CORAMM
Coral Risk Assessment, Monitoring and Modelling

THE CORAMM (CORAL RISK ASSESSMENT, MONITORING AND MODELLING) PROJECT

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INTRODUCTION

The CORAMM project is aimed at improving the understanding of the impacts of high suspended sediment loads and drill cuttings on cold water coral communities. The project is multidisciplinary in approach, with sedimentologists, biologists, modellers and representatives from Statoilhydro all involved in furthering the current understanding of these ecosystems. The project has four workpackages. WP1 concentrates on the development of novel video and image analysis tools to enable a better and faster evaluation of coral community structure and varying health status. WP2 assembles and further develops sensor systems for environmental monitoring with special emphasis on particle dynamics. These systems can be used as autonomous stand-alone units or can be linked to the internet. WP3 carries out specific experiments with live coral colonies to better understand and predict the effect of different particle size and microbial composition. WP4 will build advanced ecosystem models for cold water corals and use a physiological-based approach to predict the effect of different sediment loads on the performance of coldwater corals. This poster presents the first insights of the first 18 months of research.

Video Mosaicing

Jacobs University Bremen, Goteborg University and the University of New Hampshire have been collaborating on developing novel computer mosaicing applications to produce composite images of reef structure. The aim of producing these images is to allow spatial information regarding coral distribution and condition to be more readily assessed than is possible from a set of individual images or video data directly. The CORAMM workgroup, in collaboration with Yuri Rzhanov of the University of New Hampshire have collected a range of video and still image material from Norwegian *Lophelia pertusa* reefs. Additionally video material has been provided by StatoilHydro for this mosaicing work. At the Sven Loven Centre for Marine Science (Goteborg University) modifications to a SPERRE 600 ROV (Fig. 5) have allowed the collection of very high quality, well positioned video footage from the Tisler reef to be collected, and these data will be a focus of forthcoming work. An example mosaic is given here (Fig. 6).

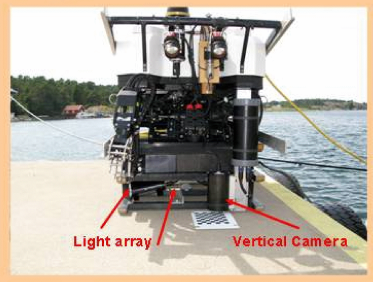


Fig 5) ROV used in collection of video data from Tisler reef for mosaicing.

Fig 6) Mosaic image produced by Jacobs University, Goteborg University and Yuri Rzhanov from the University of New Hampshire. The image shows the variation in *Lophelia pertusa* density across ~10m of the Tisler reef, Norway. The raw video footage was collected by the ROV above.

Workpackage 1

Workpackage 1 aims to develop innovative video and image analysis techniques to improve assessments of coral community structure and reef health. Work thus far has focused on two main topics:

1) Developing methodologies to mosaic video and still images from coral reefs (collected by ROVs, submersibles and videosleds) and import these mosaics into GIS maps.

2) Developing automated classification methods to assess coral reef health and distribution from still images (incl. still images extracted from a video stream).

Automated classification of coral reef health and distribution

The Alfred Wegner Institute for Polar and Marine Research and Bielefeld University have led work on developing computer algorithms that can 'learn' to recognise particular corals, substrates or other organisms from still images extracted from a video stream. In summary, the system works by relying on experts to identify areas of a set of images covered by a particular organism or representing a type of substrate. Given a sufficiently high number of expert identified features, the computer system, can 'learn' how a particular feature or substrate can be differentiated from the remainder of the image. Once the system has been taught, a larger dataset of images can be fed to the system and an automated analysis of areas of each image covered by features it has 'learnt' can be made. See Figures 1-4. This method is the focus of presentation **7.07** on Thursday.

Automated processing stages

Fig 1) Experts identify features (coral, sponges etc) on selection of images.

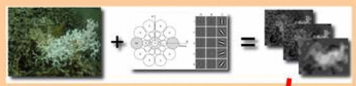


Fig 2) Computer system 'learns' from expert labels to identify image data with various features.

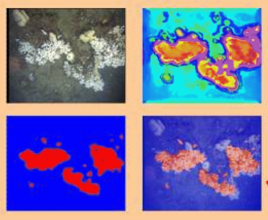


Fig 3) 'Trained' computer system examines other images in dataset and assigns identification names to features.

