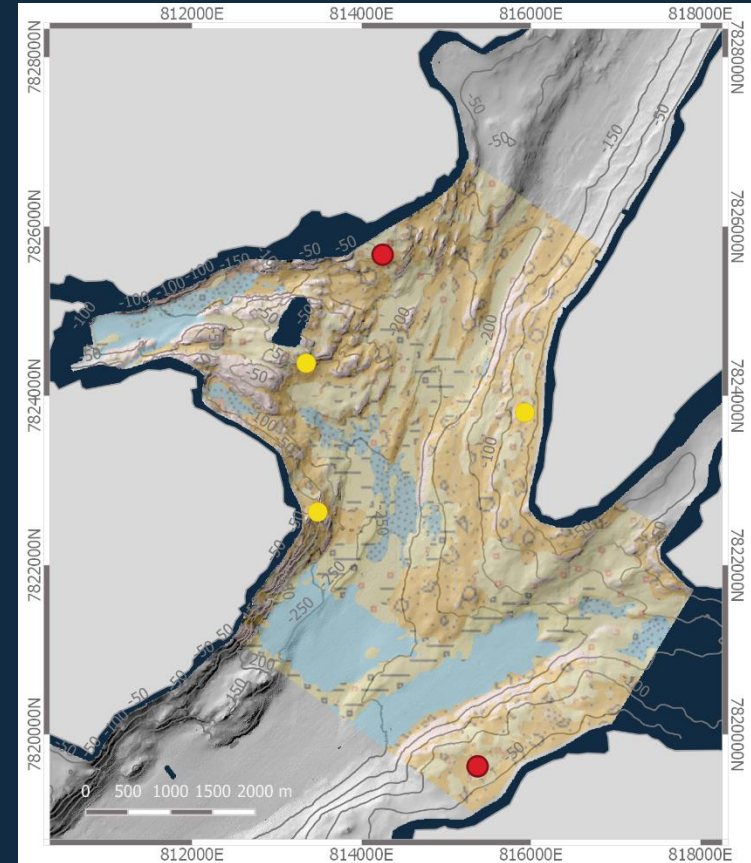
Study sites – bathymetry and substrate mapping



Oksfjorden



Vargsundet



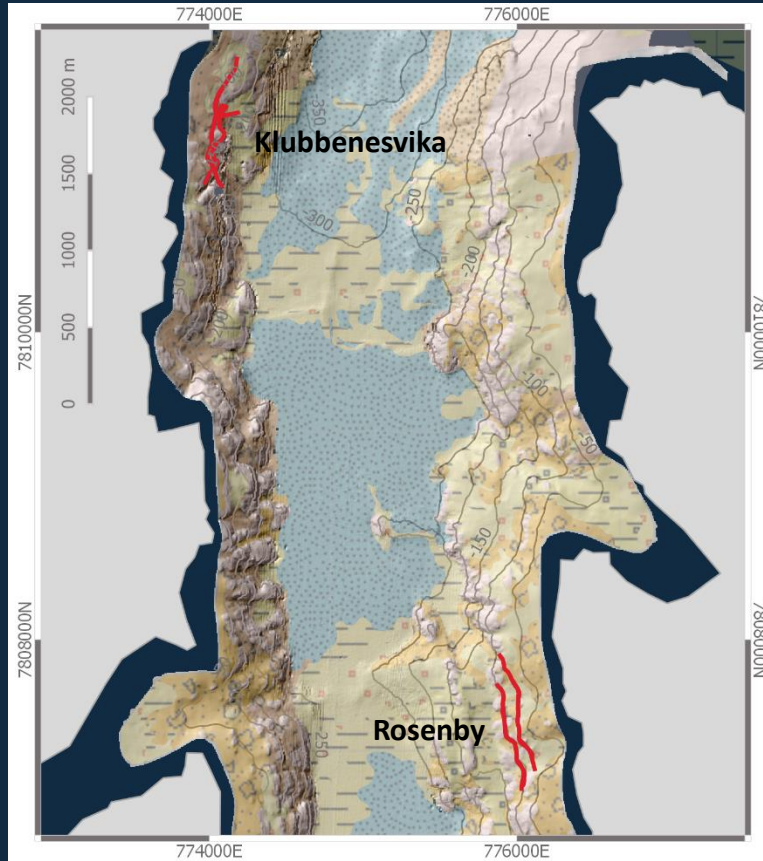
- Mud
- Sandy mud
- Muddy sand
- Gravelly sandy mud
- Gravelly muddy sand
- Gravelly sand
- Sandy gravel
- Gravel
- Sand, gravel, and cobbles
- Sand, gravel, cobbles and boulders
- Gravel, cobbles and boulders
- Thin or discontinuous sediment cover on bedrock

- Farm locations (3)
- Reference sites (5)

