Cruise report outline

**Cruise name**

B6-2009

**Research Vessel**

Bjarni Sæmundsson

**Cruise dates**

11-26th of June 2009

**Location(s)**

Five areas in the southeastern Icelandic shelf were explored (Fig. 1):

1) Parallel ridges in the Lónsdjúp trough
2) Shelf slope on the Lónsdjúp trough
3) Shelf slope in the Papagrunn region
4) Skeiðarárdjúp trough.
5) Rosegarden area region.

**Chief Scientist**

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**Scientific personnel**

Steinunn Hilma Ólafsdóttir (project leader of the Coral Mapping project)
Julian Burgos (researcher with the CoralFISH project, in charge of acoustics)
Haraldur Einarsson (fishing gear specialist)
Páll Arnar Þorsteinsson (technician and ROV pilot)
John Sales (chief ROV pilot, hired from UKPS offshore).

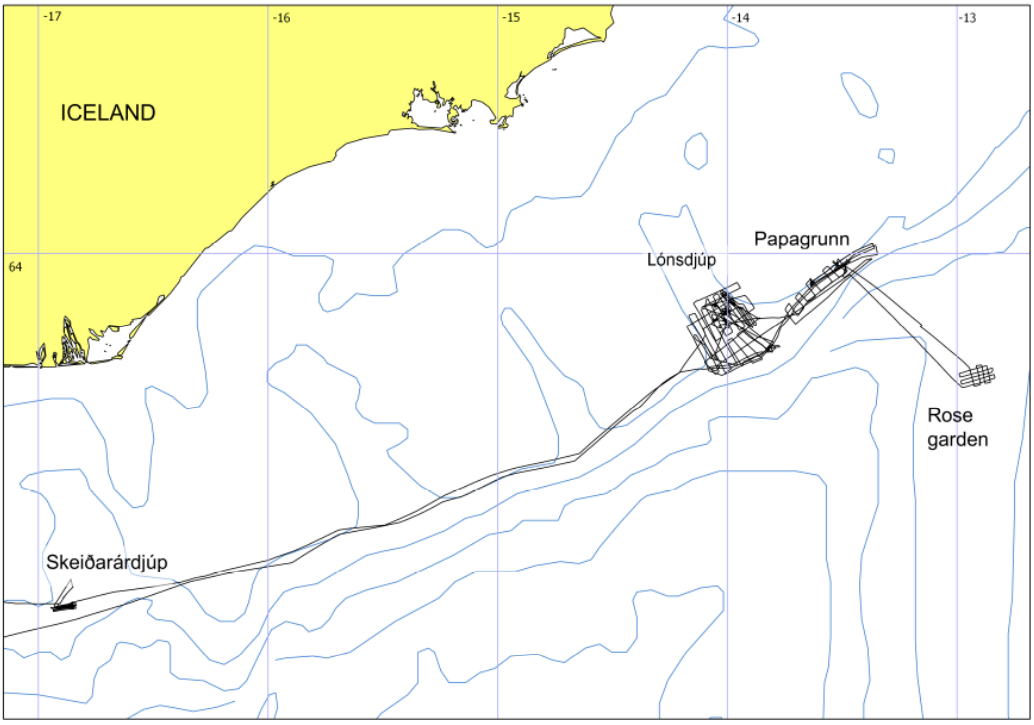


Figure 1. The track of the RV Bjarni Sæmundsson and locations of the study sites: Skeiðarárdjúp trough, parallel ridges and shelf slope in the Lónsdjúp trough, the shelf slope in the Papagrunn region, and the Rosegarden area.

# Cruise background & objectives

The cruise was funded by the coralMAP and CoralFISH projects. The coralMAP project aims to identify, delineate and describe new coral grounds and characterize their accompanying fauna, with the purpose of delineating areas for protection. In addition to these, the specific objectives of the CoralFISH project for this cruise were to explore the interaction between fish and cold-water coral habitats, following identification of suitable study sites.

# Pre-cruise planning

Various sources of information were examined to identify potential coral grounds:

### High resolution bathymetry maps

High resolution bathymetry maps were produced from multibeam sonar data by the bottom mapping program of the Icelandic Marine Research Institute. At some locations, the resolution of the multibeam data was sufficiently high to identify individual coral mounds. In most cases, the judgement of the general landscape settings was useful to delimit likely coral areas based on variety of topographical features such as ridges, canyon walls and shelf break areas.

### Information from fishermen

Interviews carried out with fishermen provided useful information on the distribution and state of corals in the study areas. We learned that several areas were avoided by fishermen to avoid fishing gear damage due to bottom topography (e.g. too steep slopes) or rough seabed (e.g. lava and coral grounds). In the case of Lónsdjúp case study area, fishermen deemed it “untrawlable” due to the “rough” ridges and corals. Fishermen also informed us that some areas we considered undisturbed had already been damaged by trawling. It became clear during our ROV surveys that most of this information was quite reliable.