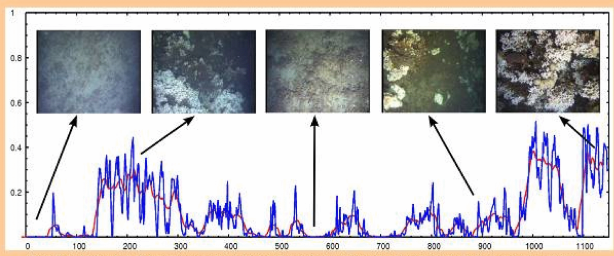


Fig 4) Graphs can be produced showing percentage of images by various features (e.g. corals, or sponges etc). Images extracted from video transects can provide graphs of spatial variation in coverage, as shown here for *Lophelia pertusa*).

Workpackage 2

Workpackage 2 has focused on testing, assessing and developing a number of sensor types for utilisation in the *Lophelia pertusa* reef environment. Work has been carried out predominantly at the Tisler reef, Norway (Fig. 7) with additional work being also conducted at a selection of locations along the Norwegian margin.

At the Tisler reef Lander systems (Fig. 9) have been deployed to collect time-series data on flow conditions, particle size, concentration and composition, temperature, salinity, turbidity and chlorophyll concentration in the water column within the reef structure and in the surrounding waters (Fig. 8). A selection of different flow meters, sediment traps and lander designs have been used, with the aim of allowing recommendations to be made to government / industry as to the most useful designs and configurations for their requirements. In addition to the lander deployments, field campaigns with small vessels have been run throughout the spring / summer months to gain temperature, salinity, chlorophyll and oxygen concentration profiles through the water column above and around the reef. Additionally, water samples have been collected from the water column for nutrient analysis.

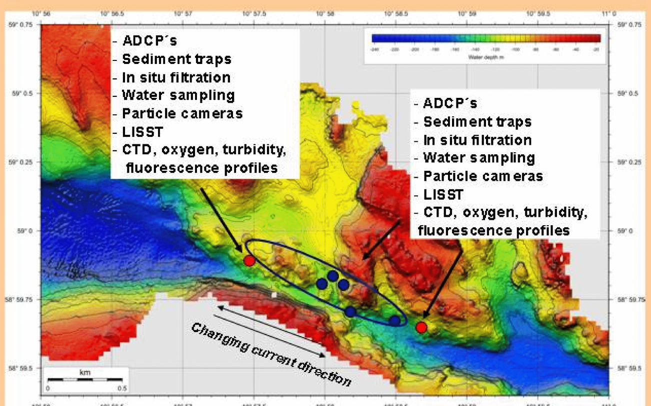
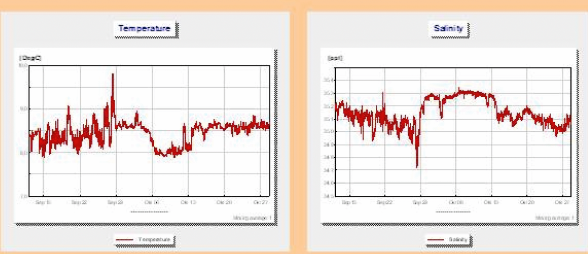


Fig 7) Map of the Tisler reef area and details of some monitoring deployments. The reef has been damaged by fishing activity in the past and has been protecte by a trawl exclusion zone for 4 years. (Discussed in talk **8.16** on Friday).



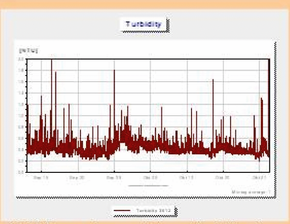


Fig 8) Temperature, salinity and turbidity of bottom waters at the Tisler reef over 6 weeks in Autumn 2008.

Fig 9) Custom built long-term deployment Lander frame with integrated sediment trap. For deployment by small vessels equipped with ROV for recovery and accurate positioning.

Workpackage 3

This workpackage concentrates on developing and running experiments in the laboratory to better understand the functioning of the coral *Lophelia pertusa*. Particular focus is on how particles within the water column may interact with *Lophelia pertusa*. All experimental work thus far has been carried out at the Sven Loven Centre of Marine Research, Goteborg University, in Sweden. The work is co-ordinated and led by Goteborg University with researchers from The Max Planck Institute of Marine Microbiology (Bremen) and Jacobs University Bremen also taking part. In all cases *L. pertusa* polyps collected from the Tisler reef, Norway have been maintained in temperature-controlled laboratories equipped with flowthrough seawater piped from the adjacent Kosterfjord from 40m depth.

