

Benthic habitats of the West Greenland shelf

What is the impact of shrimp trawling



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Sustainable Fisheries Greenland



Greenland Institute of
Natural Resources

Benthic habitats of the West Greenland shelf

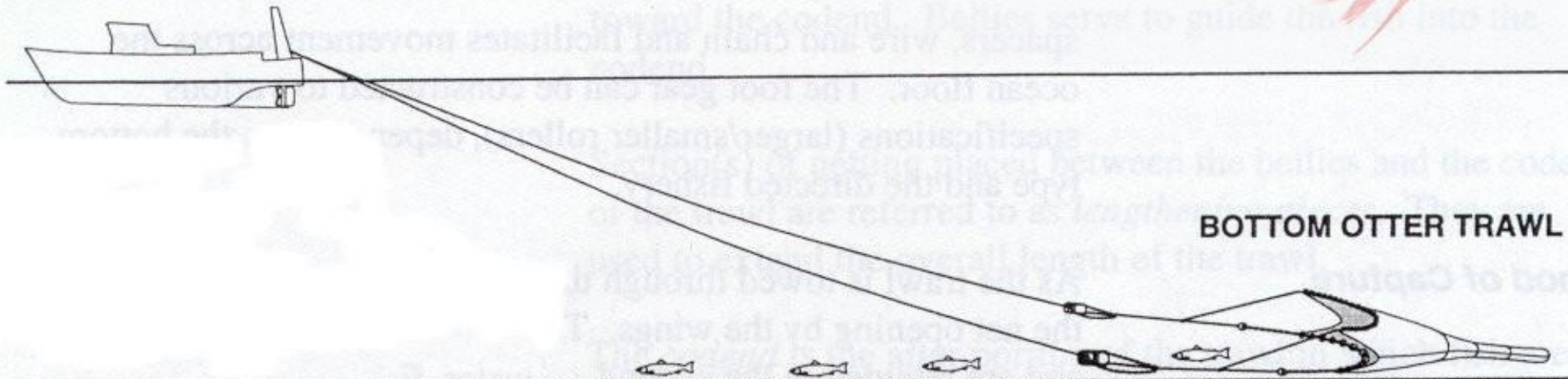
What is the impact of shrimp trawling

After this week's discussions it is clear the answer is

Don't know

How we are approaching the question

- The fishery and the market for *P. borealis*
- The certification process for “sustainability” stamp
- Our approach to impact assessment
- Back to the discussion issue of how much information do managers need for good decision making, and two-way flow of information



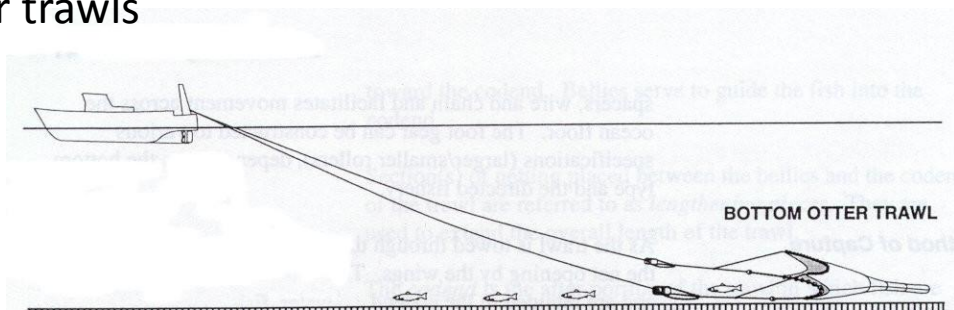


FAO Major Fishing Areas

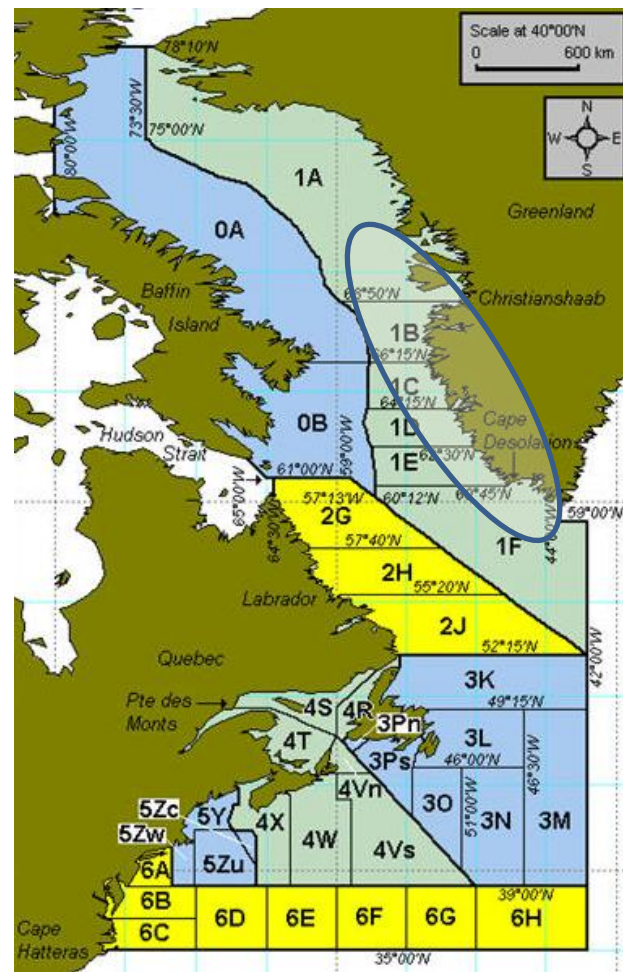
Northwest Atlantic (Major Fishing Area 21)

Fishery location West Greenland (NAFO sub-areas 1A-F and 0B)

- Inshore and offshore fleet
- 35 small vessels
- 12 factory vessels
- Otter trawls



- TAC for west and east Greenland is ~130,000 tonnes
- West Greenland fishery accounted for ~90% of that



Fishery management: Greenland Fishery Act through a series of regulations:

- Fishing licences
- Fleet quotas
- Access restrictions
- Bycatch restrictions
- Control measures, including logbooks, landing declarations, VMS (vessel monitoring system), an observer program
- Technical conservation measures, e.g. minimum mesh size



Enforcement by Directorate of Fisheries (Greenland Fisheries Licence Control)

- Track vessels, landing reports, and control the observer programme
- Observers on 60% of the offshore (and inshore fleet with processing facilities on-board)
- 10% of the inshore fleet without processing facilities

Policing is carried out by the Control Unit and through at-sea inspections by (Danish) naval vessels. Vessels are inspected at sea around 2-3 times per year

Since 2004 the TAC for the entire fishery has been set at 130,000 tonnes

Commercial market - all coldwater prawn product is exported. Product for domestic consumption is re-imported from Denmark.





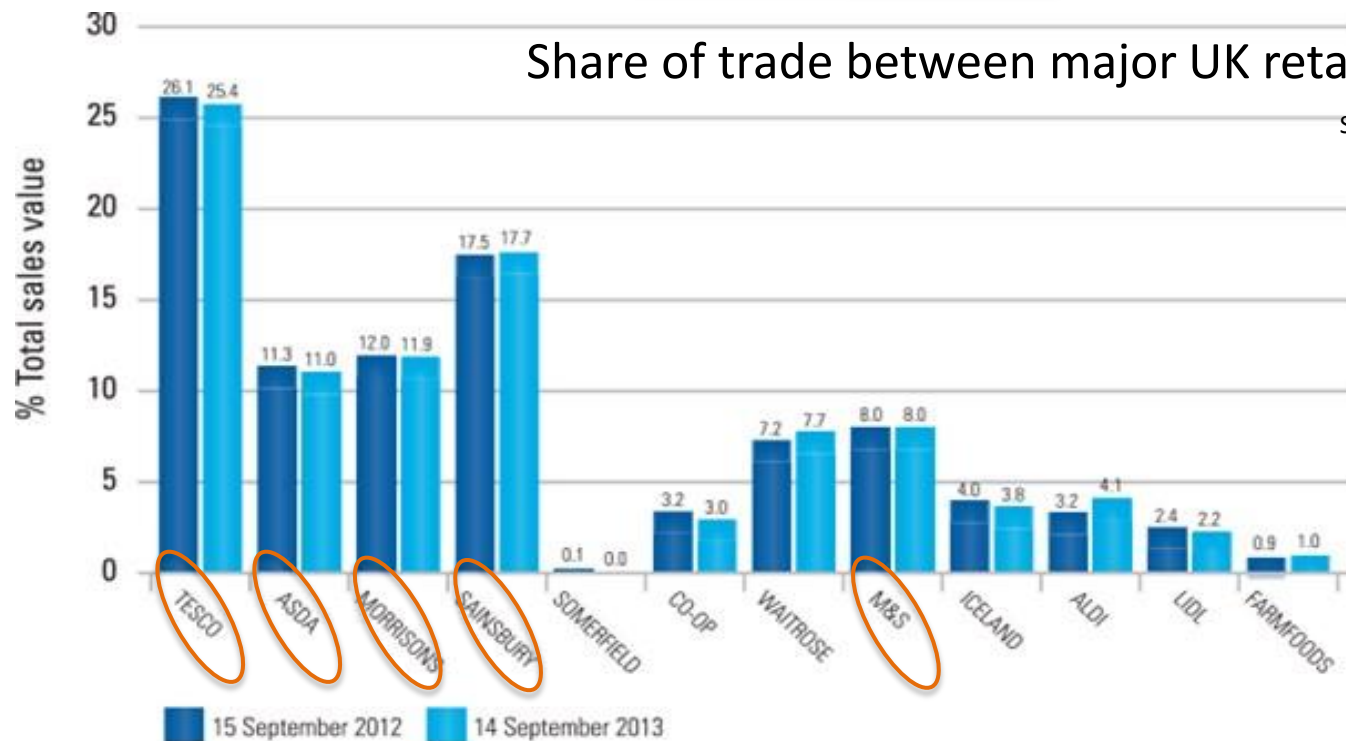
- UK imports 50% of global cold-water shrimp produce
- Royal Greenland is the UK's largest seafood supplier
- Coldwater shrimp global catch peaked at 450,000 tonnes
- Of the total catch, Canada and Greenland make up 85%



This is important because market forces (and consumer practice) are now a much bigger driver of the management practices of the industry

Share of trade between major UK retailers (all fish)

Source: Seafood (Nielsen)



Ranking of the sustainability of supermarkets' seafood

Supermarket	Sustainability of wild-caught seafood	Sustainability of farmed seafood	General issues*	Rank and grade 2006	Rank and grade 2005
M&S	A	A	A	1	1
Waitrose	A	A	B	2	2
Sainsbury's	B	B	B	3	3
Co-op	C	B	C	4	4
ASDA	C	D	C	5	9
Morrisons	C	D	C	5	8
Tesco	C	D	C	5	6
Somerfield	D	D	D	8	5
Iceland	E	E	E	9	7

*General issues: the brands and ranges of seafood covered by seafood procurement policies; transparency of policies and their implementation; and promotion of sustainable seafood.

● excellent ● good ● pass ● fail

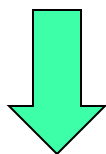


2006

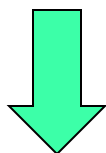
<http://www.greenpeace.org.uk/files/images/migrated/MultimediaFiles/Live/FullReport/7988.pdf>

Shifts in regulatory approach

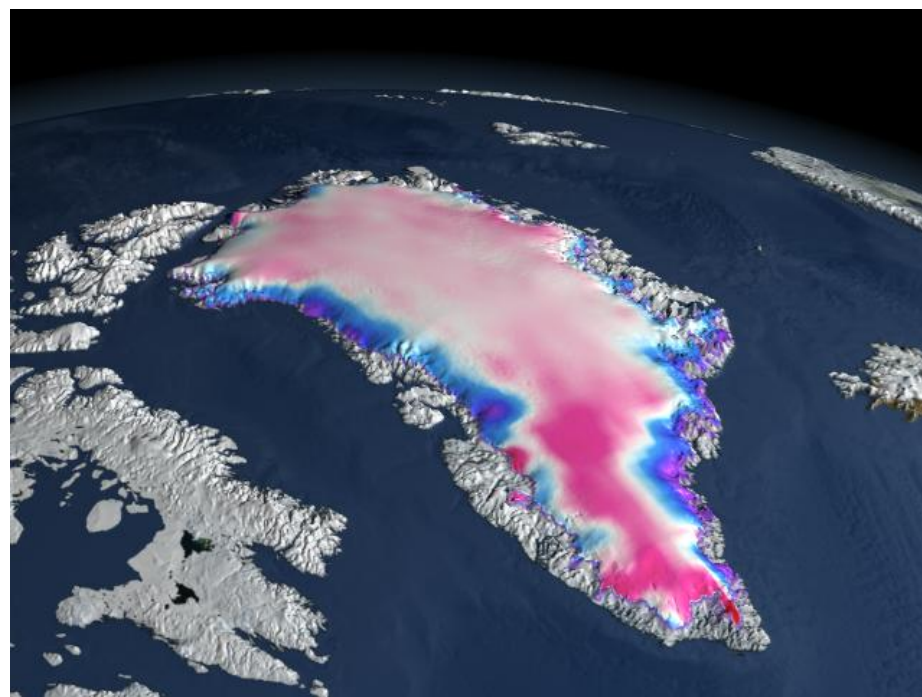
Government regulation approach



Economic incentive approach



Market based approach
(voluntary labeling)



Market-based approach to management (voluntary labeling)

In the past decade – explosion of voluntary certification and labeling schemes

- *3rd party – standard is developed by a group at arm's length from individual companies and the industry, and compliance is audited by independent organisations with no vested interest in the outcome*

Forest sector, mineral sector, organic agriculture, coffee, clothing...does it work?