**Analysis of fishing effort data**

Log-book data was analysed in order to evaluate the fishing effort at the candidate coral locations. Occurrence of patches of low or no fishing effort surrounded by higher fishing effort, suggests that fishermen avoid these areas for the reasons described above.

# Sampling equipment and methods

Video footage and photographs on and off coral grounds were obtained using a Remote Operated Vehicle (ROV). Echosounder data were used to identify potential coral grounds and to obtain indices of fish abundance. Bottom samples were collected with a triangular dredge. Temperature and salinity measurements were obtained with a CTD.

**Remote Operated vehicle**

The ROV utilized is an Apache from Sub Atlantic (Fig. 2), tethered by a 600 m umbilical cable. One dive to 700m depth was achieved by utilizing a heavier 1500m ROTV umbilical cable. The position of the ROV in relation to the ship was obtained using a portable hydroacoustic positioning reference system (Kongsberg HPR 410P). The transducer was attached to a 10.5m metal pole placed along the portside of the vessel, well below the keel of the vessel. The ROV was equipped with an MST 319 transponder. The positional data was transferred to the software Olex which contained the multibeam bathymetry data. This system allowed us to track the position of the ROV relative to the seabed landscape in real-time.

Figure 2. Remoted operated vehicle using in the survey.

The ROV was fitted with a 5 megapixel digital still camera (Kongsberg OE14-208) and a colour video camera (Kongsberg OE14-366). Light was provided by an underwater Flashgun (Kongsberg OE11-242). The ROV also was equipped with a forward-looking sonar (Tritech SeaKing DST). The sonar was used to detect changes in the seabed topography in the path of the ROV and to identify abrupt features rising above the seabed (e.g. ghostnets, large rocks or coral mounds).

**Methodology during ROV surveys**
Due to its small size, the ROV can only be used under calm seas with relatively weak currents. Conditions were appropriate during most of the survey. During ROV operations, the position of the ship was maintained using the rear anchor. The front anchor was also used in locations where bottom depth was less than 300m, to provide added positional stability. No dives were carried out during times of rapid changes in current direction, to reduce the risk of damage to the equipment.

During ROV dives, the following task were performed by the scientific crew: 1) taking notes on field sheet (e.g. on bottom type, habitat features, characterising species of invertebrates and fish) 2) monitoring that the hydroacoustic positioning device did not loose contact with the ROV, 3) monitoring the forward looking sonar 4) taking photos using the digital still camera and 5) updating the knowledge base of the VARS (Video Annotation Reference System) software.

**Acoustic survey**
Study areas were surveyed using an EK60 echosounder operating at 12, 38 and 120 kHz (see Appendix 2 for more information). We explored the use of acoustic methods to discriminate coral habitats from other seabed features or types. Following the methodology described by Fosså et al. (2005[1]) we were able to identify possible coral locations to be explored during ROV dives. Considerable effort was placed on the validation of this method by running multiple transects above areas surveyed by the ROV.

**Triangular dredge**
Nine samples were collected with a triangular dredge (Fig. 3) to provide general information on the fauna at these locations and to facilitate identification of animals from the video footage and the underwater photographs. Live coral and other conspicuous animals were removed from the triangle catch and fixed in formaldehyde for later processing. Sessile animals were removed from rocks. Samples of live specimens of *Lophelia pertusa* and *Primnoa resedaeformis* were collected for genetic analyses.

Figure 3. A large sample caught with the triangular dredge.

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[1] Fosså J.H., Lindberg B., Christensen O., Lundälv T., Svellingen I., Mortensen P.B., and Alsvvåg J. Mapping of *Lophelia* reefs in Norway: experiences and survey methods. *In* Freiwald A. and Roberts JM (eds). 2005. Cold-water corals and ecosystems. Springer-Verlag. Berlin, pp.359-391

### Hydrography

Vertical temperature and salinity profiles were obtained with a CTD (Seacat SBE 19 *plus* V2) at six locations.

# Preliminary results

### Skeiðarárdjúp

Analysis of multibeam maps revealed a large number of well-defined mounds. Mound density was highest around on the slope edge and around canyons and troughs formed by iceberg scouring during the last ice age. Acoustic data collected before the ROV dives suggested that corals were present on these mounds. Corals were found on most mounds during the six successful dives carried out in this area. The height of the mounds ranged from few meters to 20 m. The state of the corals there varied, with live corals found in some locations, and only dead coral in other sites. We observed damage from fishing gear, including entangled nets on some reefs.