Over the first 18 months of the CORAMM project we investigated how bacteria associated with marine particles may influence coral health, or potentially attack coral tissue following coverage by particulate material (locally derived sediments and rock chippings from drilling operations by the petrochemical industry investigated). Initial results indicate bacterial attack has a low impact on *L. pertusa*, even when the coral branches are covered by a large amount of material. The same study also measured oxygen concentration profiles through the covering sediments over time, to check for the development of anoxic conditions (Fig. 12).

Recently, we assessed how the activity of *L. pertusa* polyps changes following exposure to doses of particulate matter of various size classes and composition. Our data suggest that exposure to a single dose of material (even at moderate concentration) causes a change in polyp behaviour for several days (Fig.11). Follow-up work to monitor polyp behaviour during periods of constant exposure to particles is in progress.

Fig 10) 3 assessments of polyp activity. A) Extended polyps B) Visible polyps C) Retracted polyps.

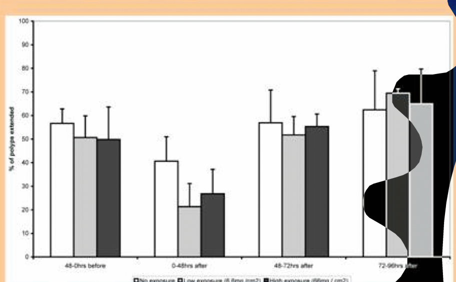


Fig 11) Percentage of coral polyps 'extended', prior to and after exposure to a dose of local sediment (simulating exposure following re-suspension by nearby trawling).

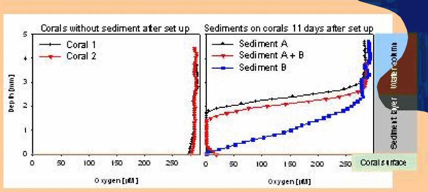


Fig 12) Graph showing oxygen concentrations in the boundary waters around coral fragments in laboratory aquaria under low flow conditions. Additionally shown is oxygen concentration within sediments deposited on corals in the laboratory after 11 days coverage. Anoxic conditions develop within the sediment.

Furthermore, there is a great amount of work ongoing in WP 3: in experiments we assess *L. pertusa* respiration rates during starvation or exposure to particles of various composition. Also, we monitor its growth rates in environments containing various concentrations and types of particulate matter. Additionally, we are studying coral feeding rates and feeding techniques under various environmental condition.

Workpackage 4

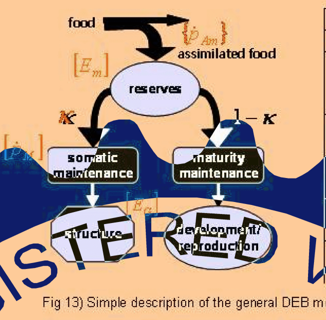
In this workpackage CORAMM aims to adapt the Dynamic Energy Budget (DEB) model (Koojiman, 2000) for *L. pertusa*, with the goal to improve our understanding of how *L. pertusa* reef ecosystem performance is affected by changes in key parameters (Fig. 13).

Stages in development of a model for cold-water corals:

1. Model for healthy corals needed, but basic ecological knowledge is not currently available available.
2. Estimation of parameters from dedicated experiments for a model of healthy corals.
3. Model and add effects of sediment stress to the model for healthy corals.

Researchers from the Centre for Marine and Estuarine Ecology (NIOO) lead this workpackage, but the interconnected nature of the CORAMM project allows input from the other workpackages to feed directly into their work. Model development stage 1 receives direct input from WP 2, whereas WP 3 inputs into development stages 2 and 3 (Fig. 14).

Modellers from this group interact regularly with the experimental workers who aim to produce data in a format readily accessible for their model development.



Primary parameter	
Symbol	Description
$\{\dot{p}_{Am}\}$	surface-specific maximum assimilation of energy
$[E_G]$	volume-specific costs of growth
$[E_m]$	maximum reserve density
$[\dot{p}_M]$	volume-specific maintenance rate
κ	partitioning parameter

Fig 13) Simple description of the general DEB model and parameters.

Fig 14) Data on respiration change in *L.pertusa* over 28 weeks of starvation. This data feeds directly into the development of the DEB model for *L.pertusa*.

Acknowledgements

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References

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