Marine Stewardship Council

Certified sustainable seafood

Standard for sustainable fishing and seafood traceability

To carry the label every business in the supply chain must have undertaken a **traceability audit** against the **MSC Chain of Custody standard**



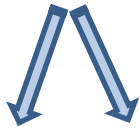
SFG

Sustainable Fisheries
Greenland

Fisheries (and seafood **businesses**) voluntarily seek certification



Assessments are carried out by independently accredited **certifiers** ('third-party certification')



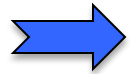
An independent assessment shows that the organisation, product or service meets standards that have been set by **impartial experts**



A certificate is issued to announce that the standard has been met

Three core principles form the MSC fisheries standard:

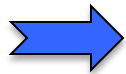
Principle 1: Sustainable fish stocks: The fishing activity must be at a level which is sustainable for the fish population. Any certified fishery must operate so that fishing can continue indefinitely and is not overexploiting the resources



Principle 2: Minimising environmental impact: Fishing operations should be managed to maintain the structure, productivity, function and diversity of the ecosystem on which the fishery depends

Principle 3: Effective management: The fishery must meet all local, national and international laws and must have a management system in place to respond to changing circumstances and maintain sustainability





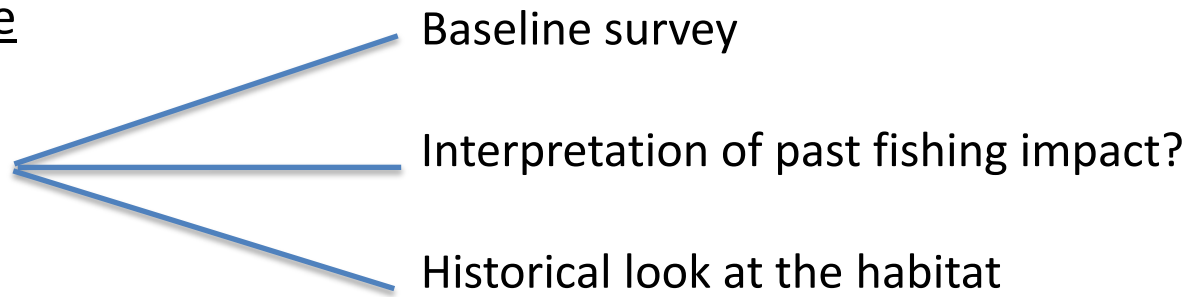
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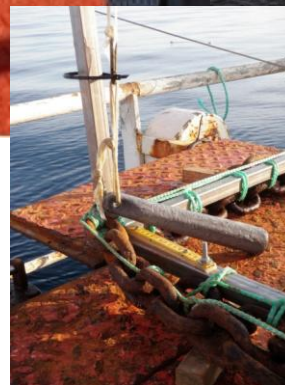
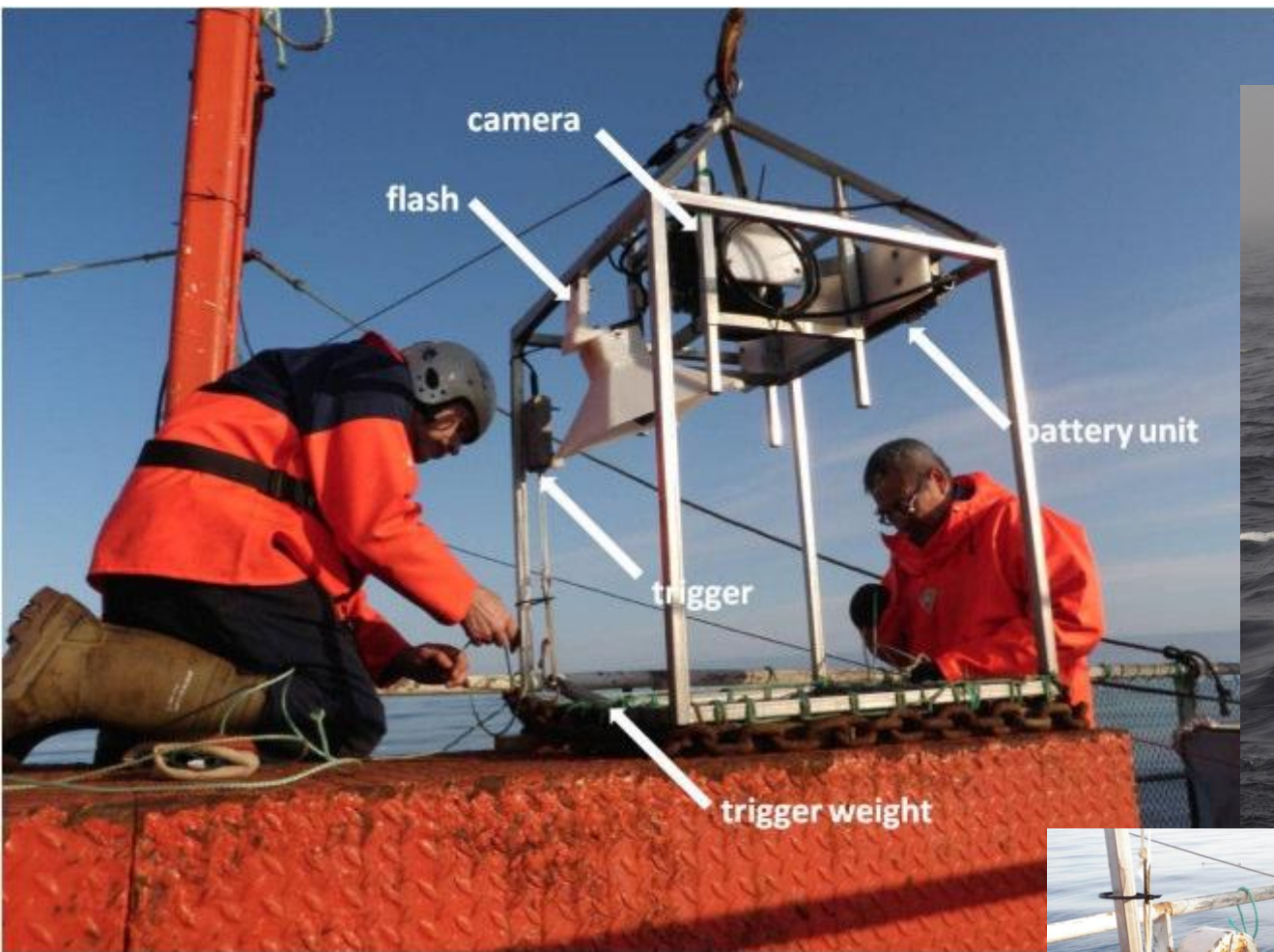
Three approaches within
this one principle

1. Community ecology
- image-based survey

2. Genetic analysis
- population connectivity

3. Environment
- habitat suitability modelling



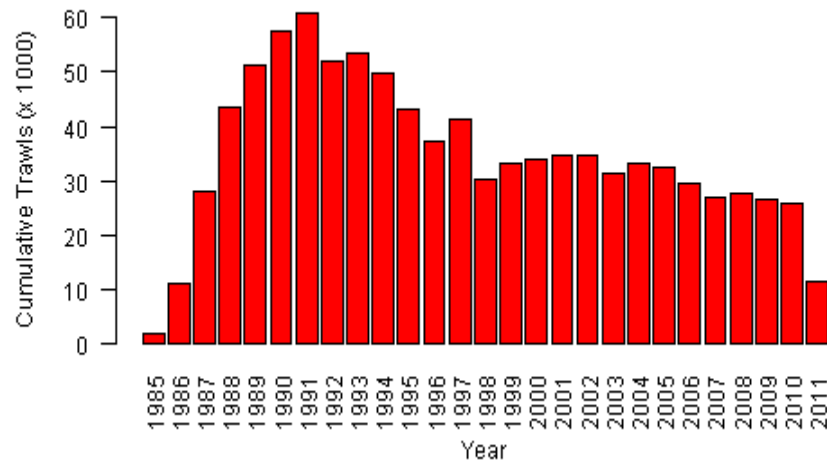




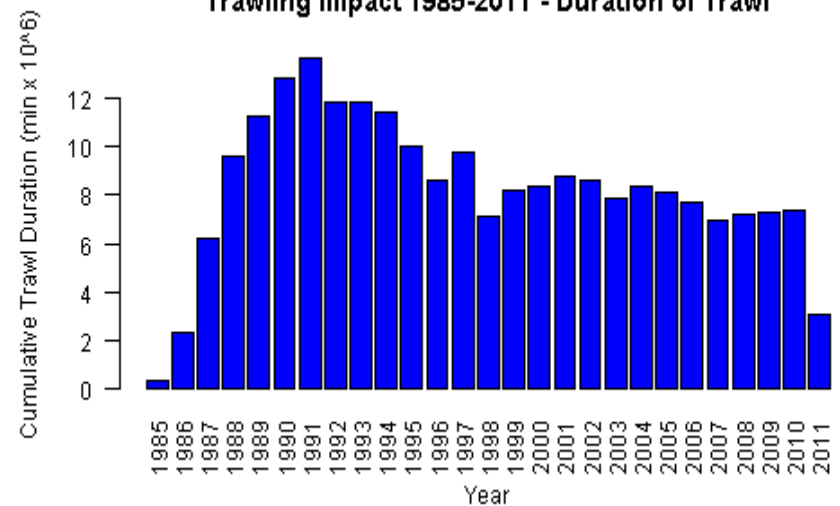
Shrimp trawl data from GINR

ID	Y	M	D	Hour	Min	Start			Hour	Min	End			Length	Duration
						Lat	Long	Depth			Lat	Long	Depth		
0	1985	7	14	10	25	66° 3' N	55° 50' W	119	12	50	66° 4' N	55° 38' W	107	9,223	145
1	1985	7	14	14	30	66° 3' N	55° 28' W	110	18	10	66° 3' N	55° 56' W	106	21,088	220
2	1985	7	15	08	00	66° 4' N	55° 26' W	109	11	00	66° 4' N	55° 44' W	115	13,547	180
3	1985	7	15	12	30	66° 5' N	55° 50' W	117	14	20	66° 6' N	55° 58' W	120	6,294	110
4	1985	7	16	01	15	67° 0' N	56° 22' W	109	02	20	66° 59' N	56° 24' W	114	2,354	65
5	1985	7	16	13	10	67° 35' N	57° 43' W	124	17	15	67° 37' N	58° 5' W	148	15,990	245
6	1985	7	16	19	30	67° 37' N	58° 2' W	146	21	30	67° 38' N	57° 48' W	140	10,060	120
7	1985	7	17	00	10	67° 27' N	57° 50' W	153	03	10	67° 24' N	57° 36' W	155	11,419	180
8	1985	7	17	04	00	67° 23' N	57° 33' W	152	08	00	67° 18' N	57° 15' W	168	15,860	240

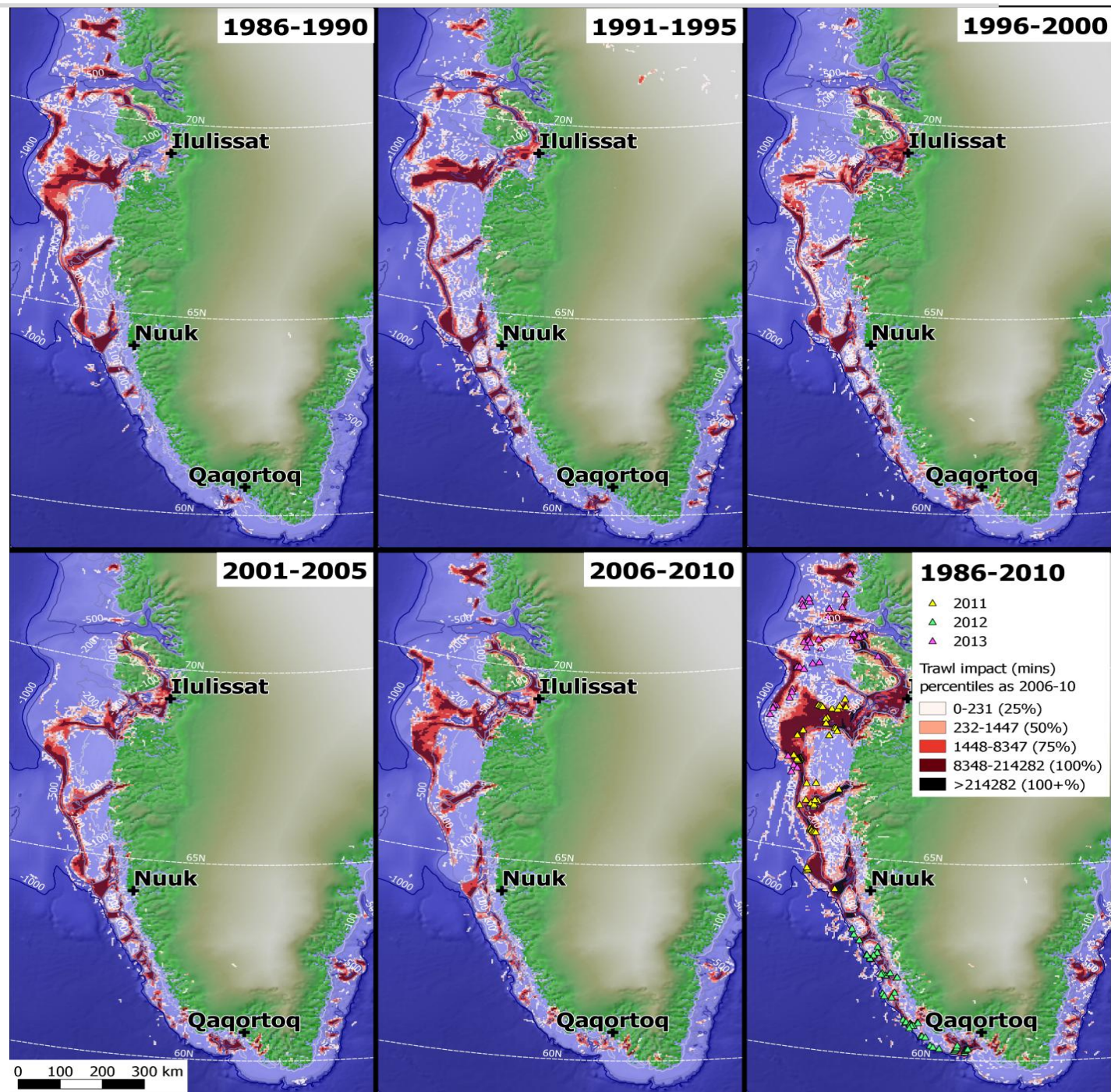
Trawling impact 1985-2011 - Total Trawls