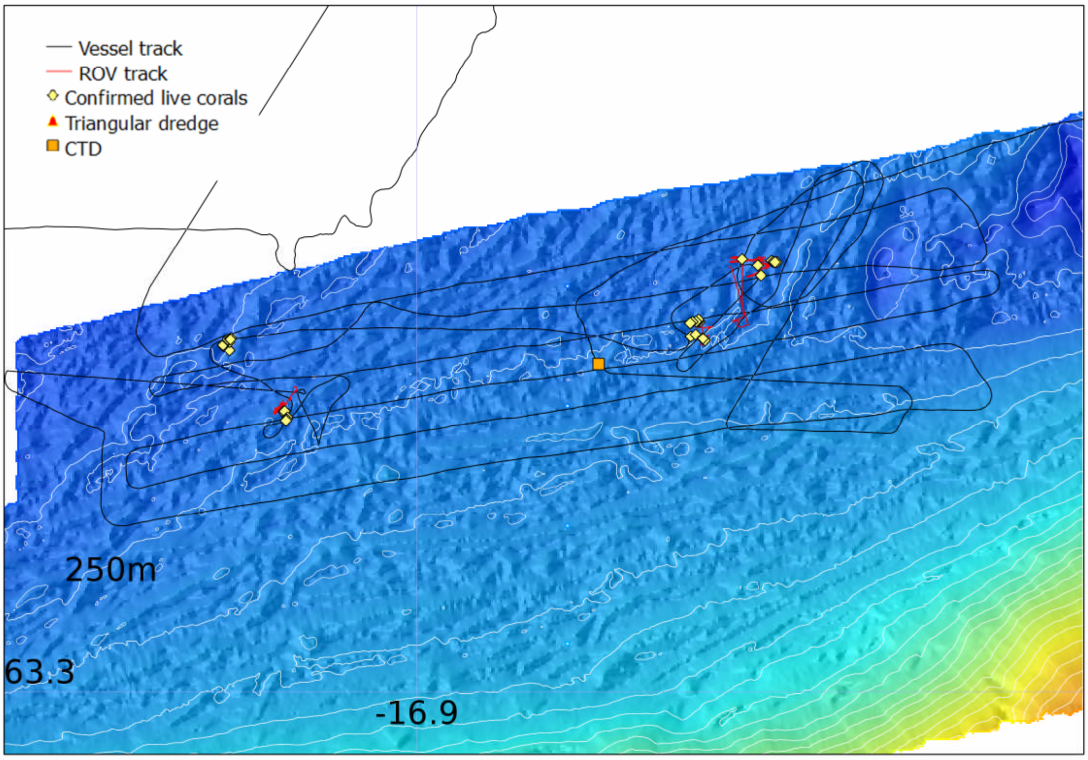


Figure 4. Skeiðarárdjúp area.

### Lónsdjúp ridges

A large proportion of the sampling effort was focused on the Lónsdjúp trough, in particular along the two parallel ridges that transvers the through. Several trawl skippers informed us that they do not fish within the perimeter of the ridges (an area of roughly 6 $nm^2$) to avoid trawl damage due to the rugged topography and the presence of corals. The analysis of log-books from the commerical fishery confirmed that there was very little trawling within this area, although some long-lining was carried out.

Echosounder data suggested that corals were mainly associated to the ridges. Subsequently, twelve ROV dives were carried out both on and off coral grounds. The video surveys revealed that the most dense coral grounds occurred in the center of the ridge area. In one of the dives we observed a clear reef formation along the ridge, but we are not able to measure the size of the reefs. Within the coral distribution area, there were differences in the species composition among locations. As an example, *Paragorgia arborea* was only found in one location. Other species exhibited a clearly patchy distribution. The density of *Primnoa resedaeformis* was high at several locations, in particular on dead corals. An interesting feature that requires further study was that corals were mainly found in the ridge slopes facing SE, possibly facing the dominant currrent direction. North of the coral area, there were predominately flat areas, characterised either by mud or sand. Dead coral was found in some locations. Small and scattered colonies of live *Lophelia* were found in the NE of the ridge area, growing on rocks scattered over rippled sand. One of the area identified as a potential coral ground based on the acoustic signal turned out to consist of aggregations of rocks and not corals. With respect to fish, preliminary findings based on the video material obtained during the cruise indicate that tusk and redfish were more numerous within the ridge area while gadoids were more abundant outside the coral grounds.

The Lónsdjúp ridges were selected as a case study area. An experimental longlining survey was carried out in this area in July 2010. Additional sampling will occur in 2010.

