November 2013

1st Annual Report

Institute of Zoology Greenland Benthic Assessment

June 2012 – May 2013

Report compiled by
K. Kemp & C. Yesson
Institute of Zoology, Zoological Society of London, Regent's Park, London, NW1 4RY, United Kingdom

For
Sustainable Fisheries Greenland
c/o Grønlands Arbejdsgiverforening, Jens Kreutzmannip Aqq. 3, P.O. Boks 73, 3900 Nuuk, Greenland

Greenland Institute of Natural Resources
Kivioq 3, P.O. Boks 570, 3900 Nuuk, Greenland

Greenland Climate Research Centre
Kivioq 3, P.O. Boks 570, 3900 Nuuk, Greenland

Contents

1. Executive summary

2. Field survey summer 2012

3. MSc project

4. Computer science to assist image processing

5. Utilising bycatch

6. Preparation for 2013 survey

7. Additional Funds

8. Conclusion

References

Appendix – Thesis: The effects of shrimp trawling on the macrobenthic fauna of West Greenland

1. Executive summary

- **Fieldwork** was conducted aboard M/T Paamuit in July 2012. This work consisted of camera surveys gathering 480 benthic images for 48 sites. Additionally, a grab sampler was used to collect specimens and sediment for 21 sites, of which 12 produced workable samples.
- An **MSc student performed her thesis project** examining the images from the 2012 survey. This project identified and documented the benthic habitats and fauna in the images from the 2012 survey, and performed a provisional analysis of taxonomic diversity in relation to fishing effort. This showed a weak negative effect of fishing impact for some habitats, but further analysis is required using more data to provide a robust analysis.
- A collaboration was continued with the **computer science** department at University College London. Software has been developed to assist in the process of identifying taxa in the benthic images. This software has resulted in a significant improvement in the speed and reliability of specimen identification
- **Coral bycatch**, collected by GINR were examined and subsampled for genetic analysis. A trial of specimen storage, extraction and genotyping was performed to test the utility of long-term frozen specimens for molecular investigation. Trials indicate these specimens are suitable for genetic analysis and some markers may show sufficient variation to examine the genetic make-up of benthic populations.

2. Field survey summer 2012

Field work was conducted aboard the M/T Paamuit from 19-30th July 2012, on Leg 4 of the annual Paamiut Rejefisk survey. This cruise operated between Nuuk and Qaqortoq. Dr Kirsty Kemp from Institute of Zoology (IoZ) and Dr Chris Yesson (IoZ) were aboard to collect benthic images along the West Greenland Shelf. The imaging survey followed the protocol outlined in a pilot study conducted the previous year (Kemp, 2011). A total of 48 stations were sampled resulting in 480 images covering 700km of continental shelf (Figure 1). Sites were located between 60°N and 64°N, and between 109 and 350m depth.

A grab sample survey was employed to collect specimens and sediment from selected locations. A total of 21 sites were sampled at depths between 121 and 530m. For some sites the grab failed to retrieve a sample, probably in areas of hard substrata. A total of 12 stations

produced significant samples (Figure 2). Additionally, coral bycatch was collected from the trawling survey. Specimens were documented, photographed and sub-sampled for future analysis. Taxonomic examination of these samples will aid in the validation of identifications made from images.