Trawling impact 1985-2011 - Duration of Trawl



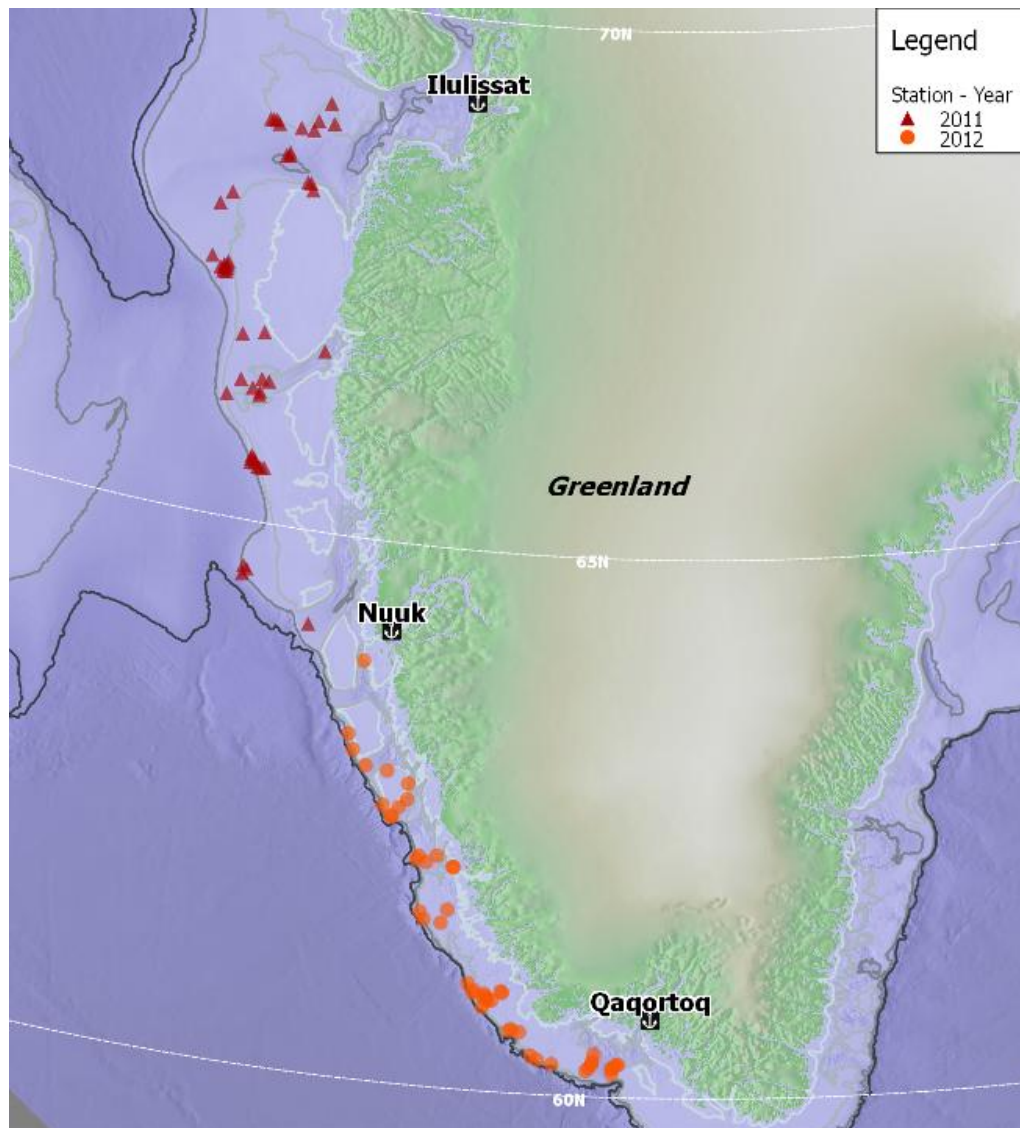
- Trawling effort has reduced
- Impact is shifting northwards
- Few untrawled areas on the western shelf



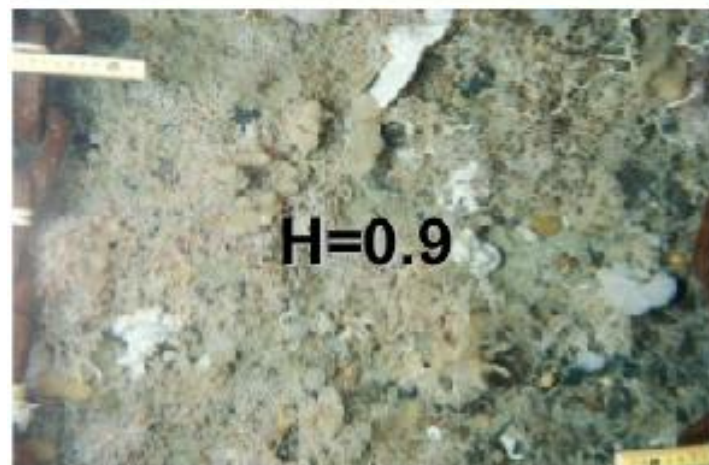
After 3 years of image sampling - 120 Stations, grouped as:

- High fishing
- Low fishing
- “Recovery”
- No impact

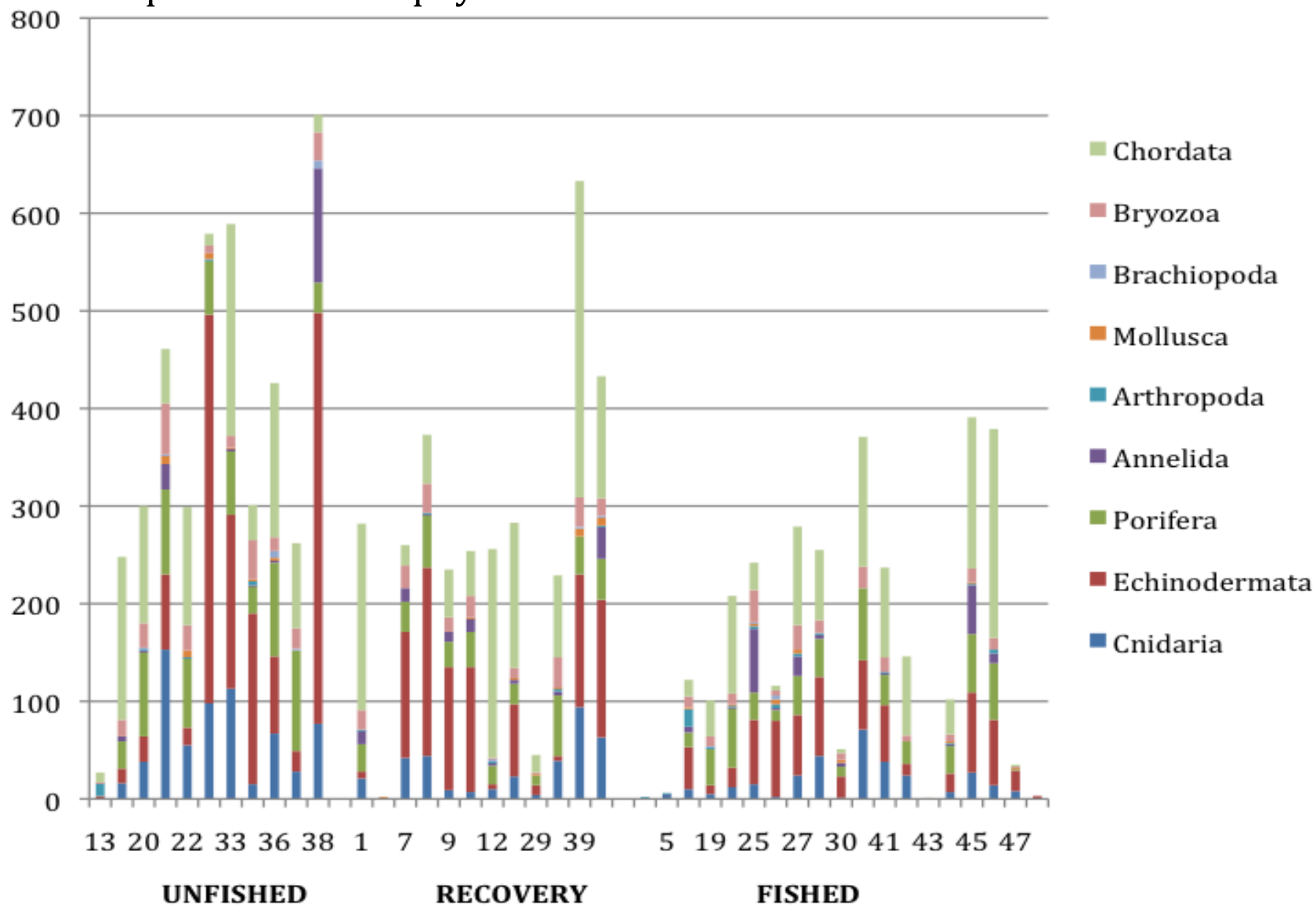
Image Sampling Locations

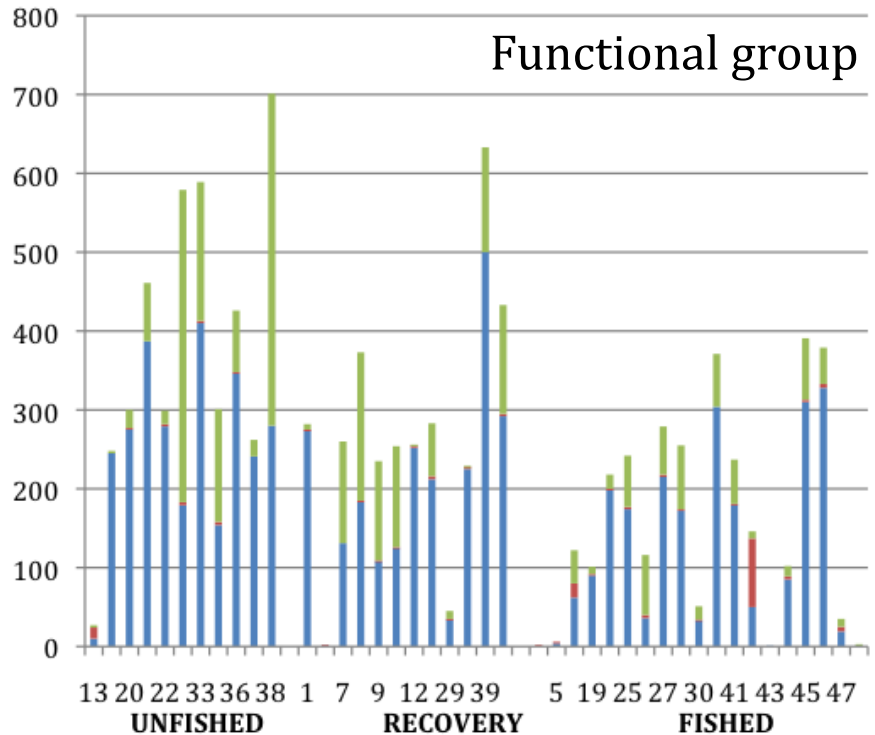


Diversity indices
Substrate type
Impact indices

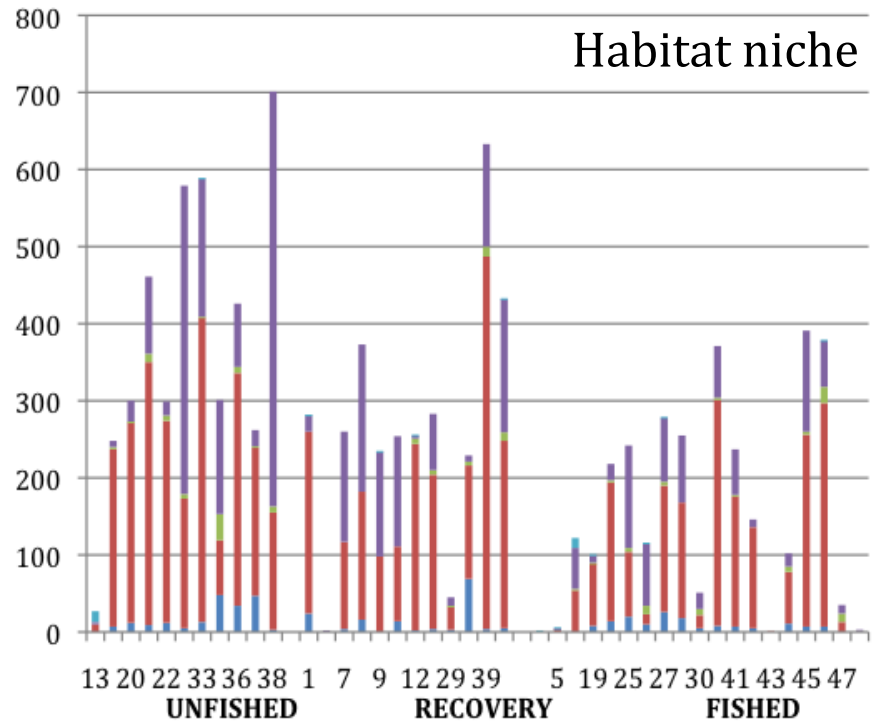


Representation at phylum level





- Multiple strategy
- Predator
- Filter feeder

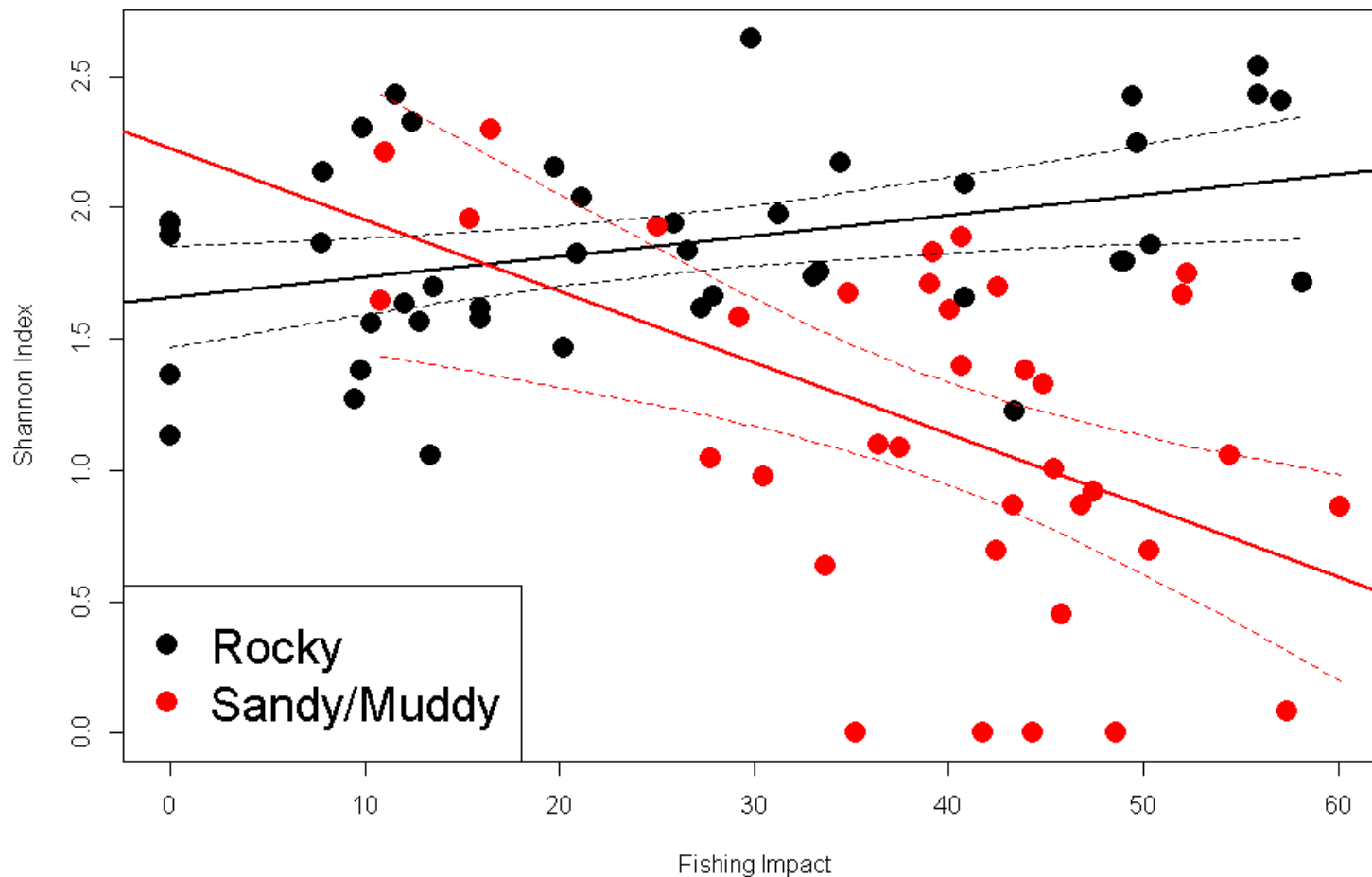


- Non habitat-forming
- Benthic motile
- Infauna
- Sessile
- Encrusting

Data steadily added – 2011, 2012, 2013

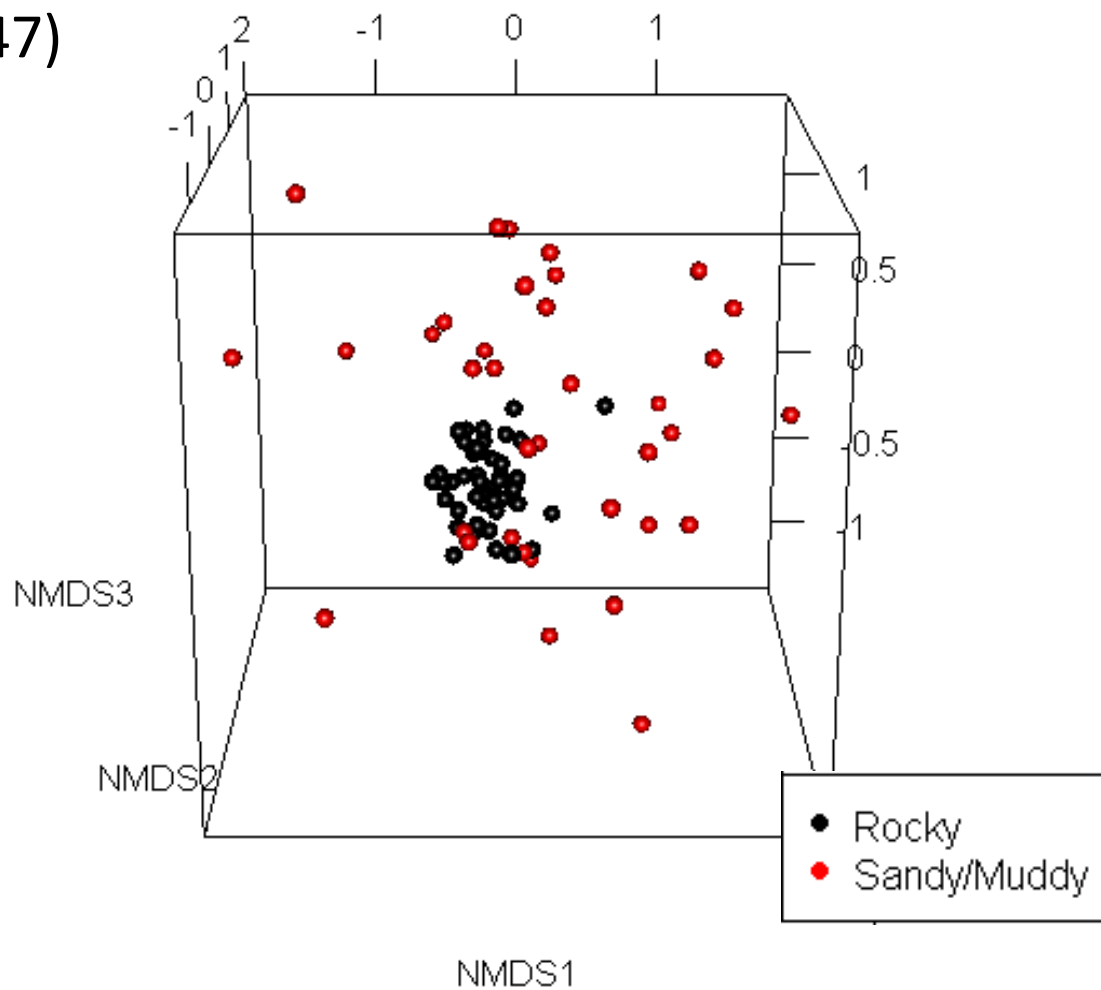
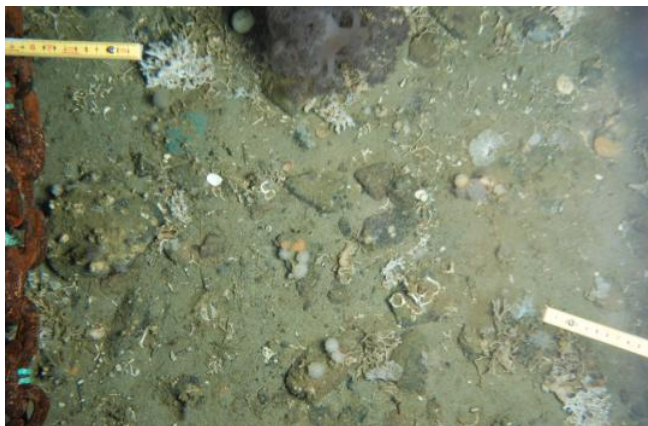
First pass interpretations

- Negative effect of trawling on diversity in mixed mud habitats
- No effect on other substrata
- Negative effect on stylasterid numbers



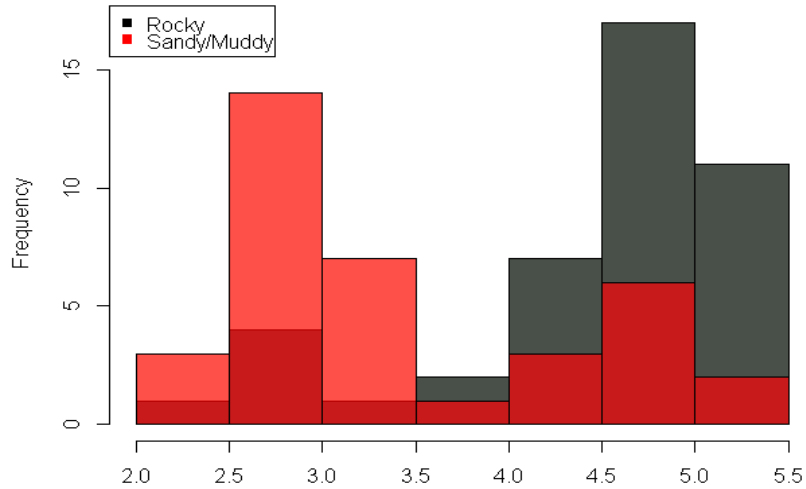
Are all sites directly comparable?

- 3D MDS plot (3d stress=1.47)