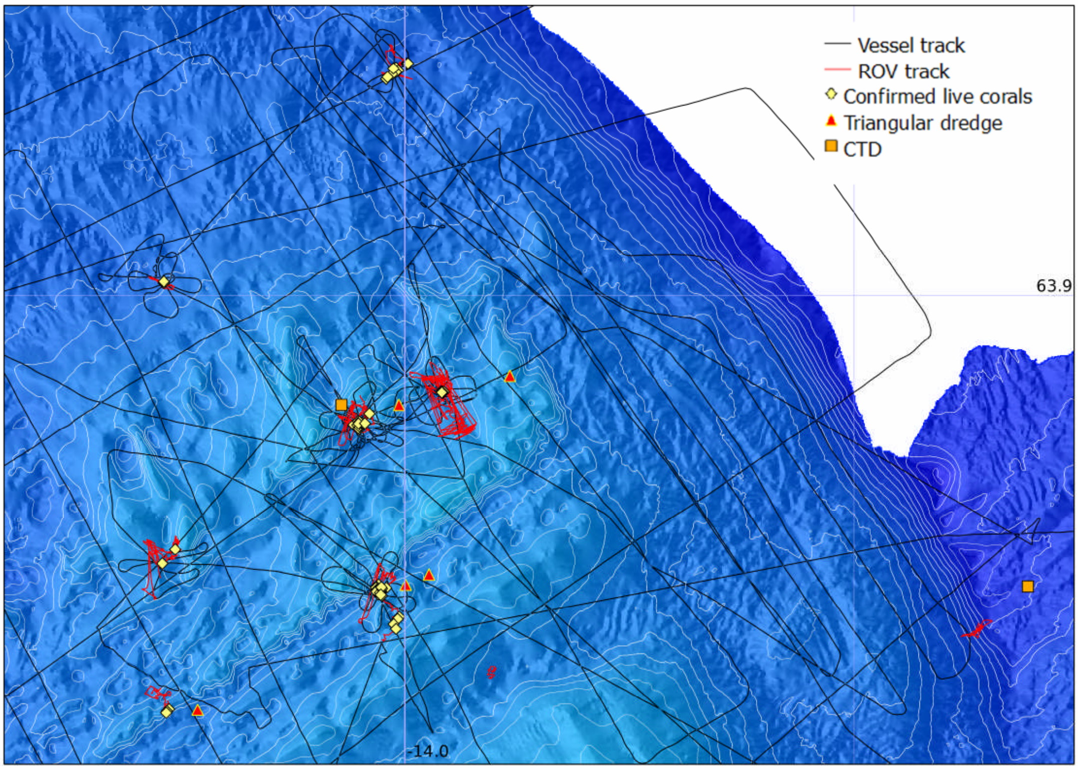


Figure 5. Lónsdjúp ridges.

**The Lónsdjúp slope**

South of Lónsdjúp, the continental slope goes from ~200 m to ~500 m depth. Here we found a continuous belt of large coral reefs extending 40-60 m in width along the shelf slope. While we could not measure the length of the reefs accurately, they seem to extend for at least a few hundreds metres along the slope edge. According to trawl skippers, only those that are familiar with the area fish in the slope, and then they trawl along well established corridors. It is likely that other extensive coral grounds are likely to be found along this slope.

