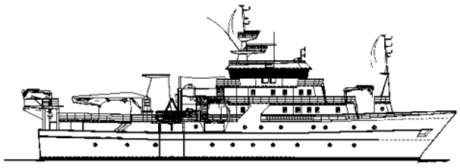
Cruise Report



RV Dr Fridtjof Nansen
Cruise No.: 2015402

Investigation of vulnerable marine ecosystems (VMEs), fisheries resources and biodiversity in the Convention Area of the Southeast Atlantic Fisheries Organisation (SEAFO)

Period: 15 January-12 February 2015
Work area: Selected seamount complexes in the Southeastern Atlantic ABNJ
Port of embarkation: Cape Town, South Africa
Port of disembarkation: Walvis Bay, Namibia

Contents

I. Summary

In January-February 2015 the R/V *Dr Fridtjof Nansen* conducted a 29 day cruise to seamounts in the SEAFO Convention Area. The cruise was part of a scientific study conducted by an international team of scientists, most of whom represented the SEAFO Contracting Parties. The overall objective of the study was to conduct basic mapping and identification of vulnerable marine ecosystems (VMEs) and fisheries resources on selected seamounts and seamount complexes in the SEAFO Convention Area. Some of the areas studied are currently closed to fishing whereas others are being or have been fished for a variety of species including Patagonian toothfish, alfonsino, pelagic armourhead (boarfish), orange roughy, and deep sea red crab.

The investigation included studies at the following seamounts: Schmitt-Ott, Wüst (2 locations), Vema, Valdivia (4 locations), and Ewing. SEAFO Conservation Measure 29/14, (www.seafo.org) classified the three first seamounts as closed to fishing, while Valdivia and Ewing were 'existing fishing areas' and thus open to fishing. Unfortunately bad weather forecasts prevented studies on the Discovery seamounts, i.e. the southernmost planned study area where longline fisheries for Patagonian toothfish are being conducted.

The report presents first results on bathymetry, VME-indicator organism presence, fisheries resources, and evidence of human footprint in the different study areas. Data have been submitted to SEAFO and the biological collection is deposited in the IZIKO South African Museum in Cape Town. Data and material collected during the study will be analysed further and results published.

Most of the SEAFO Convention area is deep ocean (i.e. deeper than 2000m) and the seamounts visited are small relatively shallow sites protruding from a vast deep ocean floor. Multibeam echosounder mapping showed that several seamounts were appreciably deeper than suggested by authoritative sources. In most areas, the potential fishing areas are thus smaller than appreciated earlier.

All seamounts visited had VME indicators (mainly corals), but there was diversity amongst the seamounts in terms of taxonomical composition and density, presumably depending on depth, shape, hydrographical setting, geological and ecological history etc. At Schmitt-Ott there was a pronounced dominance of gorgonian corals. In all others, diversity was greater, and more scleractinians (stony corals) occurred. In many cases scleractinians were mainly dead and probably ancient. In Valdivia and Ewing, which are open to fisheries, scleractinians (dead or alive) seemed restricted to slopes of knolls, and in the Valdivia Bank and Western Valdivia the summit substrate was virtually bare rock.

Abundance estimation of fish resources targeted in SEAFO was very difficult due to rugged topography and the character of distributions of the target organisms that tend to form

aggregations (shoals and schools) near summits of the seamount. Sampling with midwater trawl and use of hydroacoustics is challenging but has some potential. Unidentifiable summit schools were observed in Erica, Valdivia and Ewing. In Ewing these were likely to be orange roughy, and in Valdivia North they were unidentifiable but possibly alfonsino. Bottom trawling was only possible on sandy bottoms on deep plains, not in the main fishing areas on slopes and summits. Pelagic armourhead was locally numerous in video records, but appeared generally limited in distribution. Very few were observed in the main former fishing area of Valdivia, none in Ewing. Orange roughy was common in video records around the summit in Ewing. A few juveniles occurred in a bottom trawl catch on the deep plain in Valdivia. Even in Valdivia, which is a large area <2000m compared with all the other seamounts (probably the largest of the 'existing fishing areas' in SEAFO), potential fishing areas are restricted because only minor subareas are shallower than 500-1000m and suitable for the target fish resources alfonsino, armourhead and orange roughy. The fishing area for crab is much larger, however, because crabs are distributed across a more extensive depth range than the fishes.