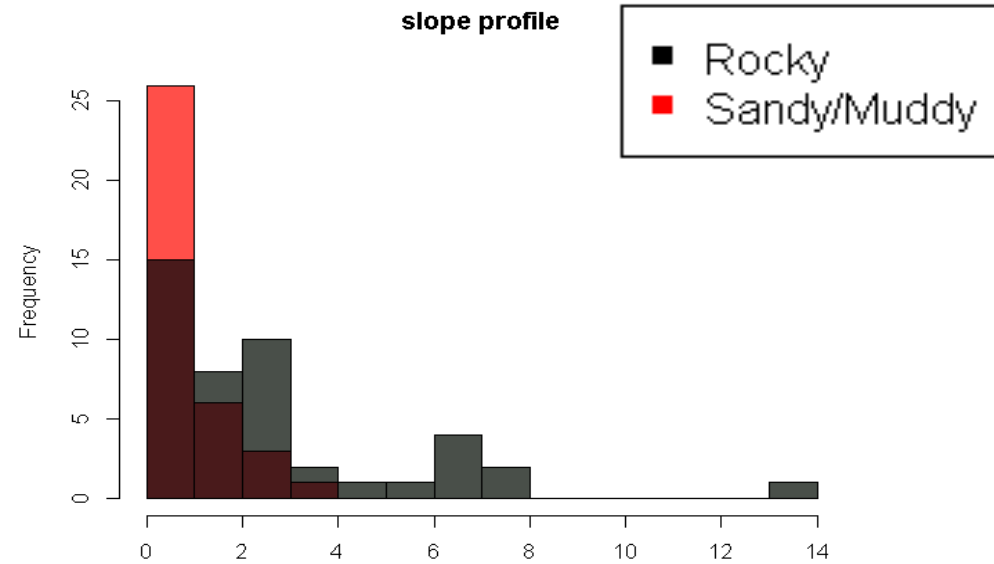


Habitats differ by environment

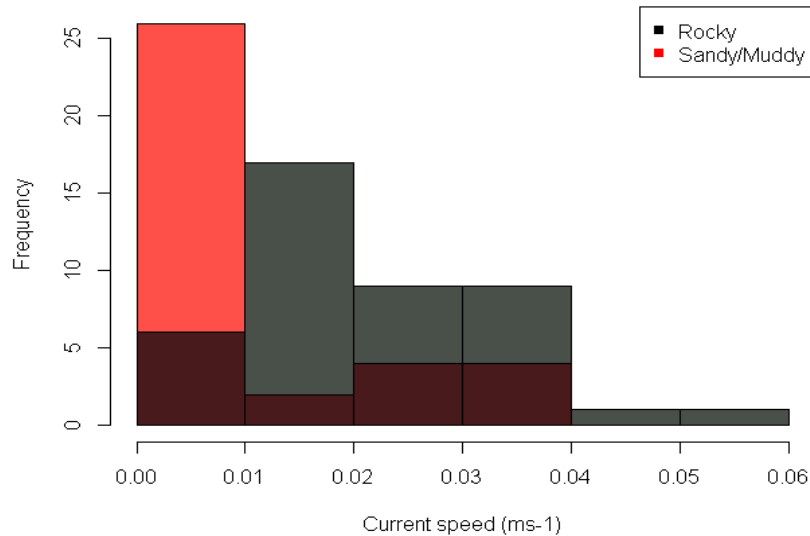
Temperature profile



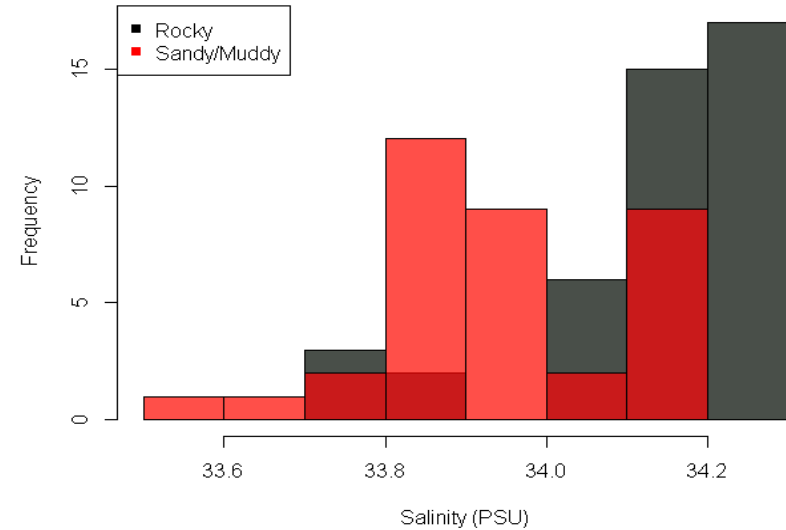
slope profile



Current.Speed profile



Salinity profile



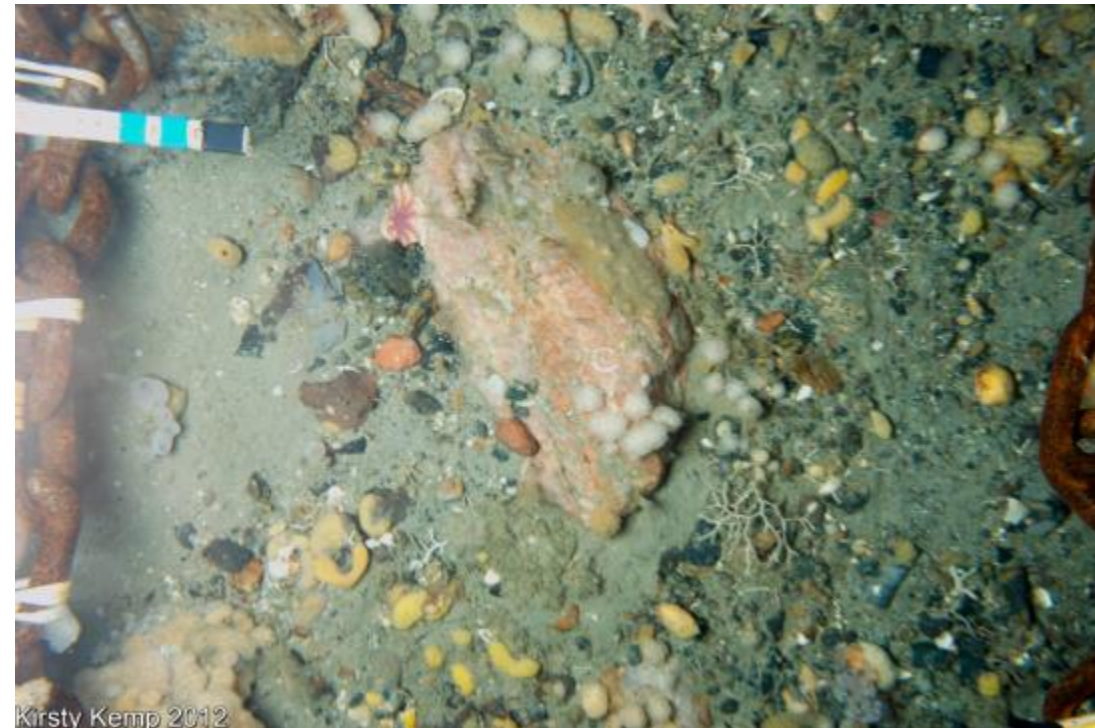
What effects diversity?

Generalised linear models

Diversity:
Function of Fishing + Environment

Muddy seabed:
- Fishing impact**

Rocky seabed:
+ Depth***
- Current Speed***



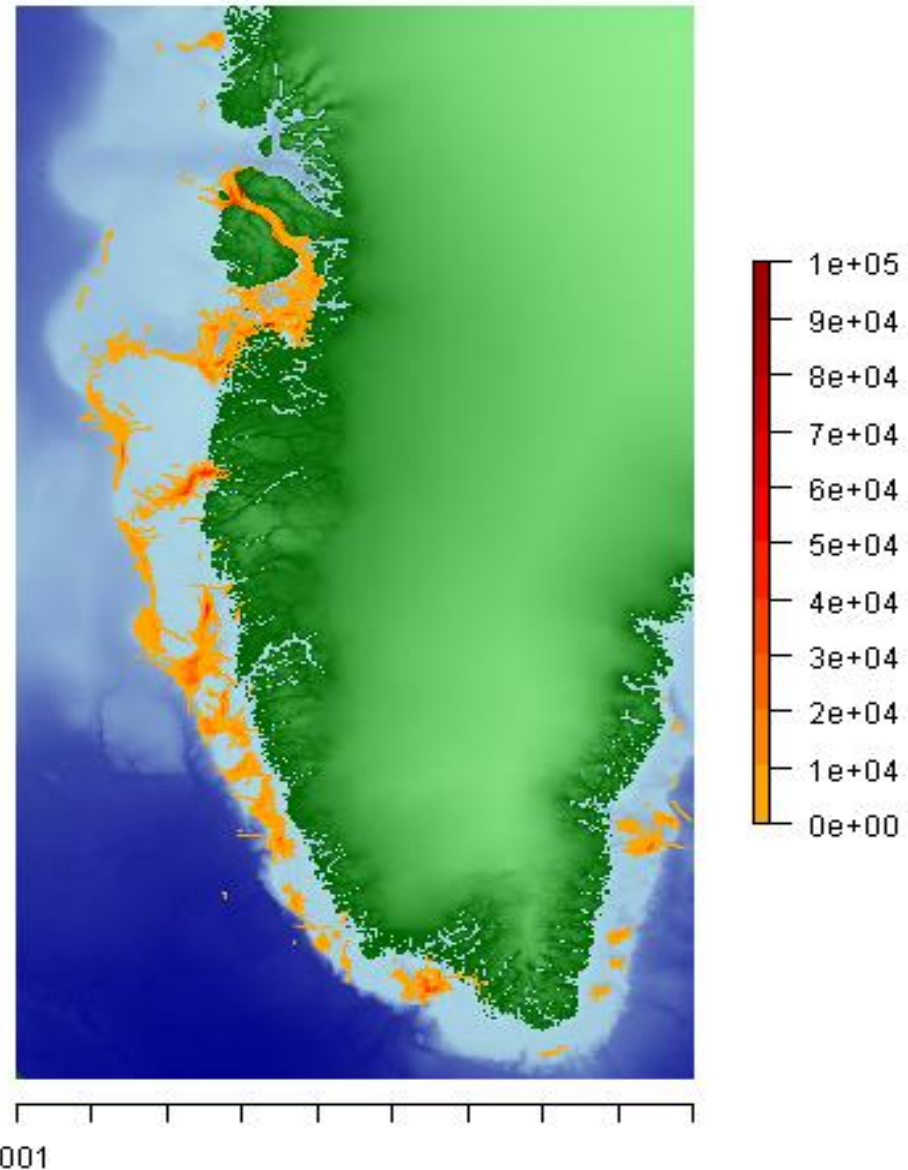
- Given this evidence that **environment** makes a difference to diversity,
- It must be duly considered as an important determinant of distributions
- CY and CT poster

Considerations now

- Fishing is shifting
- Environment is shifting
 - temperature
 - glacial runoff

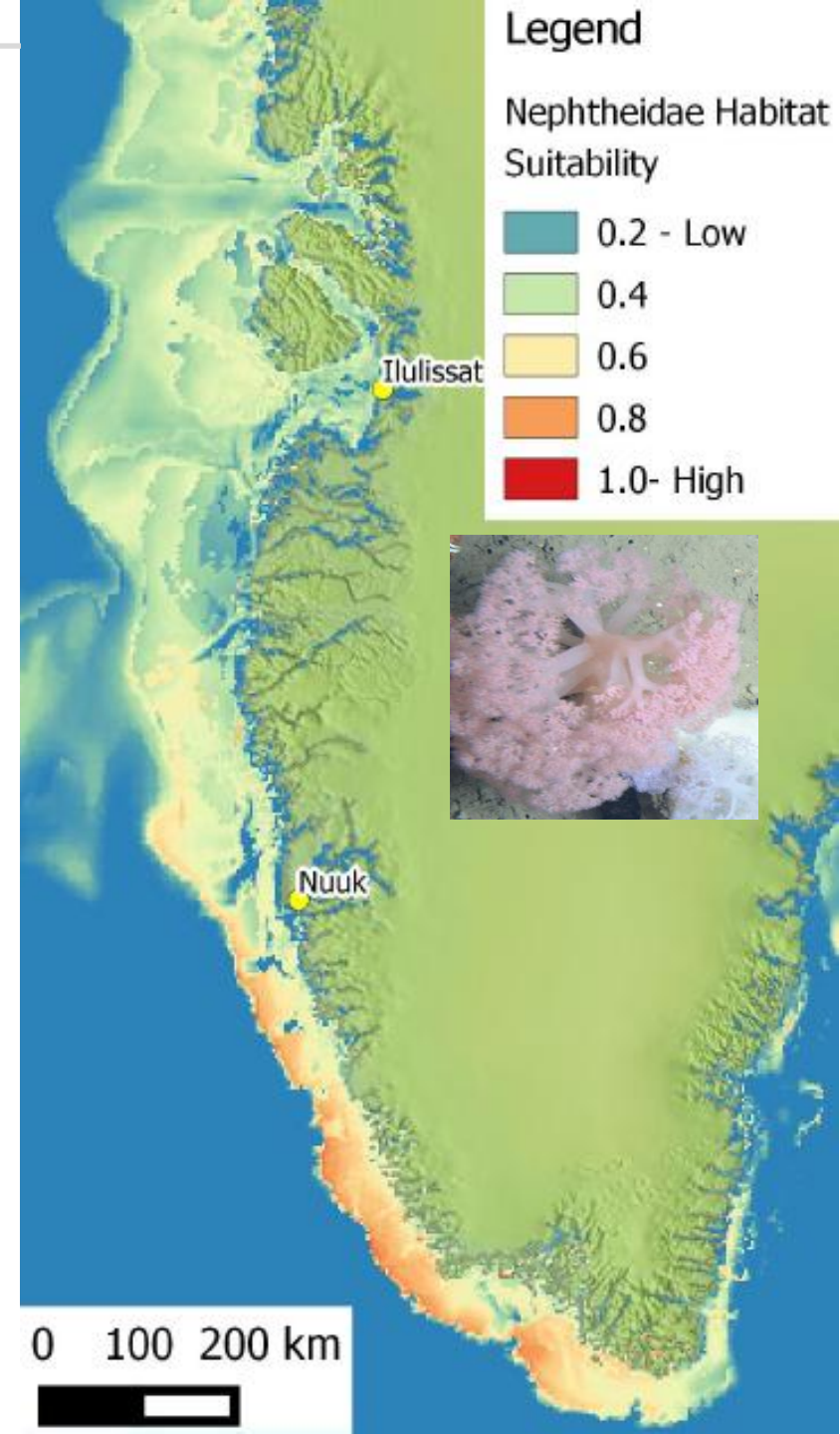
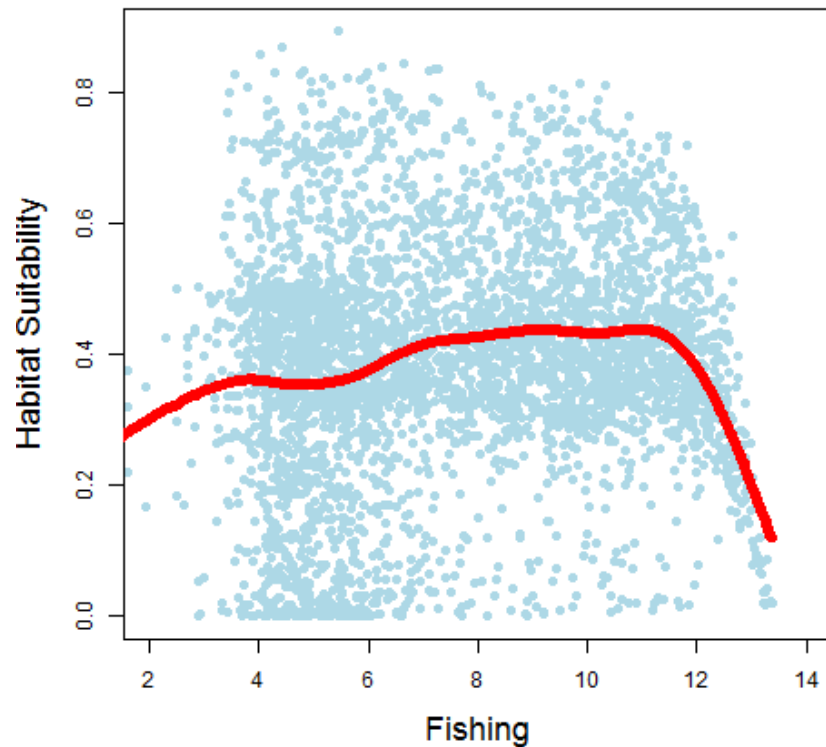
Incorporation of HSM

Annual Shrimp Trawls (Hours)



Habitat Suitability Modelling

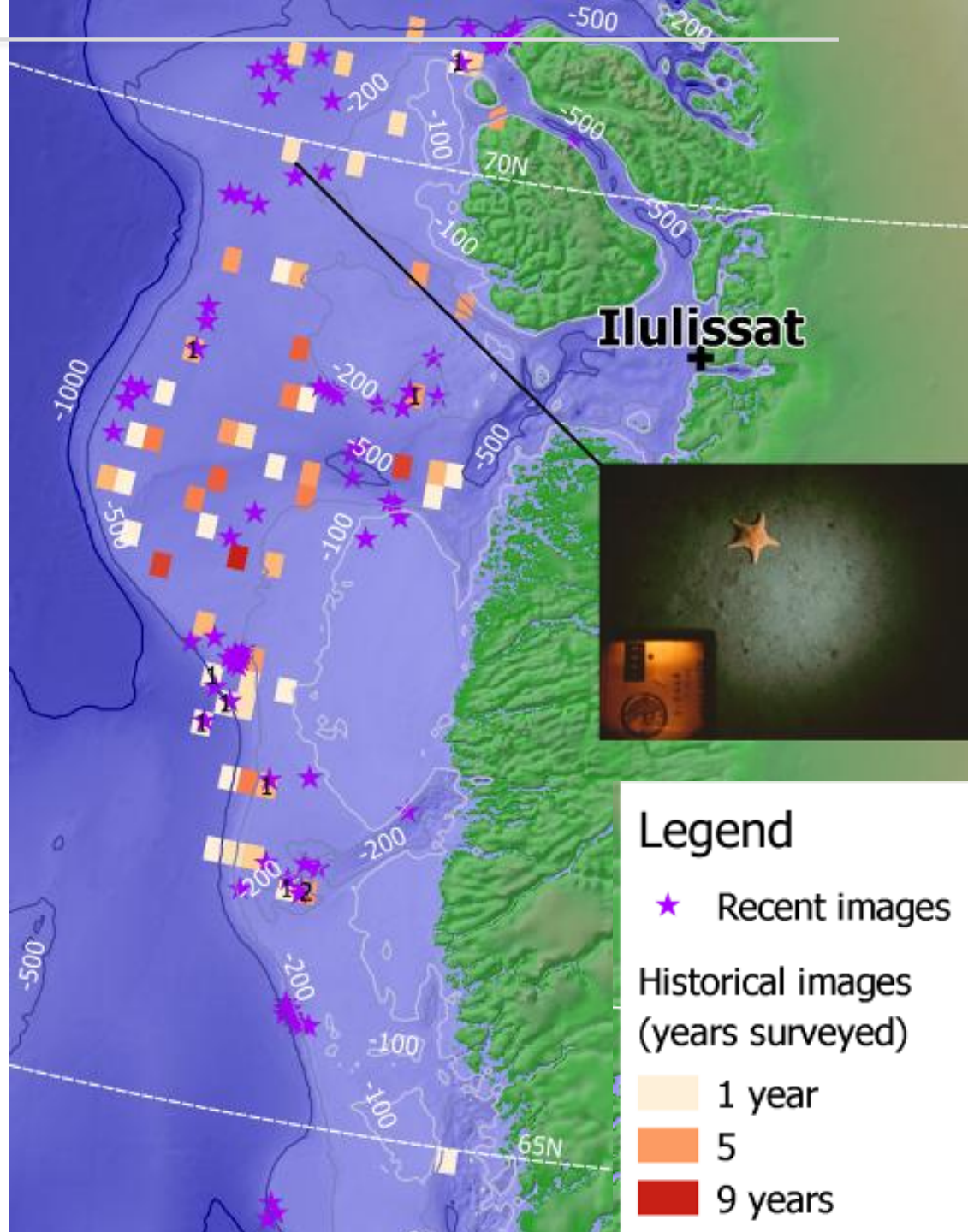
- Limited sampling of taxa
- Good models/maps of environment
- HSM helps us estimate continuous distribution
- Noteworthy response of model to fishing impact