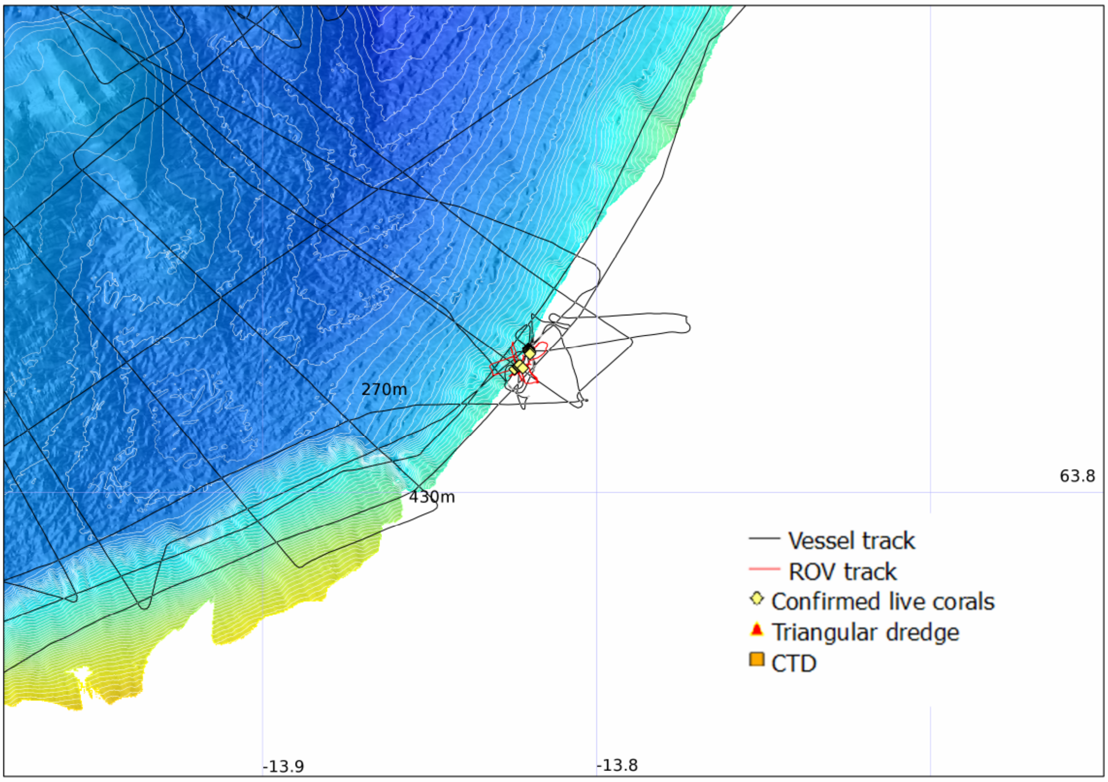

Figure 6.  Lónsdjúp slope.

**The Papagrunn slope**

Examinations of multibeam maps revealed numerous mounds at the bottom of the continental slope, down to 600-700 m depth.  In a benthic survey carried out in 2003, live coral was found at 690-730 m depth in this area.  ROV observations and triangular dredge samples revealed the occurrence of large rocks in the slope and down to 500 m depth.  No live corals were found, but some patches of dead coral were observed.  It was not possible to establish if live coral occurred in the area.  It is possible that the observed dead coral represented the periphery of live coral grounds.  The echosounder data did not suggested the presence of coral grounds at 400 – 500 m depth, but there were numerous signals indicative of coral grounds at 500 – 700 m.  Occurrence of live corals below 500 m depth was confirmed when live specimens were collected with a triangular dredge.  To enable ROV operations below 500 m depth, we replaced the ROV umbilical cable with an ROTV cable.  The ROTV cable is longer (1500 m) and heavier, and is certified for deeper waters  This setup, although reducing the manoeuvrability of the ROV, allowed us to survey areas down to 700 m depth.  At this depth, no corals were found, but instead we observed some impressive sponge grounds with associated fauna that appear to be highly diverse.  Fishermen informed us that they avoid trawling at 400 to 550 m depth range as they deem these unsuitable for trawling due to the roughness of the seabed and strong currents.

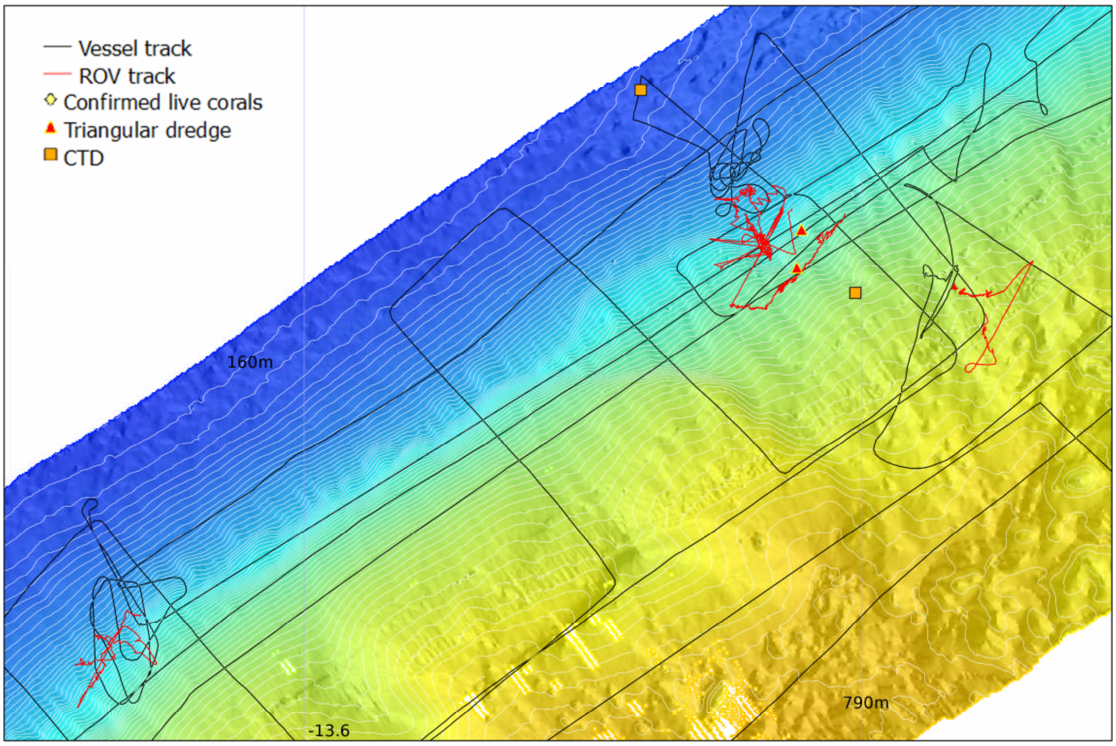


Figure 7. The Papagrunn slope. No live coral was observed during the ROV dives in this area.