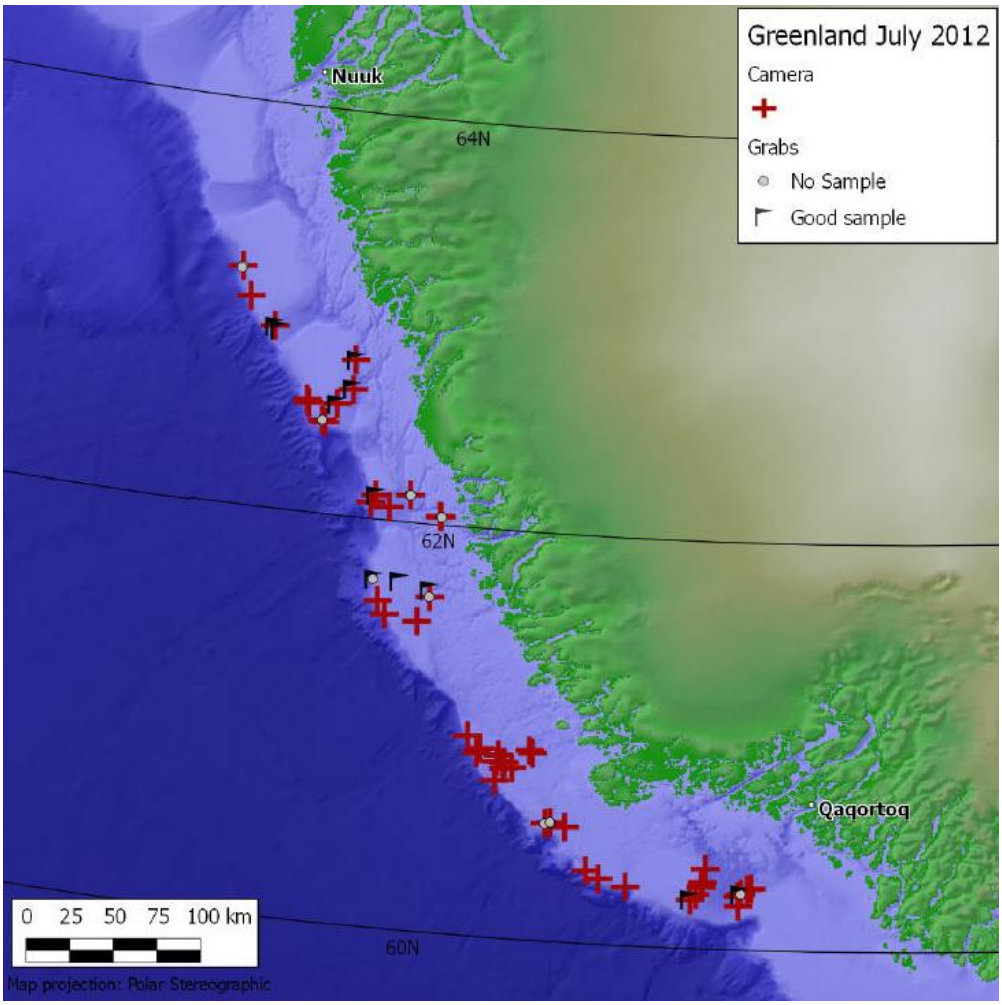

Figure 1. Camera and grab sampling locations for the 2012 survey.

Figure 2.Grab sampler in action and example specimens

3. MSc project

An MSc student was recruited to undertake processing and analysis of imagery collected in 2012 and identification and cataloguing of the faunal samples collected in the grabs. Poppy Simon, *funded by University College London (UCL)*, performed her MSc project on this topic, under the supervision of Dr Kirsty Kemp, as part of the MSci Research Project in Biological Sciences. The resulting thesis entitled ñThe effects of shrimp trawling on the macrobenthic fauna of West Greenlandòis presented as an appendix to this document, but we will provide a short summary herein.

Images collected on the 2012 field season were examined, and the fauna were identified predominantly to class level, although the quality of identification possible varies by taxonomic group. A wide variety of fauna were identified, and examples of these are shown in Figure 3. Provisional analyses of these data were performed. Diversity metric, such as number of organisms and the Shannon Index were calculated for each station and these were compared with fishing impact in the area.

GINR provided shrimp trawl fishing data (1975 to 2011) for the survey region. These data were used to create a map of fishing activity and intensity and this was used to identify sites

for camera surveying. Camera stations included: 13 sites which have been unfished, 22 sites which have had high fishing activity historically and presently, and 13 sites which may be considered potential recovery sites (fished historically but not recently). Fishing impact was measured by cumulating trawling effort derived from start and end locations of shrimp trawls between 1986 and 2010.

Analysis showed a mixed picture for the relationship between total trawling effort and diversity. A negative effect of increased trawling effort on diversity for mixed mud habitats was observed, but no effect was found for habitats on other substrata (mud, pebble and rubble). Additionally a negative correlation was observed between fishing effort and the number of Stylasterid corals (a hydrocoral classed as a vulnerable marine organism).

These represent provisional analysis based on one year of data. The low number of samples reduces the statistical power of such analyses and a clearer picture will emerge when sampling is continued. Furthermore, these analyses only focus on one explanatory factor (fishing impact) to explain patterns of diversity, but at this stage we cannot rule out other factors (such as environmental conditions) being the primary cause of the observed variation in diversity.