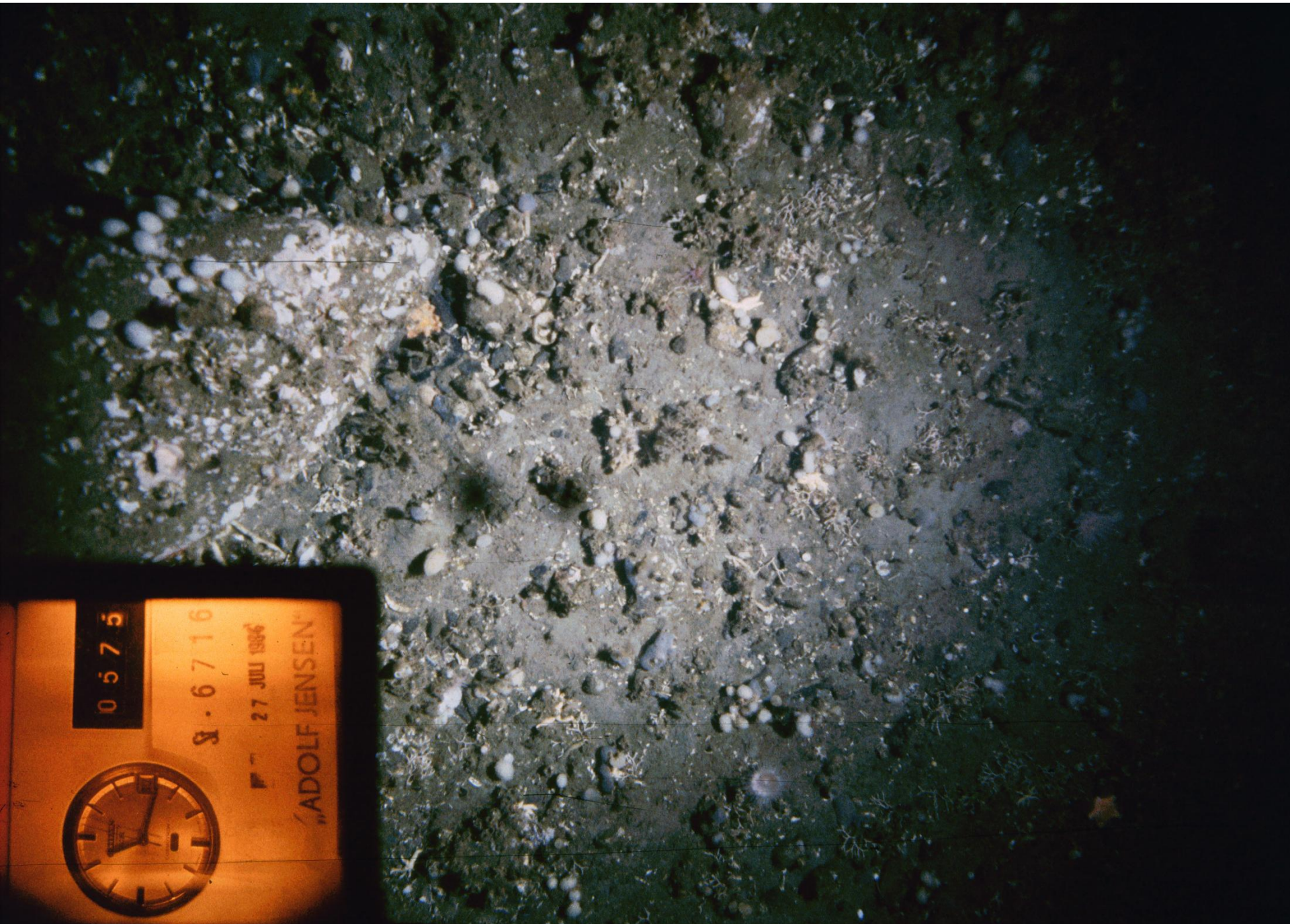
Historical Photographs



- Benthic images
(Per Kanneworff, GINR 1975-1986)
- 50 reels of film (~40,000 images)
- Measure change from 40 years before now
- 100+ stations from our work and 100+ stations from PK's work...
- and 5 overlap







0575

9.6716

27 JUL 1986

ADOLF JENSEN

Historical Photographs

Legend

Station Year

▲ 1977-1980

▲ 1984

Trawling Impact 1975-1984

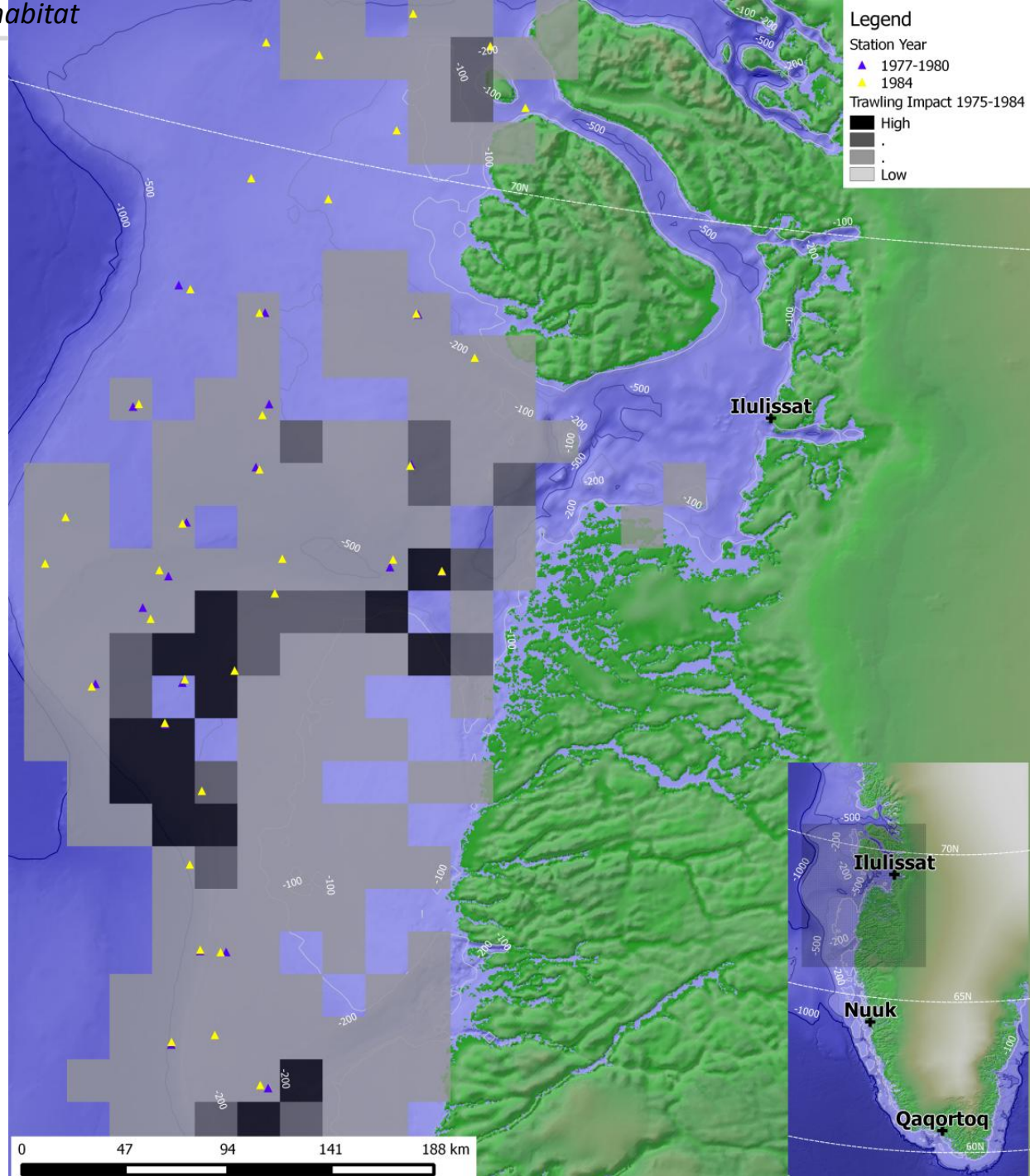
■ High

■ .

■ .

■ Low

Can clearly see the
courser grid of fishing
data here



Legend

Station Year

▲ 1977-1980

▲ 1984

Trawling Impact 1975-1984

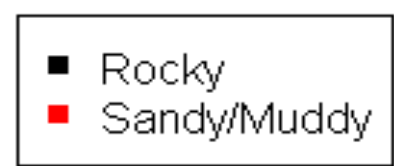
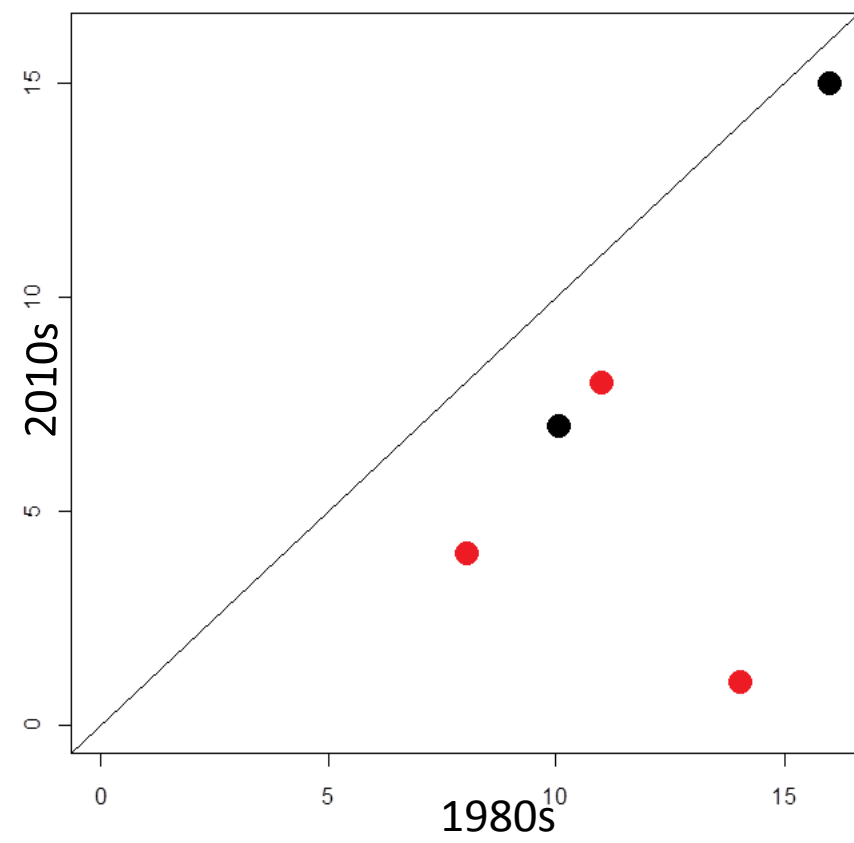
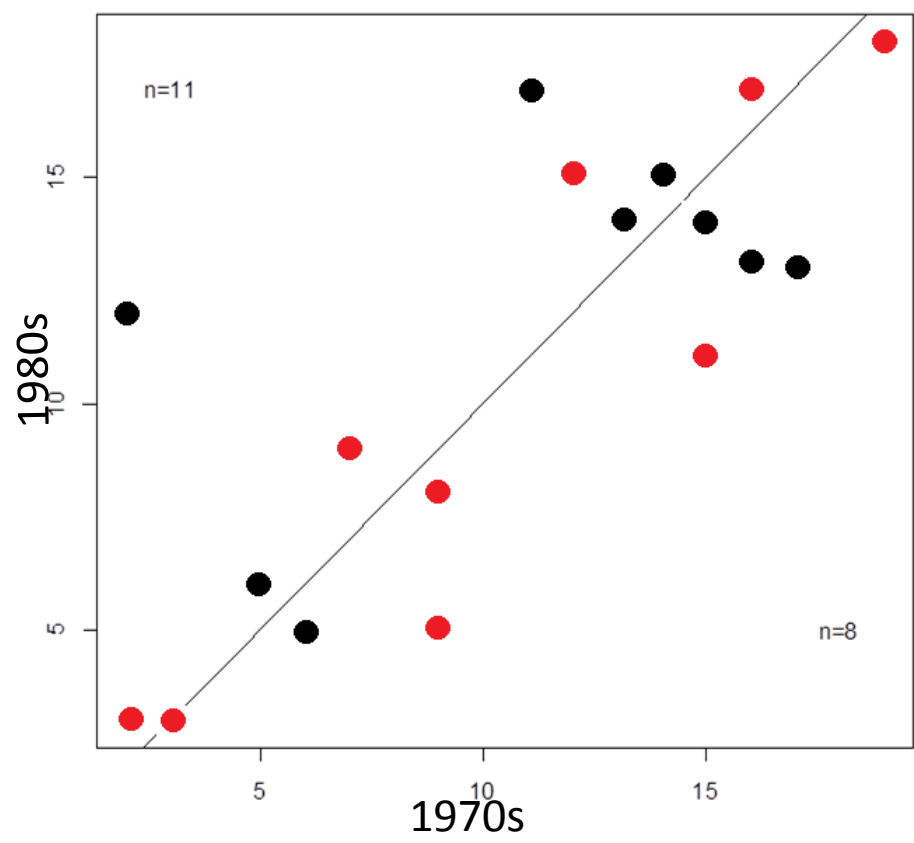
■ High

■ .