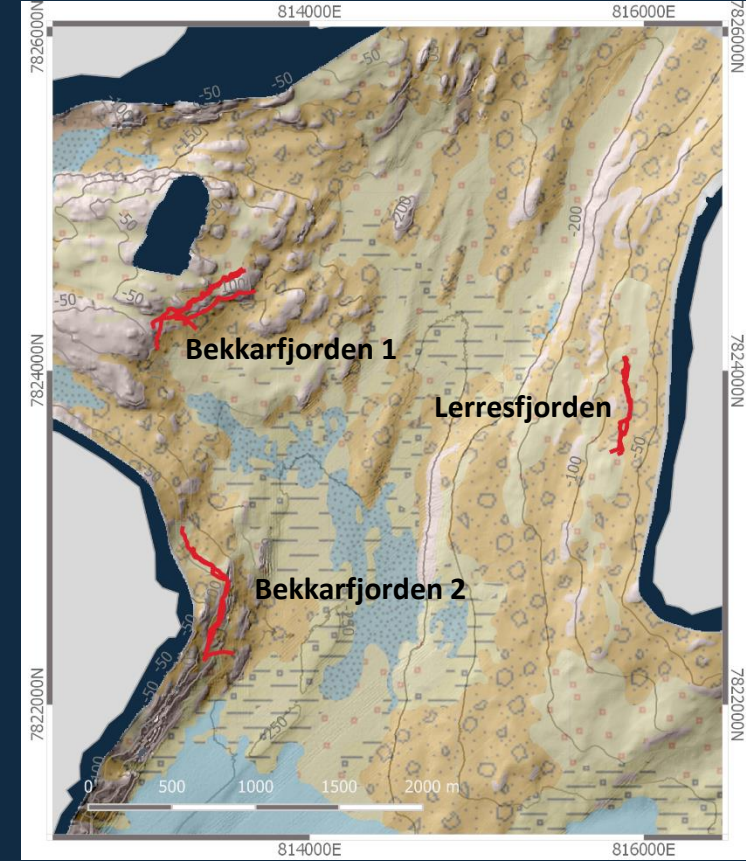
Study sites – reference sites



Oksfjorden

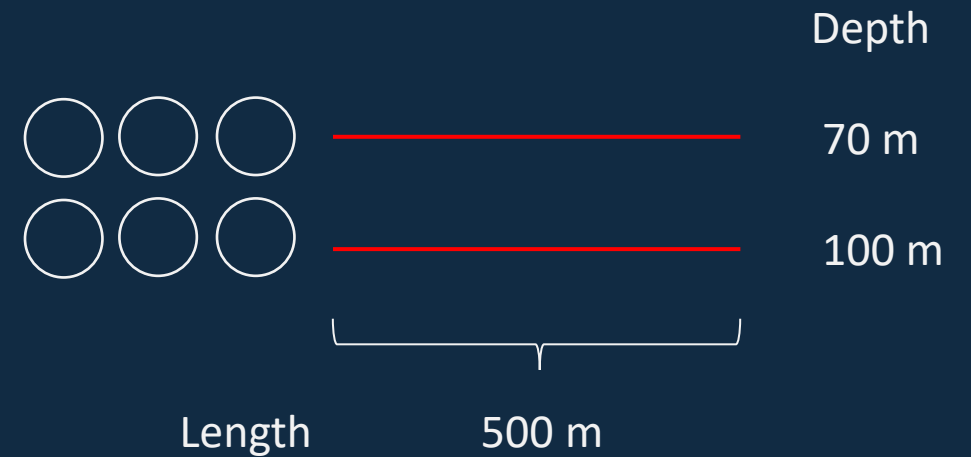
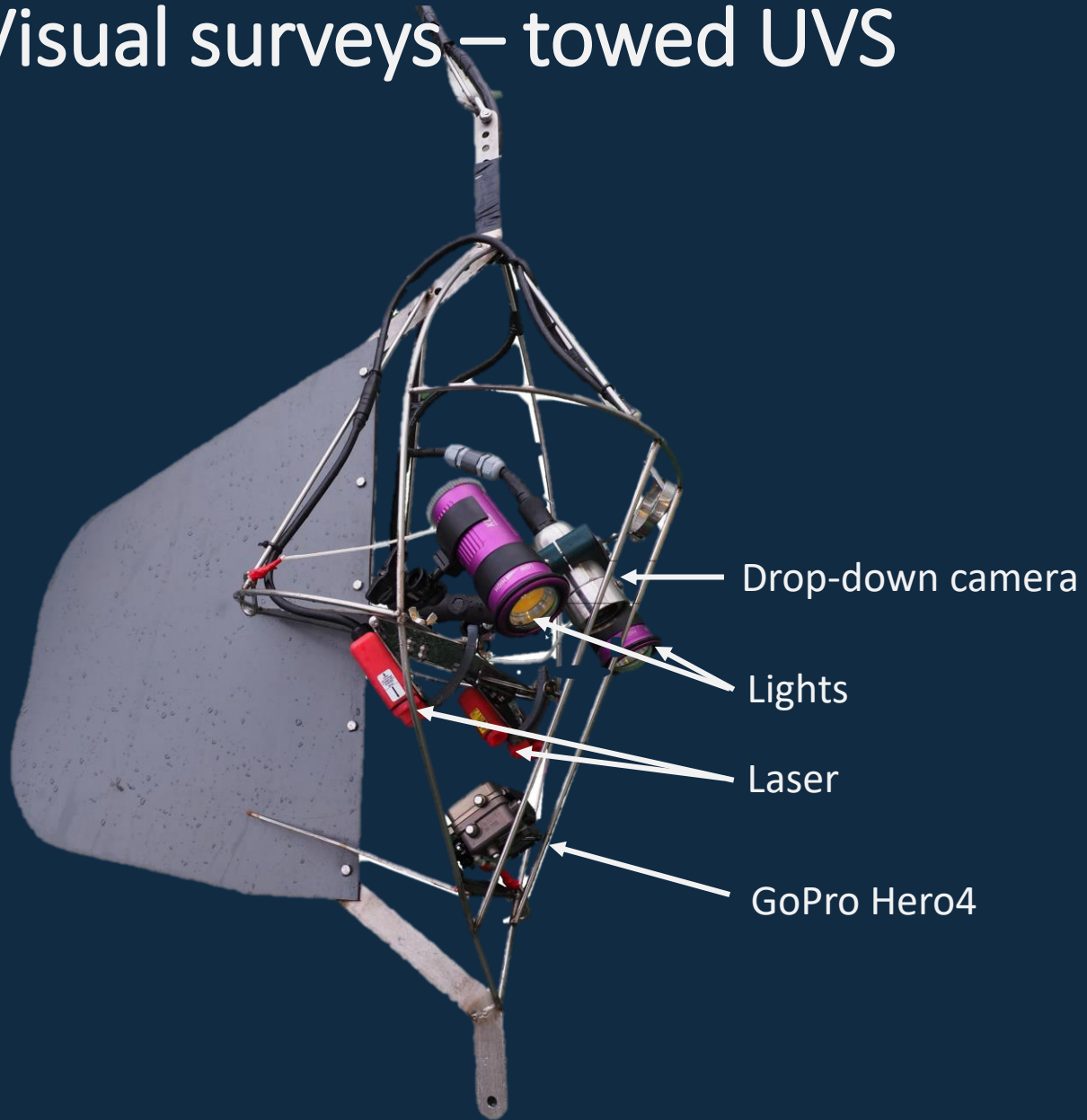