This project demonstrates the wide variety of organisms observed on the seabed, and provides a solid foundation for future work.

Figure 3. Selection of organisms observed in the 2012 benthic images.

4. Computer science to assist image processing

The collaboration with University College London (UCL) was continued to examine ways in which computer science can assist in the processing of images. Dr Grigorios Skolidis, an expert in computer learning, was recruited in November 2012 to work specifically on developing techniques for the automation of image analysis to generate ecologically useful

data. Dr Skolidis worked at the computer science department at UCL under the supervision of Dr Kirsty Kemp (IoZ) and Professor Mark Girolami (UCL).

This work has focussed on facilitating the processing of benthic images by generating a tool to assist labelling and identification of taxa within images by biological researchers. The software being developed offers a user-friendly, web-browser-based interface to enable users to manually label species of marine life across a set of seabed images. As shown in Figure 4, organisms recognised by the user in the image can be highlighted and annotated directly through the interface. Each annotation is automatically stored in a database for biodiversity evaluation, which also allows for subsequent editing or refinement at a later date. To enable large-scale labelling of the same set of images, including crowd-sourcing initiatives, multiple users can log-in through their own accounts. This also allows for transfer of knowledge between different users: expertly-labelled data may be used to teach non-expert users about the appearance of each species, and a confidence measure may be imposed for each label based on the user's track record and experience.

We have found that this software significantly reduces the time taken to isolate and identify specimens seen in the images and produces a database of identifications for each image that is ready for analysis

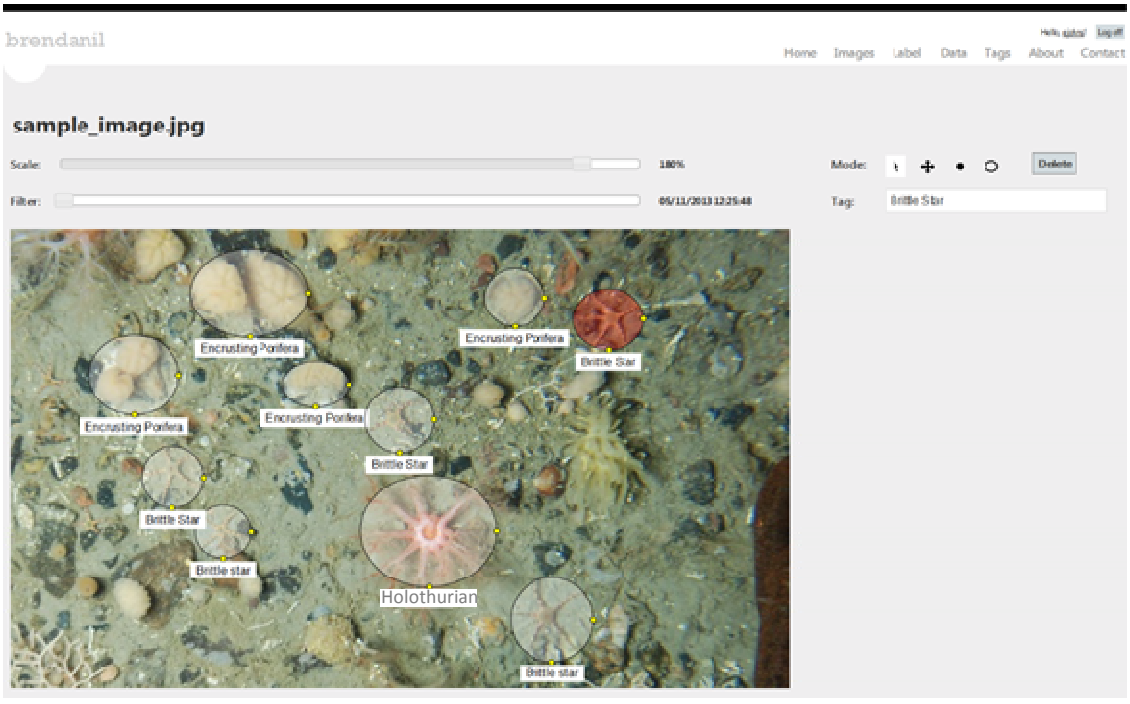

Figure 4. The new all-inclusive tool in operation allowing for intuitive labelling and annotation.