**Rose garden**

The Rose garden (Rósagarðurinn) has often been considered as very rich coral ground. Corals are likely to be found on mounds located on the top of a large seamount in the southern part of the Rose garden. In this area we collected acoustic area, but did not deploy the ROV due to the large depth (600-700 m). In future surveys, we may adopt the methodology used in the Papagrunn to dive to deeper waters.

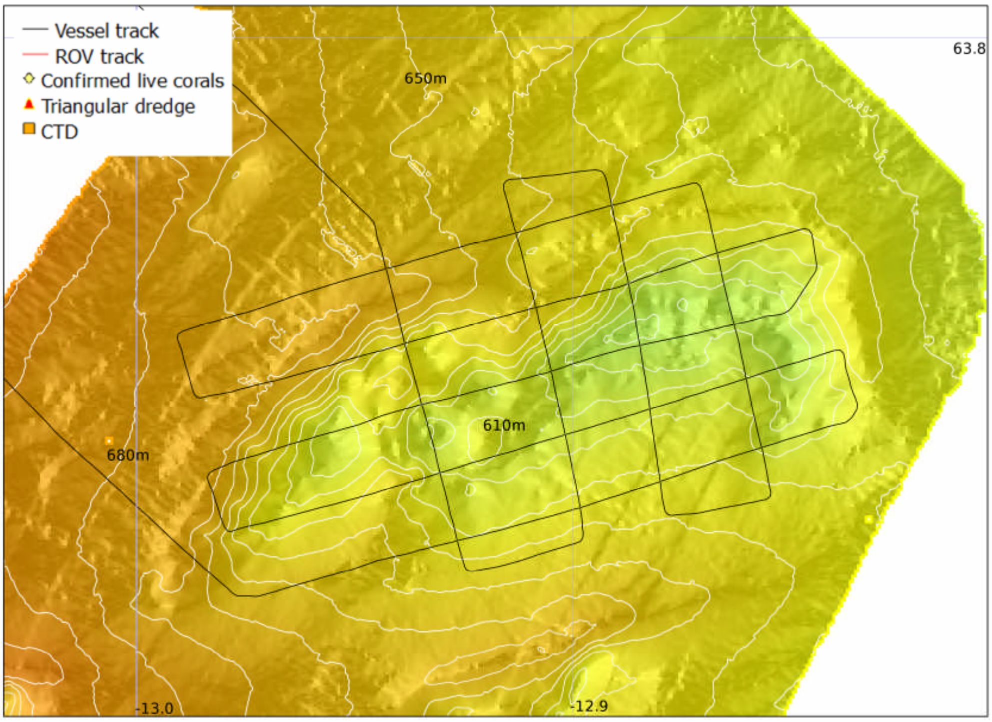


Figure 8. The Rose. Only acoustic data was collected in this area.

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Appendix 1.

## Daily log for the cruise B6-2009

| Date | Area | Depth (m) | Equipment | Dive no: | Coral condition/remarks |
|---|---|---|---|---|---|
| 13. June | V-Skeidarárdjúp | 230-250 | ROV | 1-4 | Dive 1 – no coral<br>Dive 2-4 – live LP/coral top |
| 14. June | V-Skeidarárdjúp | 240-250 | ROV<br>CTD | 5-7 | Dive 5-7 – live LP/coral top |
| 15. June | Lónsdjúp | 270-290 | ROV<br><br><br>CTD | 8-11 | Dive 8-9 – dead LP<br>Dive 10 – live LP<br>Dive 11 – live LP/ coral top |
| 16. June | Lónsdjúp | 280-290<br><br>287 | ROV<br><br>Triangle 365<br>Triangle 366 | 12-13 | Dive 12 – dead LP<br>Dive 13 – live LP/coral top<br>Coral rubble<br>Coral rubble, dead coral lumps |
| 17. June | Lónsdjúp | 180-220 | ROV | 14-15 | Dive 14 – live LP/scattered<br>Dive 15 – no coral |
| 18. June | Lónsdjúp | 280-295 | CTD | 16-17 | Dive 16 – no coral<br>Dive 17 – live LP/coral top & coral reef |
| 19. June | Lónsdjúp | 245 | | 18 | Dive 18 – small live LP, dead coral top |
| 19. June | Continental slope of Lónsdjúp | 440-490 | ROV | 19-20 | Dive 19 and 20 – live LP/large coral reef |
| 20. June | Papagrunn | 320-350 | ROV | 21-23 | Dive 21 – no coral<br>Dive 22 – un successful dive<br>Dive 23 – coral rubble |
| 21. June | Continental slope of Papagrunn<br><br><br>Lónsdjúp<br>Lónsdjúp | <br>530 m<br>500 m<br><br>284 m | CTD<br>ROV<br>Triangle 380<br><br>Triangle 382<br><br>CTD<br>CTD | <br>24 | 2 locations<br>Dive 24 – soft coral “garden”<br>Large boulders, rubbles, small fragments of live LP |
| 22. June | Lónsdjúp | 270<br><br>240<br><br>280 | Triangle383<br><br>Triangle 384<br><br>Triangle 385 | | Dead coral, small fragments of live LP<br>Mud sample, small fragments of live LP<br>Live LP lumps |
| 23. June | Continental slope of Papagrunn | 420-450 | Triangle 388<br><br>Triangle 389 | | Boulders, live LP fragments<br><br>Live LP fragments |
| 24. June | Beneath continental slope of Papagrunn<br><br>Lónsdjúp | 670<br><br><br>270-280 | ROV /<br>ROTV<br>umbilical | 25<br><br><br><br>26 | Dive 25 – dens population of sponges<br><br><br>Dive 26 – no coral |