Vargsundet

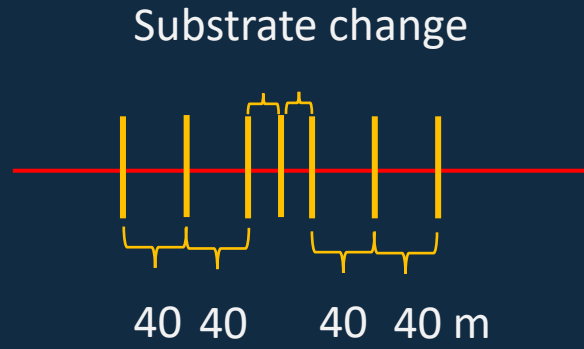


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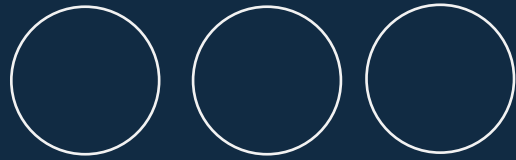
Visual surveys – towed UVS



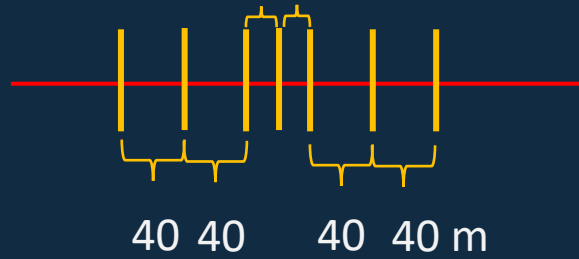
Video annotation



Video annotation



Substrate change



1. Substrate type

1. Bedrock



2. Patchy bedrock / broken reef



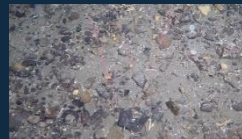
3. Boulders



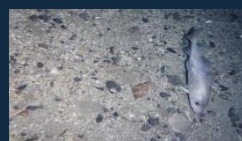
4. Broken rocks



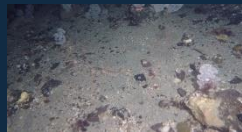
5. Gravel & cobbles



5. Shellsand



7. Sand



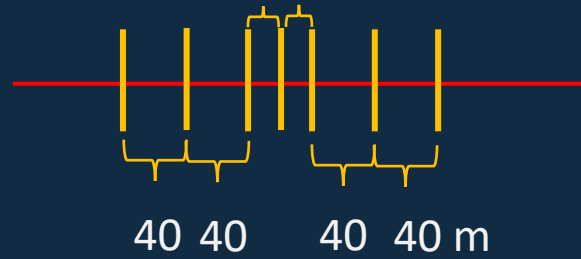
8. Gravelly sand



Video annotation



Substrate change

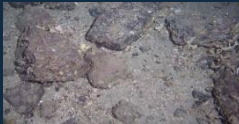


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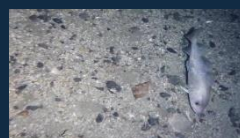
4. Broken rocks



5. Gravel & cobbles



5. Shellsand



7. Sand



8. Gravelly sand



2. Slope

flat



moderate



steep



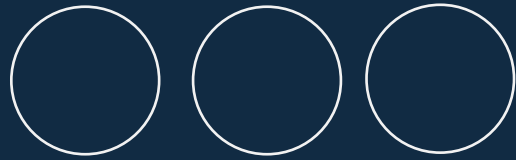
near-vertical



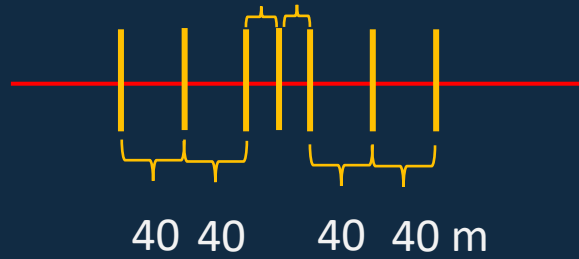
overhang



Video annotation



Substrate change



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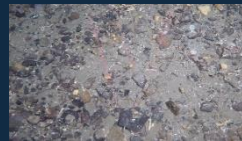
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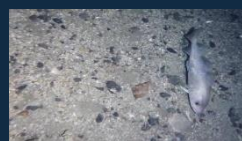
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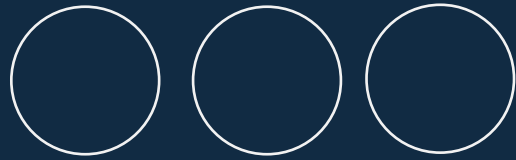
overhang



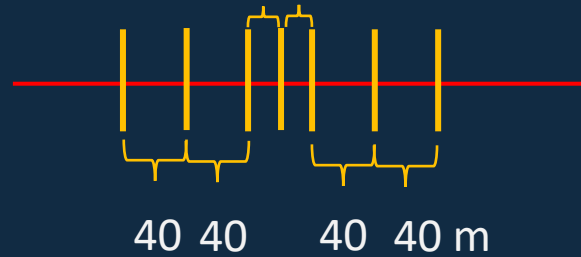
3. Epifaunal species

- Enumerated (within frame & distinguishable)
- Identified to highest possible taxonomic level
- Densities (individuals m²)

Video annotation



Substrate change

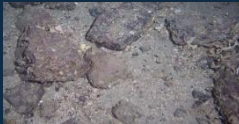


1. Substrate type

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2. Patchy bedrock / broken reef



3. Boulders



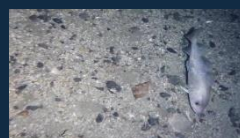
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2. Slope

flat



moderate



steep



near-vertical



overhang



3. Epifaunal species

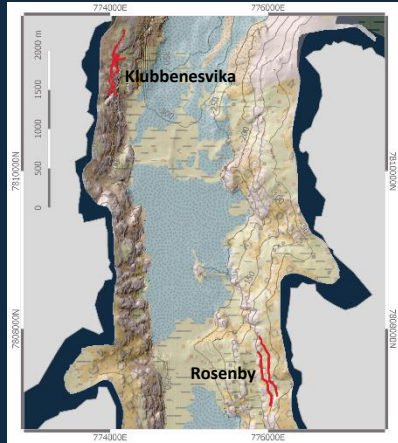
- Enumerated (within frame & distinguishable)
- Identified to highest possible taxonomic level
- Densities (individual m²)