5. Utilising bycatch

The Greenland Institute of Natural Resources (GINR) have been collecting bycatch of corals and sponges from the annual stock assessment surveys since 2009. These specimens are provisionally identified aboard the ship and then documented and stored in refrigeration units at GINR in Nuuk. During the 2012 field season, these specimens were examined by Dr Kirsty Kemp and Dr Chris Yesson, and photographs and sub-samples were taken for further investigation. These samples represent a valuable resource for documenting and describing the benthic fauna of the West Greenland shelf. They provide direct evidence of large, vulnerable organisms such as corals and sponges. However, the provisional identifications for some specimens are inexact whilst others are incorrect. Provisional identifications were revised, but a more detailed analysis of features is required to provide robust species-level identifications.

These bycatch specimens have been subjected to cycles of freezing and thawing, which can potentially degrade and fragment DNA. Test DNA extractions were performed to examine the utility of these specimens for genetic analysis. These tests showed that the majority of samples could be used for molecular studies, and trials with selected genetic markers revealed extractions of sufficient quality to sequence regions of more than 700 base pairs. The sequence region used for DNA barcoding of corals (MutS, McFadden et al. 2011) was successfully sequenced for 23 test samples, and demonstrated promising levels of variation for a comprehensive analysis.In collaboration with Dr Nannette Hammeken and other members of GINR, a new sampling strategy has been put in place to collect sub-samples of coral and sponge bycatch during the annual stock assessment trawls. Sub-samples of corals and sponges will be stored in ethanol (or other DNA preserving liquids) alongside the main specimens which will continue to be frozen and housed in GINR.

6. Preparation for 2013 survey

In preparation for the 2013 field survey money that was dedicated in the original budget to pay for shiptime was reallocated towards the purchase of a camera system from Marine Systems Technology, USA. This purchase enabled freedom from any constraints which might arise from the need by GINR/GCCR to use their own camera. It also theoretically enables the simultaneous deployment of a vertical and horizontal camera, when the GCCR camera is available, which could potentially greatly increase the usefulness of the image-based data. A frame for this camera was requested and built in Nuuk by Nanoq Smeden.

7. Additional Funds

The majority of the work outlined above was directly funded by this project, but a significant minority contribution was made from other sources, which are detailed here. IoZ sourced funds (£4000) to purchase and transport a DayGrab for physical sampling. IoZ sourced funds for travel and accommodation (£1900) and salary (3 weeks, £1500) for Chris Yesson, an expert on habitat suitability modeling and phylogenetics, to join Kirsty Kemp on the survey. Further funds were sourced by IoZ to support the genetic laboratory work undertaken by Irina Chemshirova (£1000), to pay for transport and insurance of the deepwater camera system (£1420) and to purchase computer equipment (£1098). £13,000 were sourced from external funds to support salary costs on the project. This external financial contribution towards the running of this project totals £23,918.

8. Conclusion

This year saw a successful field season, that significantly enhanced our sampling. These images document a wide variety of fauna in the area, and provide the foundation for a comprehensive analysis of benthic habitats. The provisional analysis showed a mixed picture in terms of the impact of shrimp trawling and demonstrate the need for further sampling. The collaboration with computer scientists has produced a useful tool for improving the accuracy and efficiency of making identifications from seabed images. The bycatch housed at GINR is a valuable resource which could be used to enhance our knowledge of species distributions and perform analyses to document patterns of genetic diversity in the region.

References

Kemp, K. (2011) Diversity and ecosystem function indices of the macrobenthic community, West Greenland shelf (200-600m), in response to varied impact. Report to Sustainable Fisheries Greenland.

McFadden, C. S., Benayahu, Y., Pante, E., Thoma, J. N., Nevarez, P. A. & France, S. C. (2011) Limitations of mitochondrial gene barcoding in Octocorallia. Molecular Ecology Resources 11: 19ï 31.

Simon, P. (2013) The effects of shrimp trawling on the macrobenthic fauna of West Greenland. MSci Research Project in Biological Sciences, Imperial College, University of London. Supervised by Dr Kirsty Kemp. - Attached as an appendix to this document.