Appendix 2

## Collection of acoustic data

During the cruise acoustic data was collected continuously using a Simrad EK60 echosounder operating at 18, 38 and 120 kHz. The system is calibrated regularly through the year and thus additional calibration procedures were not performed in this cruise. Calibration settings were kept constant during the cruise and are shown in Table 1. Bottom detection was verified visually and corrected whenever necessary. The data exported by the echosounder was saved as raw files and analyzed using the Echoview software.

Acoustic data was collected with four objectives:

a) To detect seabed features that could be identified as potential coral mounds and aid the selection of ROV dive sites.

b) To ground truth the bottom scattering properties with video observations obtained with the ROV.

c) To collect bottom scattering data (both first and second bottom) to be used for bottom classification analysis. The first bottom consists in the direct reflection from the seabed, while the second bottom is a double reflection between the seabed and the surface of the water.

d) To obtain a relative measure of fish abundance in the water column.

To accomplish these objectives, the survey consisted on a combination of three sampling designs.

a) "Loops" over diving sites. For bottom classification purposes, it is necessary to ground truth the acoustic data with ROV video footage. Attempts to dive directly down to a potential coral location (on the basis of the bottom scattering characteristics) proved often to be difficult. Due to strong currents and variable current direction, it was difficult to maintain the vessel on the same spot, and similarly to control the ROV. As an alternative, we decided to obtain acoustic data in the same location as the ROV observations were carried out. Given the small footprint of the ROV dive, we aimed to maximise the probability of sailing directly above the ROV diving sites by performing multiple passes approaching the dive sites from multiple angles. This method proved successful and in many cases we managed to sail directly over ROV diving sites.

b) Parallel transects oriented perpendicular to the main bathymetric features, to obtain information on bottom properties and fish distributions. Given the multiple objectives of the survey and the time constraints, no exploratory trawling could be carried out, and the species composition and size distribution of scatterers in the water column remains unidentified. Frequency differencing (38 vs 120 kHz) will allow separating fish from large zooplankton, at least at depths above 300m.

c) Transects following depth contours on the continental shelf slope. The identification of possible coral mounds in steep slopes was difficult due to the distortion of the bottom features and failures in bottom detection. By sailing along depth contours we minimized the change in depth, and obtained data that could be compared to less steep areas.

During the survey we explore methods to use bottom backscatter to identify coral mounds. Four approaches were considered:

a) Visual examination of the "first bottom" backscatter, to locate mounds as structures raising ~ 5m from the surrounding bottom. In most cases, they were also characterized by greater thickness of the high (>-43 dB) acoustic density layer.

b) Frequency differencing method. *Lophelia* reefs can be identified by frequency differencing, in particular using the backscatter at 38 kHz and the difference between backscatter at 38 and 120 kHz (δ120, Fosså et al. 2005[1]). Preliminary trials suggested that coral grounds off SE Iceland also have lower acoustic densities at 38 kHz and higher delta 120 than non-coral bottom (Fig. 1).

c) Echo-integration of first bottom. Hutin et al. (2005[2]) proposed that the integration of the acoustic echo of the first bottom could be used to aid bottom classification. During the survey we compared echo integration values between coral and non-coral areas. Initial trials yielded no clear differences.

d) A multivariate approach, combining multiple metrics, principal component analysis (PCA) and model-based clustering. Using the virtual variables module in Echoview, an array of descriptive metrics was exported from the first and second bottoms. The initial objective was to emulate the metrics utilized in proprietary bottom classification systems, in particular RoxAnn and QTC. Metrics include the echo integral of the second bottom, the echo integral of the high acoustic density layer (>-43 dB) in the first bottom, and measures of variability of volume backscatter strength in both bottoms. The metrics set was reduced using PCA. A model based clustering on the first two eigenvectors yielded no clear cluster structure. Additional work is necessary to evaluate if this approach can be used to isolate the bottom characteristics typical of coral areas.