4. Hydrodynamics - ROMS

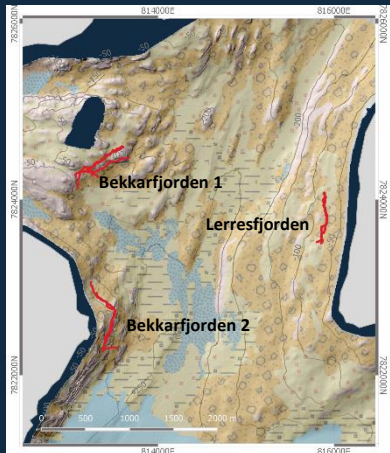
- Bottom current velocity (ms⁻¹)

Environmental characteristics

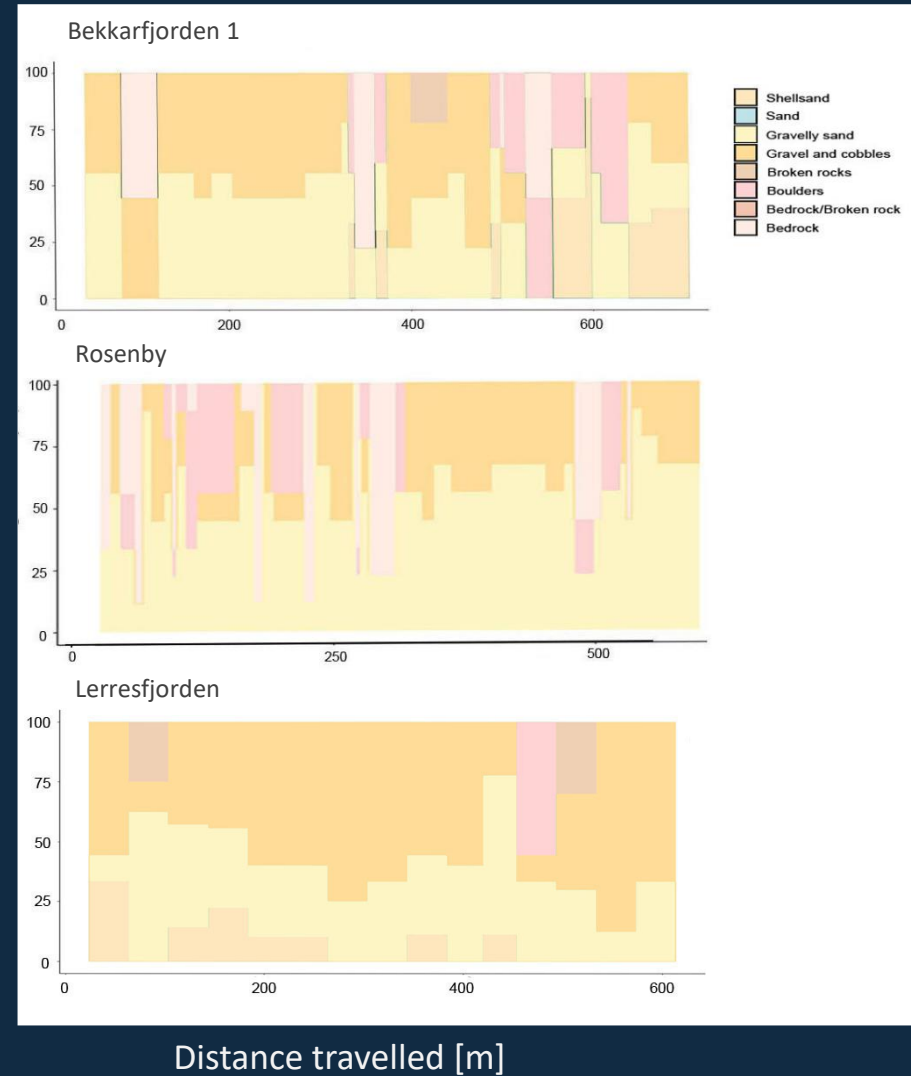
Oksfjorden



Vargsundet

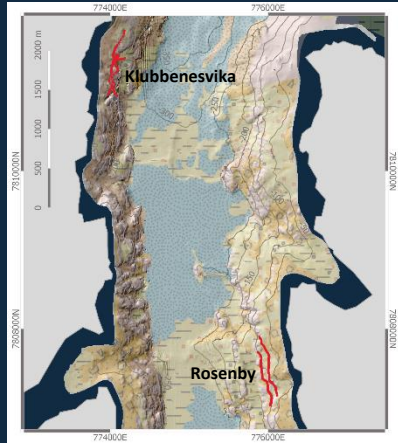


Substrate percentage cover [%]

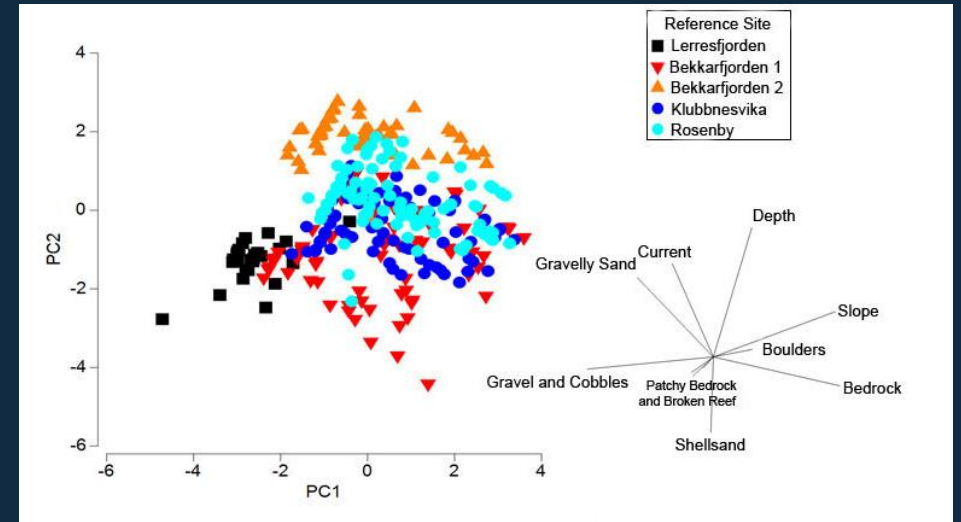
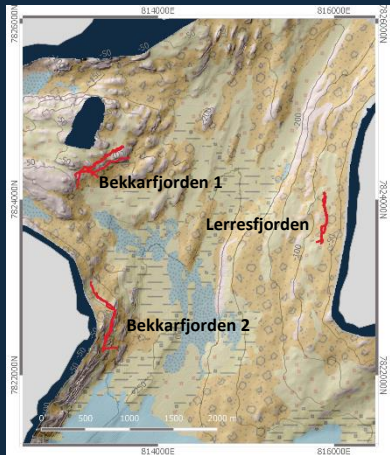