■ .

■ Low

Temporal comparisons – site richness



Taxon richness
Low n (11, 5 stations)
But indicators of decline in richness over longer time view

Sampling current and historical bycatch & grabs

ID	Samples Collected (251)
Neptheidae	197
(Gersemia)	26
(Duva)	15
Paragorgia	10
Anthoptilidae	7
Others	37



Paragorgia



Nephtheidae



Duva



Gersemia

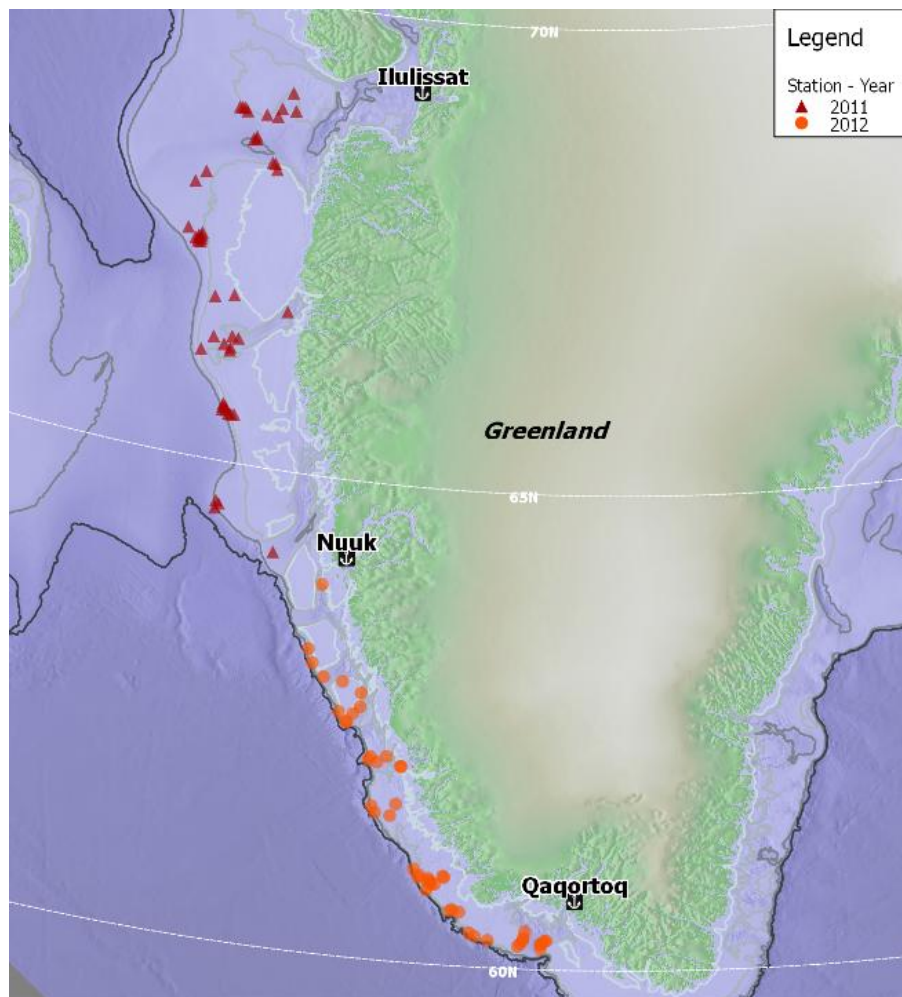


Vulnerable marine organisms
bycatch

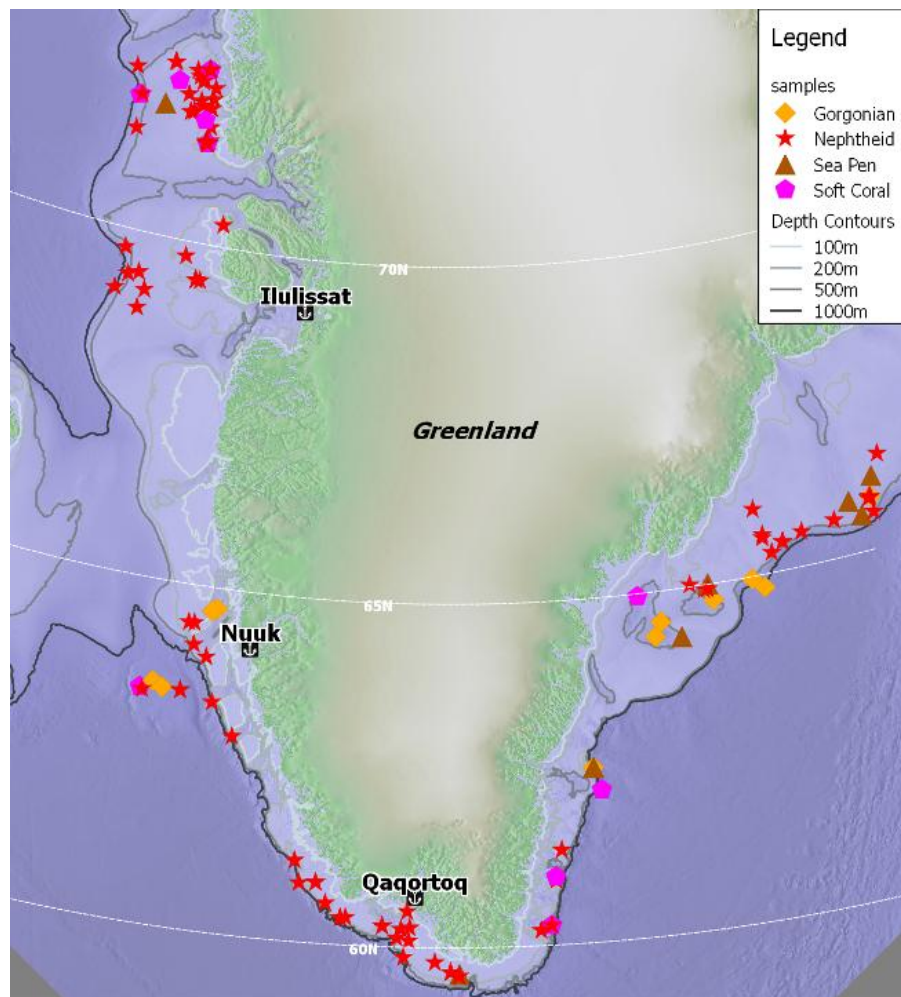


GINR foresight to collect bycatch

The picture after 3 years of sampling Image Sampling Locations



Bycatch Sampling Locations





Nephtheidae



Duva



Gersemia

Summary of genetic work (and taxonomy)

- 251 mixed soft coral samples
- Nephtheids most numerous (~200) and therefore our target group
 - Family-level identification difficult in this group and taxonomy a bit muddled
 - Uncertain how many spp there are
 - Ole Tendal, Zoological Museum, Copenhagen
- Bonus - we'll get DNA taxonomy on this difficult group
- Ultimately looking for any genetic patterns across the fishing gradient

Computer assisted recognition Collaboration with UCL


brendanil Hello, ejohns! [Log off](#)

[Home](#) [Images](#) [Label](#) [Data](#) [Tags](#) [About](#) [Contact](#)

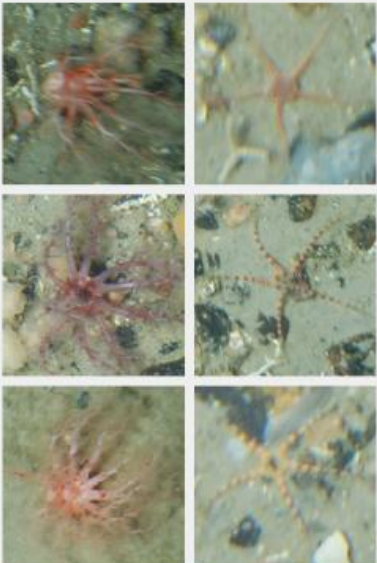
sample_image.jpg

Scale: 180% Mode:

Filter: 05/11/2013 12:25:48 Tag:

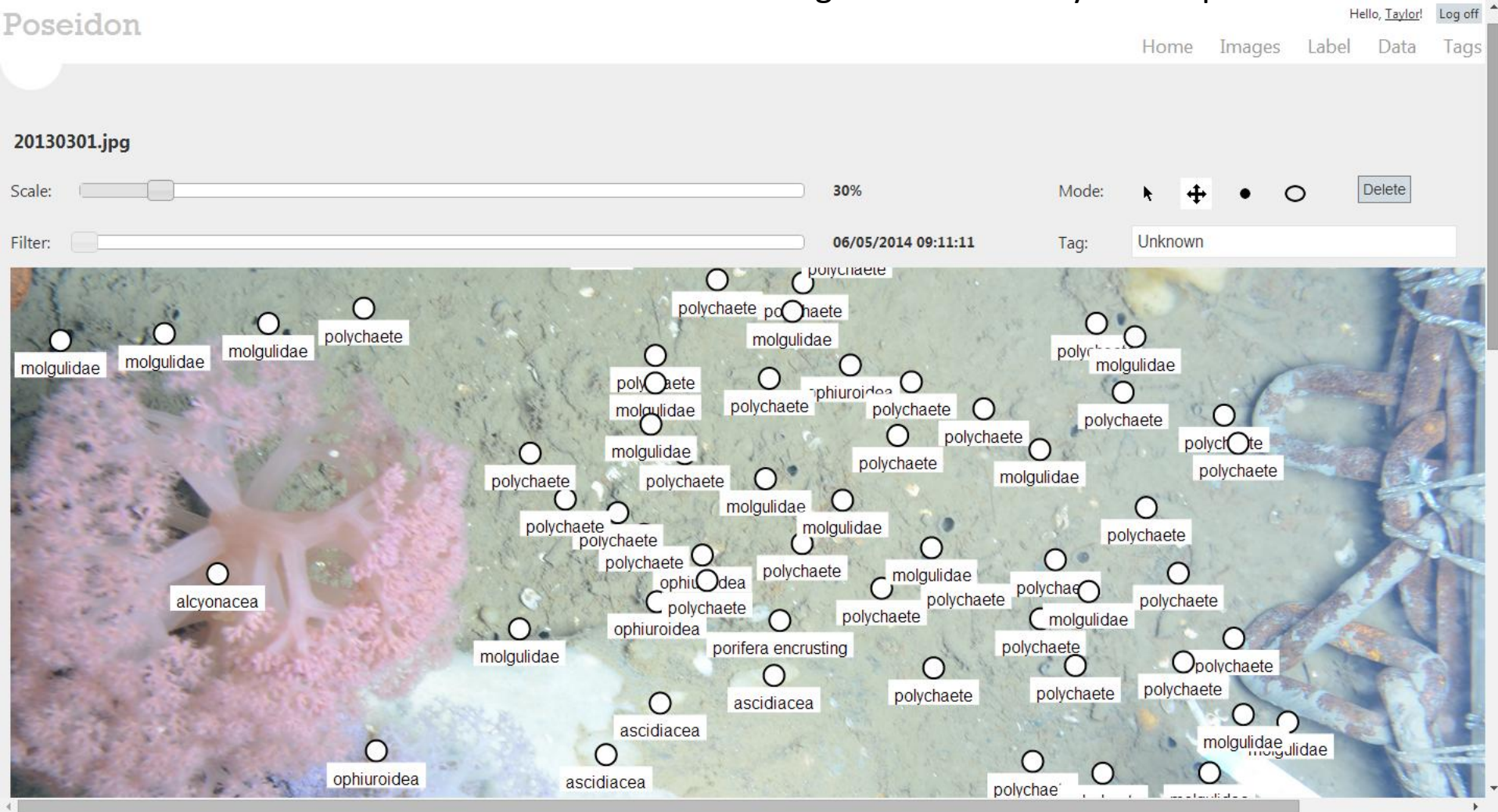


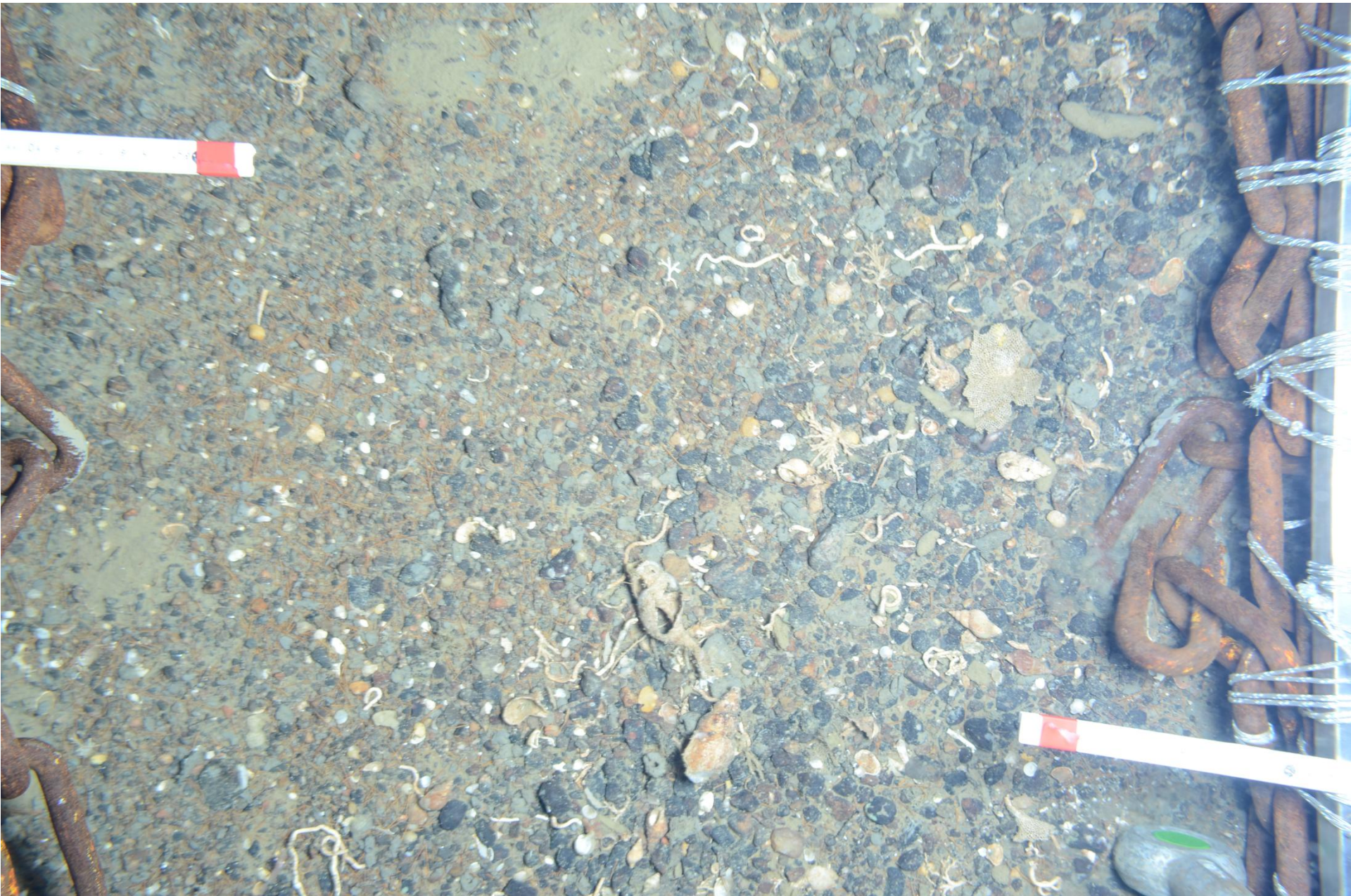
Holothurian **Brittle Star** **No Organism**



Poseidon the labelling tool: How to improve analysis consistency and efficiency

- Machine learning towards automation of analysis
- Building a tool for use by non-experts







Summing up

Indications of Results

1. Title answer – we don't know

Provisionally: negative impact on soft sediment diversity, but need to do more

2. Environmental conditions (beyond substrate) are important considerations

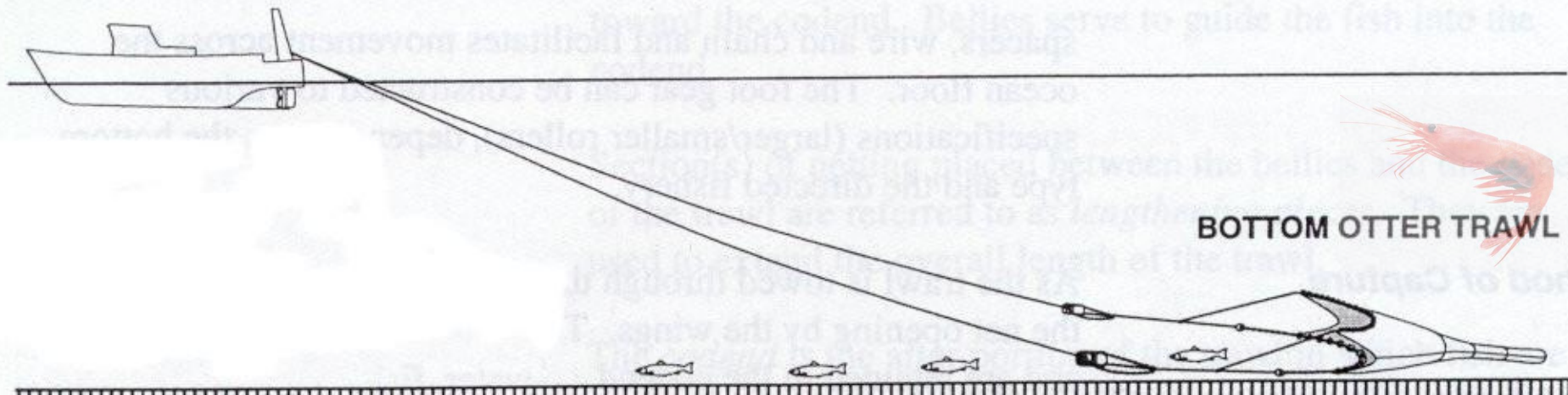
Thoughts about the process

3. Meetings like this – difficult and complex thing being approached similarly by many

Back to the discussion issue of how much information do managers need for good decision making

MSC context and credit to industry

4. Shifting goalposts....surely should be interpreted as a positive thing



Contributors and Collaborators

Sustainable Fisheries Greenland
Greenland Institute of Natural Resources

Michael Kingsley

Nanette Hammeken

Martin Blicher

Officers and Crew of M/T Paamiut

University College London - Edward Johns
Zoological Society of London students

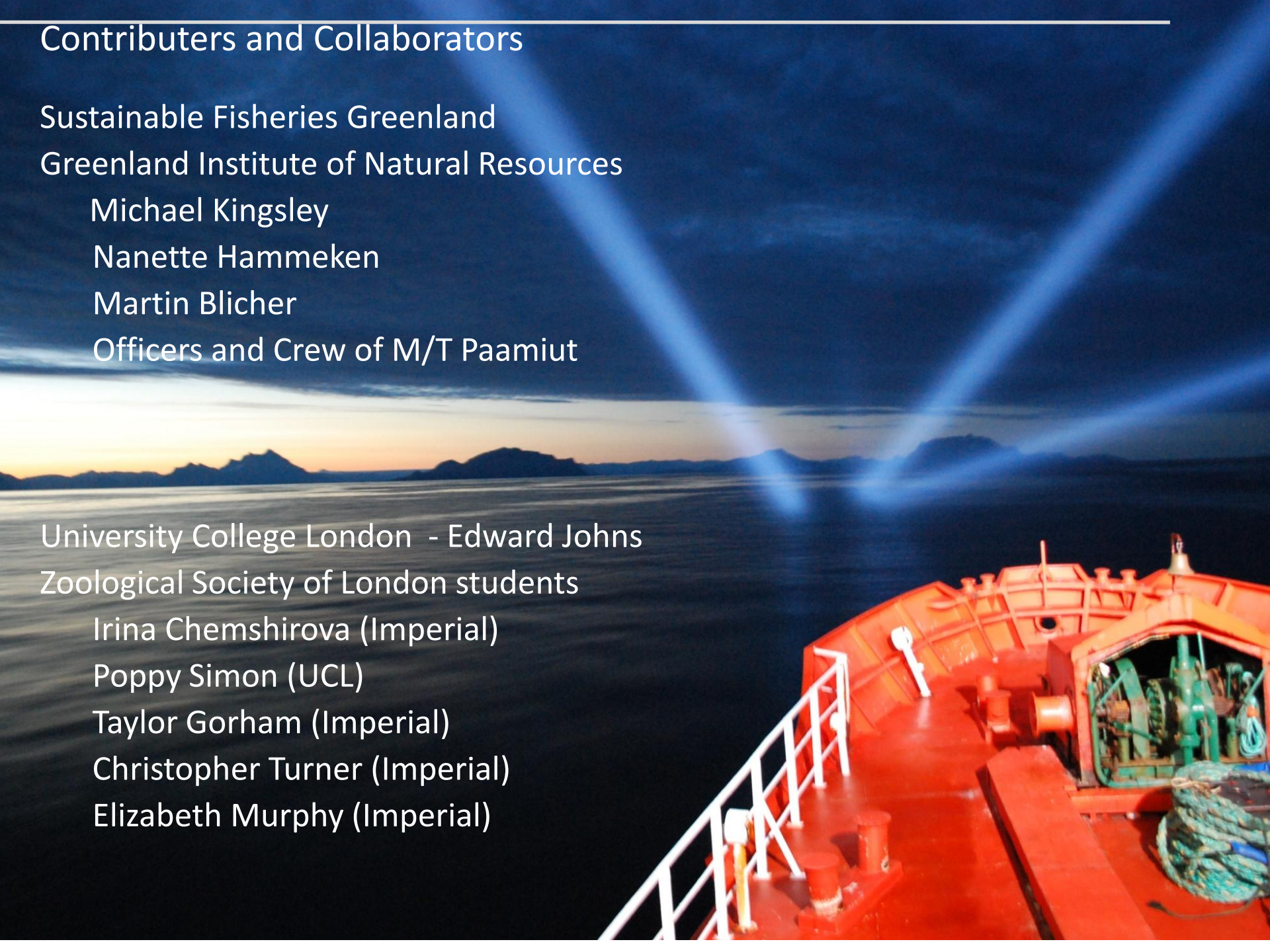
Irina Chemshirova (Imperial)

Poppy Simon (UCL)

Taylor Gorham (Imperial)

Christopher Turner (Imperial)

Elizabeth Murphy (Imperial)





ZSL

Institute of Zoology

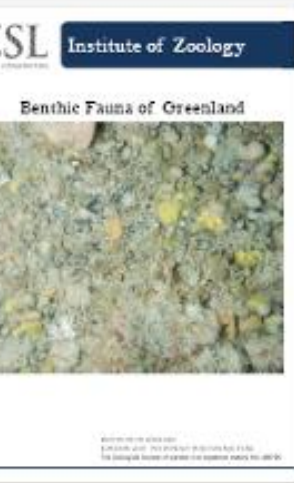
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Page 1



Sea Anemones



Soft Corals

Page 2



Cluster Anemones or Zoanths?



Stony Corals

Page 3



Hydrozoa



Hydrocorals

Starfish



Institute of Zoology

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Sustainable Fisheries Greenland



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Bi-annual reporting of survey results

Generation of shipboard and lab identification guides

ZSL Institute of Zoology

Cruise report: Camera Survey

MT Paamiut SFW RejeFisk Survey Tugt 1
June 11-20, 2011. Nuuk - Qaanaaq



Report compiled by
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For
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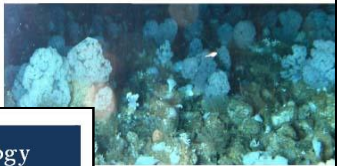
ZSL Institute of Zoology

Final Report:

Diversity and ecosystem function indices of the
macrofauna of the continental shelf (2011-2012)

Final Report:

Camera survey - MT Paamiut SFW RejeFisk Survey Tugt 1
June 11-20, 2011. Nuuk - Aasiaat



ZSL Institute of Zoology

Final Report:

MT Paamiut SFW RejeFisk Survey Tugt 4
July 19-30, 2012. Nuuk - Qaanaaq

ZSL participants: Dr Kirsty Kemp, Dr Chris Yesson

Summary of work

The benthic survey undertaken on Tugt 4 of the Paamiut RejeFisk survey was successful. More than 400 photos of the seafloor from 40 stations covering the continental shelf (Figure 1) were collected in 10 days. Only 2 days were lost to weather. Both camera and grab sampling was undertaken (Figure 2).

The benthic camera was again loaned to ZSL by Dr Martin Blicher and Rysgaard of GCCR and worked very reliably.

Nanette Hammeken and GINR provided shrimp trawl fishing data from 1979 to 2011 for the survey region. As halibut and shrimp are outside of the current target sampling depths and regions they were not included in this stage. From this data 8 sites which have been used for trawling, 13 sites which have been used for fishing activity historically and presently, and 11 sites which may be considered as recovery sites (fished historically but not recently) were targeted for survey.

Grab sampling was undertaken at 21 stations and resulted in the successful collection of a wide range of benthic samples (Figure 3). The fauna collected shows at first glance a difference to that of the 2011 survey and will be extremely useful for the identification of animals in images.

ZSL sourced funds (£5000) to purchase and transport a Q&A Grab for use on this expedition.

ZSL also sourced funds for travel and accommodation (£1900) and salary (3 weeks) for Dr Chris Yesson to join Dr Kirsty Kemp on the expedition. Dr Chris Yesson will be working on habitat suitability modeling and genetics.

Additional work

A student will begin work with Kirsty Kemp on September 1st to identify and describe the fauna collected in the grabs, and to match/associate these animals with their corresponding seafloor images (validating and ground-truthing the images).

In the days prior to the cruise, Dr Chris Yesson visited GINR and assessed the collection of by-catch on previous surveys. He provided identifications of some sub-samples of the corals to enhance the data set for genetic analysis. Dr Yesson collected 162 samples for genetic analysis.

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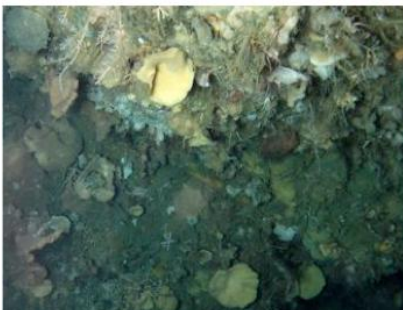
(Draft) Final Report:

Poppy Simon

Supervisor: Dr. Kirsty Kemp

BIOLM005 MSci Research Project in Biological Sciences

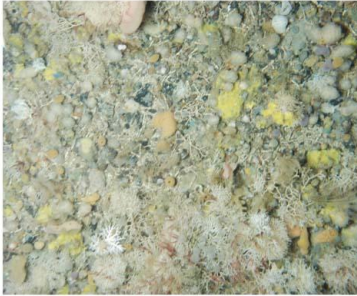
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Benthic Macrofauna of West Greenland

Guide to Identification



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Summary from 3 approaches

- Benthic habitats in Greenland are diverse
- Rocky habitats have seen lower fishing impact and seem less disturbed
- Muddy habitats may be negatively impacted by fishing
- 3 more years of surveys will give us more robust data
- A historical perspective will be useful
- Observations are feeding back into monitoring and marine spatial planning