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[2] Hutin E., Simard Y., and Archambault P. Acoustic detection of a scallop bed from a single-beam echosounder in the St. Lawrence. ICES Journal of Marine Science 62: 966-983

Table 1. Calibration settings for the transducer utilized in the survey.

| | Transducer 1 | Transducer 2 | Transducer 3 |
|---|---|---|---|
| Absorption coefficient (dB/m) | 0.0031564 | 0.0099347 | 0.0272302 |
| Sound speed (m/s) | 1482.98 | 1482.98 | 1482.98 |
| Transmitted power (W) | 2000 | 2000 | 500 |
| Two-way beam angle (dB 1 Steradian) | -17.20 | -20.70 | -20.50 |
| Transducer gain (dB) | 21.6800 | 24.9100 | 22.7000 |
| Sa correction (dB) | -0.82 | -0.68 | -0.88 |
| Transmitted pulse length (ms) | 0.512 | 0.512 | 0.512 |
| Frequency (kHz) | 18 | 38.00 | 120.00 |
| Minor-axis 3dB beam angle | 9.79 | 7.30 | 6.53 |
| Major-axis 3dB beam angle | 9.65 | 7.00 | 7.28 |

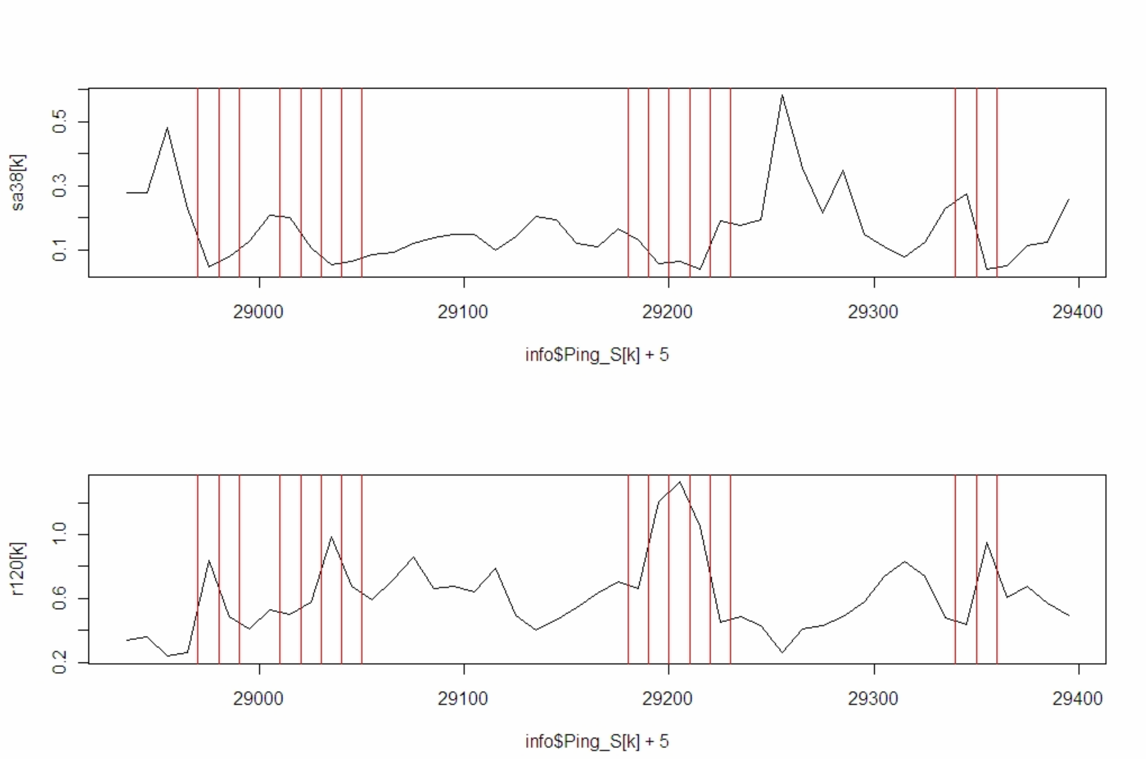


Figure 9.  Volume backscatter strength at 38 kHz (above) and difference between volume backscatter strengths at 38 and 120 kHz (frequency differencing, below) along one of the transects in the Lónsdjúp area.  Values were calculated for 10 ping intervals. Red lines indicate the location of possible coral mounds.   These locations were, in general, characterized by low volume backscatter strength at 38 kHz and high frequency differencing.