Environmental characteristics

Oksfjorden

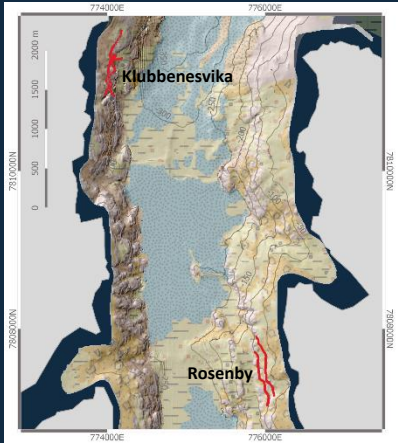


Vargsundet



Environmental characteristics

Oksfjorden



Bedrock



Boulders



Gravel & cobbles



Gravelly sand



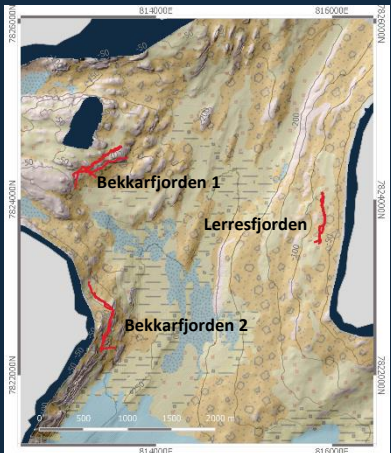
steep

flat

near-vertical

Current flow:
0.03 m/s

Vargsundet



Bekkarfjorden

Gravel & cobbles



Gravelly sand



Bedrock



Boulders

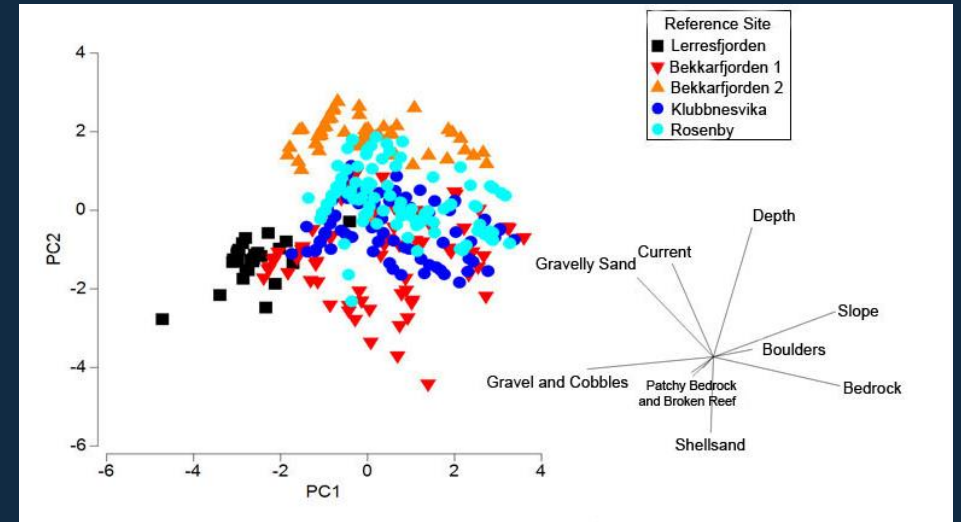


steep

flat

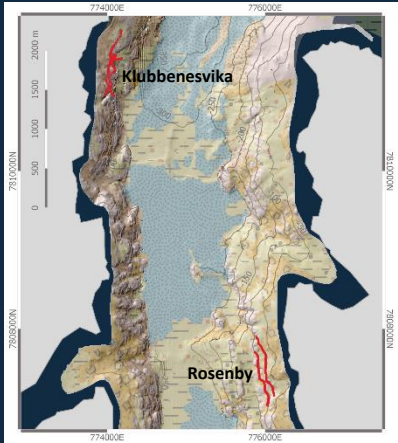
near-vertical

Current flow:
0.03 – 0.05 m/s



Environmental characteristics

Oksfjorden



Bedrock



steep



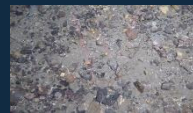
Boulders



flat



Gravel & cobbles



near-vertical



Gravelly sand



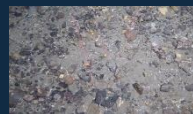
Current flow:
0.03 m/s

Vargsundet



Bekkarfjorden

Gravel & cobbles



steep



Gravelly sand



flat



Bedrock



near-vertical



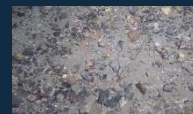
Boulders



Current flow:
0.03 – 0.05 m/s

Lerresfjorden

Gravel & cobbles



flat



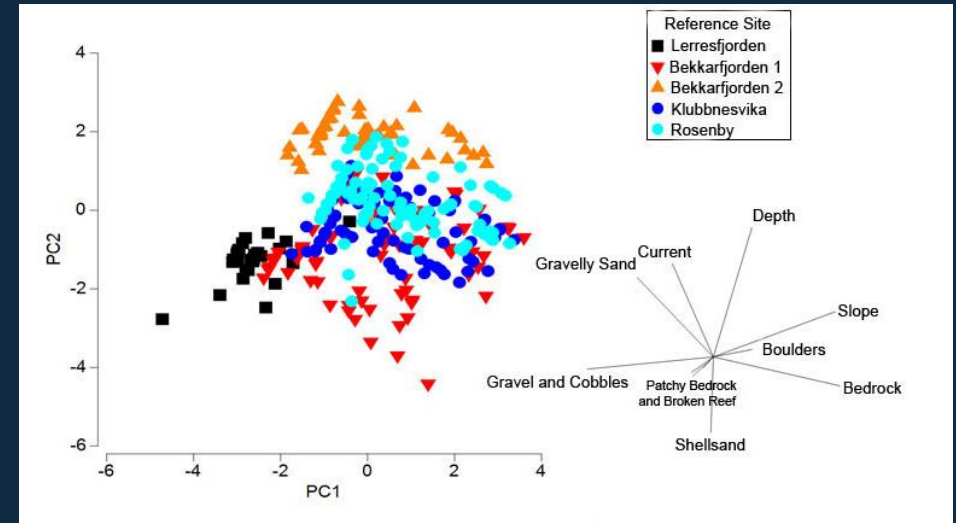
Gravelly sand



moderate



Current flow:
0.04 m/s



Epifaunal assemblage composition

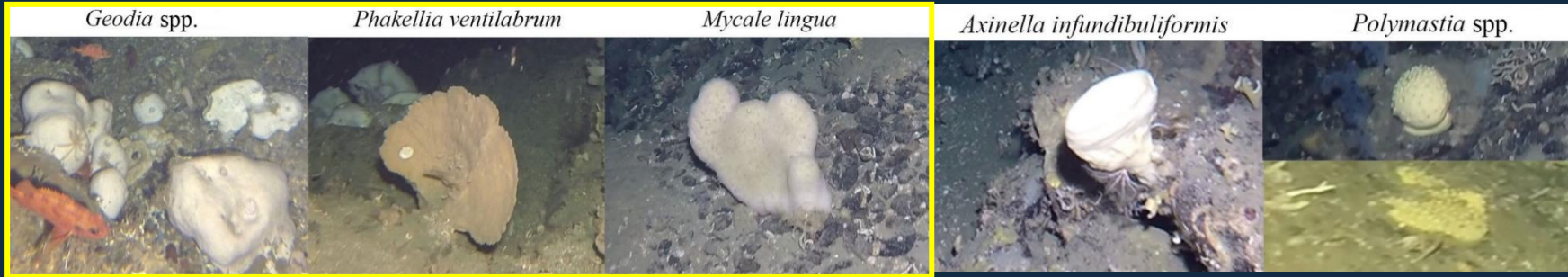
Dominating taxa



- 5 sponge taxa dominate epifaunal assemblages

Epifaunal assemblage composition

Dominating taxa



- 5 sponge taxa dominate epifaunal assemblages
- Densities comparable to extensive sponge grounds - "ostur" sponge habitats
 - hotspots for marine biodiversity
 - High filtering capacity = significant role in carbon processing, vulnerable

Epifaunal assemblage composition

Dominating taxa

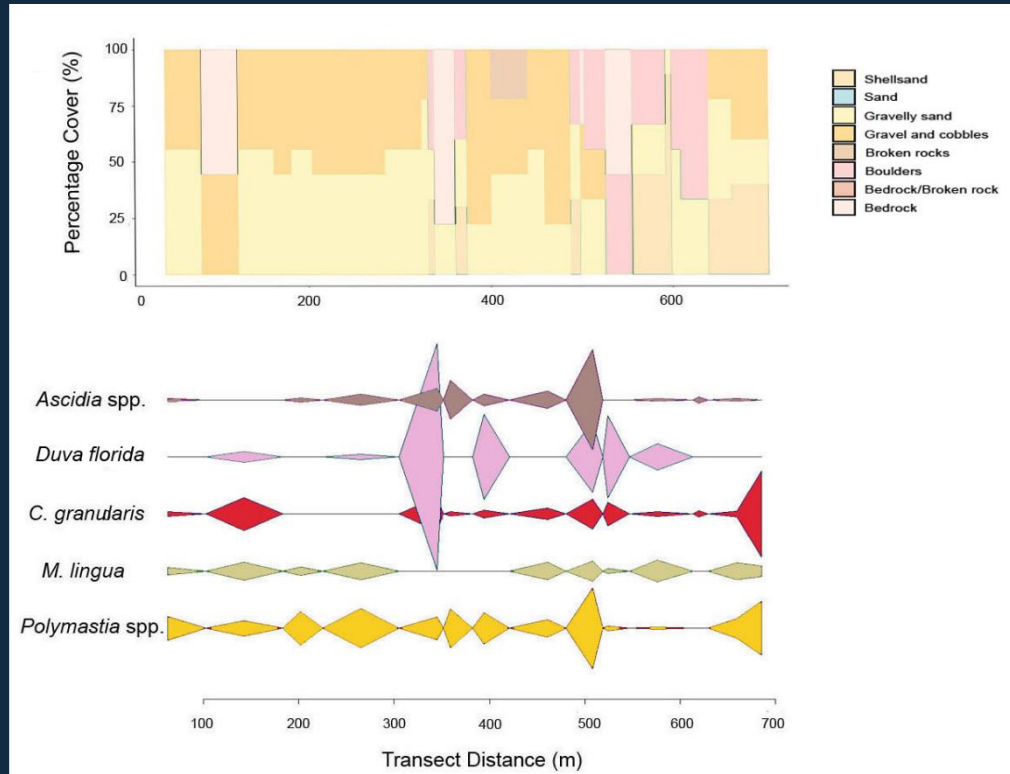


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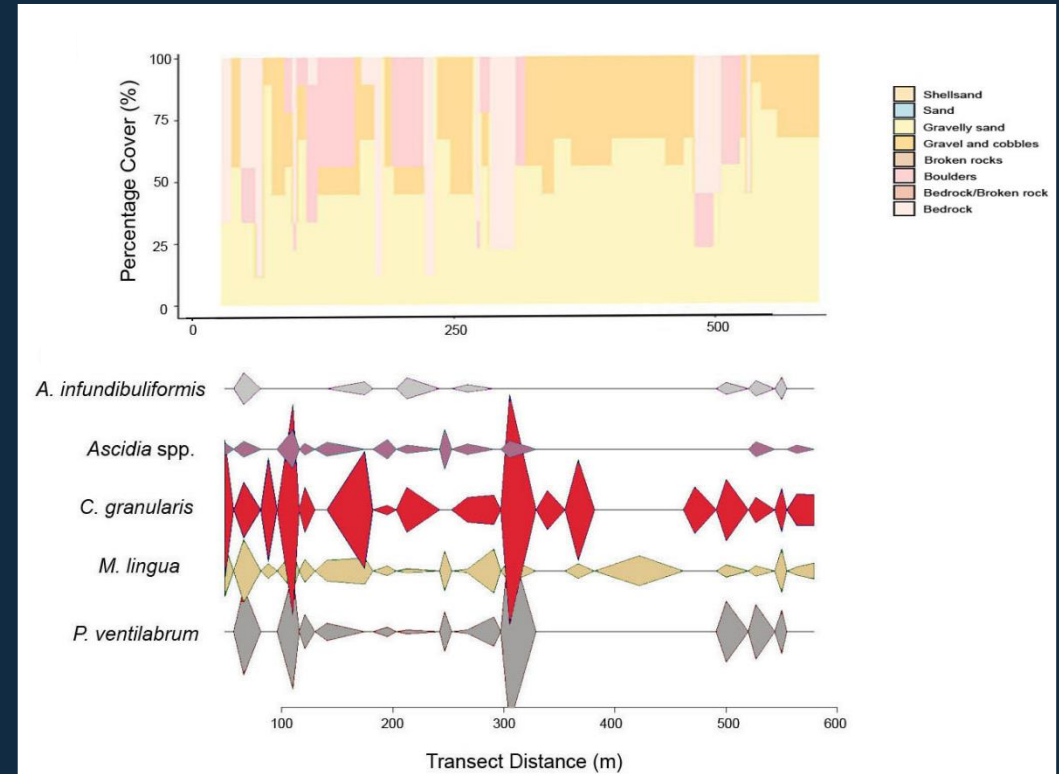


Epifaunal assemblages & environmental drivers

Bekkarfjorden 1

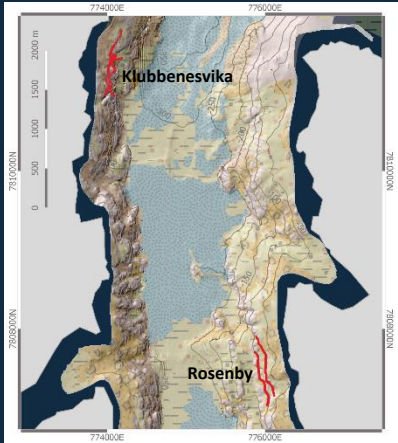


Rosenby

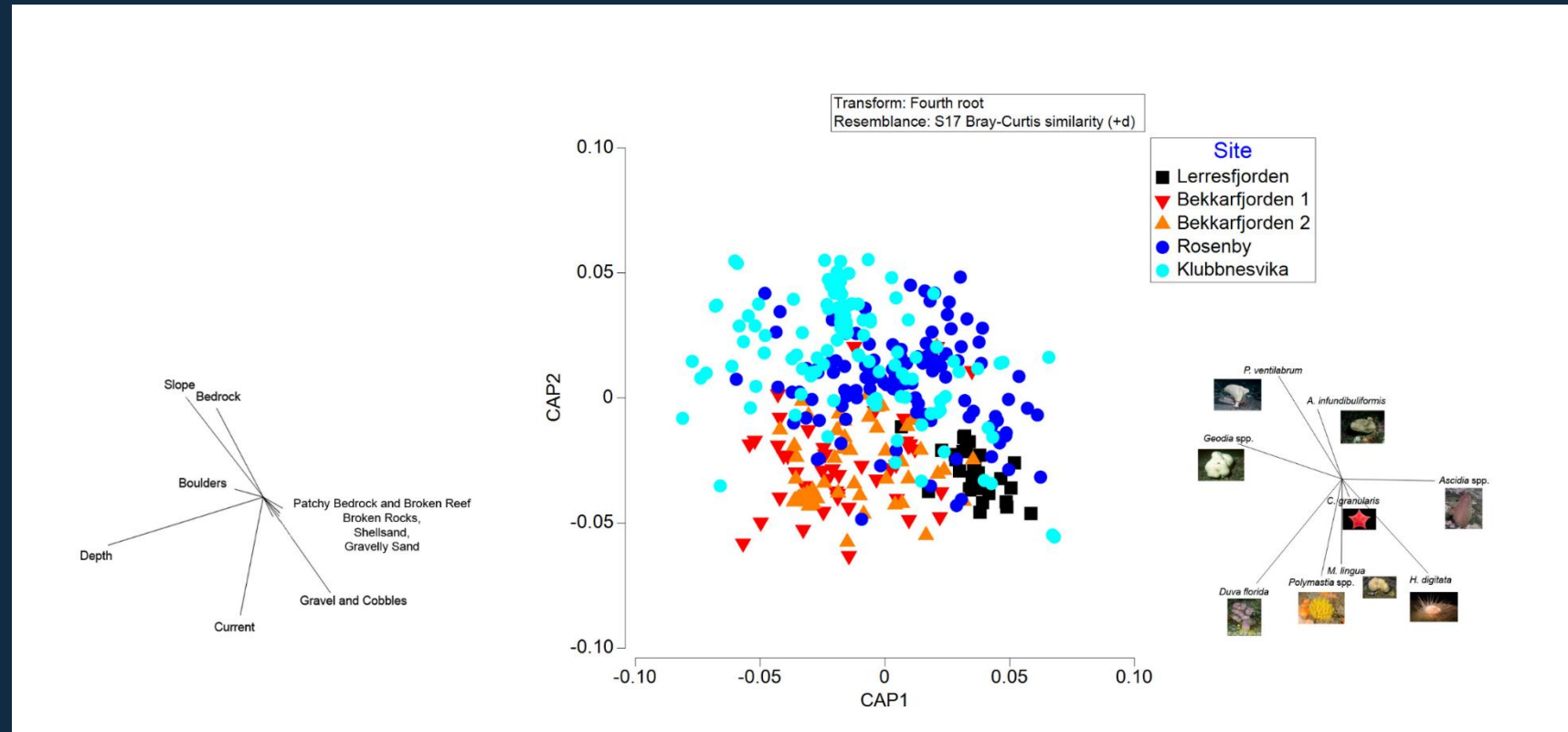


Epifaunal assemblages & environmental drivers

Oksfjorden



Vargsundet



Marginal tests	Variable	SS (trace)	Pseudo-F	P	Proportion
DISTLIM	Depth	60436	19.23	0.001	0.041
	Current	58228	18.50	0.001	0.039
	Slope	38521	12.07	0.001	0.026
	Bedrock	33622	10.50	0.001	0.023
	Gravel and Cobbles	33153	10.35	0.001	0.023

Dominant taxa & habitat association

Taxa

Substrate

Current flow

Depth

Slope



Bedrock



Boulders





0.02 - 0.03 m/s

Dominant taxa & habitat association

Taxa	Substrate	Current flow	Depth	Slope
 <i>Geodia</i> spp. <i>Phakellia ventilabrum</i> <i>Axinella infundibuliformis</i>	Bedrock Boulders	0.02 - 0.03 m/s	G/P: 70 & 100 m	

Dominant taxa & habitat association

Taxa	Substrate	Current flow	Depth	Slope
 <p><i>Geodia</i> spp. <i>Phakellia ventilabrum</i> <i>Axinella infundibuliformis</i></p>	<p>Bedrock</p> <p>Boulders</p> 	0.02 - 0.03 m/s	G/P: 70 & 100 m A: 70 m	






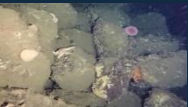










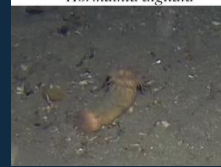



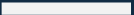
Dominant taxa & habitat association

Taxa	Substrate	Current flow	Depth	Slope
<p><i>Geodia</i> spp. <i>Phakellia ventilabrum</i> <i>Axinella infundibuliformis</i></p> 	<p>→</p> <p>Bedrock</p> <p>Boulders</p> 	0.02 - 0.03 m/s	G/P: 70 & 100 m A: 70 m	
<p><i>Mycale lingua</i></p> 	<p>→</p> <p>Gravel & cobbles</p> <p>Gravelly sand</p> 	0.04 - 0.05 m/s	70 & 100 m	






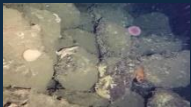



















Dominant taxa & habitat association

Taxa	Substrate	Current flow	Depth	Slope
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<p><i>Duva florida</i></p> 	<p>→</p> <p>Bedrock</p> <p>Boulders</p> <p>Gravel & cobbles</p> <p>Gravelly sand</p> 	0.05 m/s	100 m	





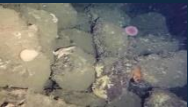



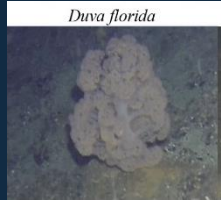











Dominant taxa & habitat association

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<i>Mycale lingua</i> 	 Gravel & cobbles  Gravelly sand 	0.04 - 0.05 m/s	70 & 100 m		
<i>Duva florida</i> 	 Bedrock  Boulders 	Gravel & cobbles  Gravelly sand 	0.05 m/s	100 m	
<i>Hormathia digitata</i> 	 Gravel & cobbles  Gravelly sand 	0.05 m/s	70 m		








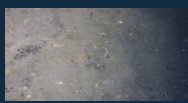











Dominant taxa & habitat association

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<i>Duva florida</i> 	 Bedrock  Boulders 	Gravel & cobbles  Gravelly sand 	0.05 m/s	100 m	
<i>Hormathia digitata</i> 	 Gravel & cobbles  Gravelly sand 	0.05 m/s	70 m		
<i>Ceramaster granularis</i>  <i>Ascidia</i> spp.  <i>Polymastia</i> spp. 	 All sites				

Dominant taxa & habitat association

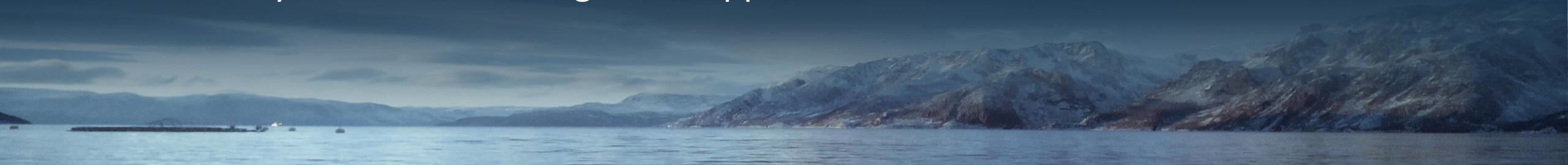
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Dominant taxa & habitat association

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<i>Duva florida</i> 	→ Bedrock  Boulders 	Gravel & cobbles  Gravelly sand 	0.05 m/s	100 m	
<i>Hormathia digitata</i> 	→ Gravel & cobbles  Gravelly sand 	0.05 m/s	70 m	—	
<i>Ceramaster granularis</i>  <i>Ascidia</i> spp.  <i>Polymastia</i> spp. 	→ All sites	Pol: 0.05 m/s	Asc: 70 m		

Summary

- Mixed & hardbottom habitats and their associated epifaunal assemblages are characterised by a patchy distribution
- Main environmental drivers for epifaunal assemblage composition: Depth, current, slope, bedrock, gravel & cobbles
- Epifaunal assemblages dominated by five sponges species
 - Densities in some areas comparable to ostur sponge beds
- Softcoral *Duva florida* dominant at one survey site
 - general lack of knowledge on spatial distribution and biology
- Identified environmental ranges for dominant taxa
 - Valuable for predictive species distribution models, which can be used in ecosystem-based management approaches.



Publication

Dunlop, K., Harendza, A., Plassen, L., Keeley, N., 2020. Epifaunal habitat associations of sessile epifauna on mixed and hard bottom substrates in northern Norwegian fjords. *Frontiers in Marine Science, Marine Ecosystem Ecology*. (in review).





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