Frequent video observations of lost pots and rope were made in Vema and some in Valdivia. These items could not be aged, but may well have been abandoned or lost many years ago. In Ewing, lost trawl gear was observed in one of the summit dives. On the main Valdivia Bank and Valdivia West summit what was suspected to be trawl door skid marks on the bare rocky substrate were observed. No evidence of impacts of trawling or pot fishing was observed in areas of soft sediments, including the extensive areas with coral rubble. In areas with high densities of live (and dead) coral that may be regarded as candidate VMEs, the impression from the video records is that the benthic communities are intact and not impacted by fishing.

II. Objectives

Analyse occurrence and abundance of benthopelagic fish and sessile epibenthos, including indicators of VMEs, in selected ‘existing fishing areas’ and areas closed to fishing within the SEAFO CA.

III. Background

The cruise conducted with the R/V Dr Fridtjof Nansen was a contribution to the work of the Southeast Atlantic Fisheries Organization (SEAFO) through a collaboration involving SEAFO, the EAF-Nansen Project, the FAO Norway Deep-sea fisheries project and the ABNJ Deep Seas Project of the FAO-led Common Oceans Programme (www.commonoceans.org). One of the aims of the FAO Deep Seas projects is to facilitate activities in support of the efforts by regional fisheries management organizations (RFMOs) to meet objectives in relation to the United Nations General Assembly (UNGA) resolution 61/105 and to implement the FAO International Guidelines for the Management of Deep-Sea Fisheries in the High Seas (FAO 2009, http://www.fao.org/docrep/011/i0816t/i0816t00.htm). The ABNJ Deep Seas Project selected the Southeast Atlantic Ocean as one of the pilot areas, where SEAFO, as the RFMO with competence to regulate bottom fishing in that region, is the key partner.

Despite a shortage of data on the occurrence of ‘vulnerable marine ecosystems’ (VMEs), as defined in the FAO Guidelines (2009), SEAFO has introduced comprehensive measures to protect such ecosystems from significant adverse impacts within the convention area. The convention area has been divided into agreed ‘existing fishing areas’, i.e. areas were fisheries were conducted within a recent reference period, and more extensive ‘new fishing areas’ where this was not the case. Commercial harvesting is essentially restricted to the ‘existing fishing areas’, where it is further regulated by other measures such as species-specific TACs, gear restrictions and other measures aimed to conserve e.g. sharks. Because they were likely to represent locations and features inhabited by VMEs, SEAFO has furthermore closed 11 subareas of the convention area to all fishing activity (Fig. 1) (At the time of the cruise the area definitions in force were included in the SEAFO Conservation Measure 29/14 which in 2015 was replaced by a new measure. The 11 closures remain, and a new area on the Valdivia was closed to other gears than pots and longlines). Some of these closures had previously been fished. To select candidate closure areas best available bathymetry data were compiled to locate subareas recognised in the FAO guidelines as VME features, i.e. areas and habitats likely to have VMEs such as seamounts. In implementing its area-based management, fishing was assumed restricted to the upper 2000m of any feature, hence an updated map of areas shallower than 2000m was the basis of further selection (Fig. 1). In SEAFO such areas are seamounts or seamount complexes of various sizes and shapes.

The spatial distribution of VME indicators such as corals and sponges (i.e. as given in the FAO Deep-Sea fishery guidelines, 2009) is however not well known in SEAFO, hence a need for further information from scientific investigations at sea has been recognised. Also, there is a pronounced shortage of fisheries-independent data for assessing the status and providing advice on targeted fisheries resources such as Patagonian toothfish, pelagic armourhead, alfonsino, orange roughy and deep-sea red crabs. These knowledge and information gaps motivated the proposal for the 2015 cruise in SEAFO on the R/V *Dr. Fridtjof Nansen*.

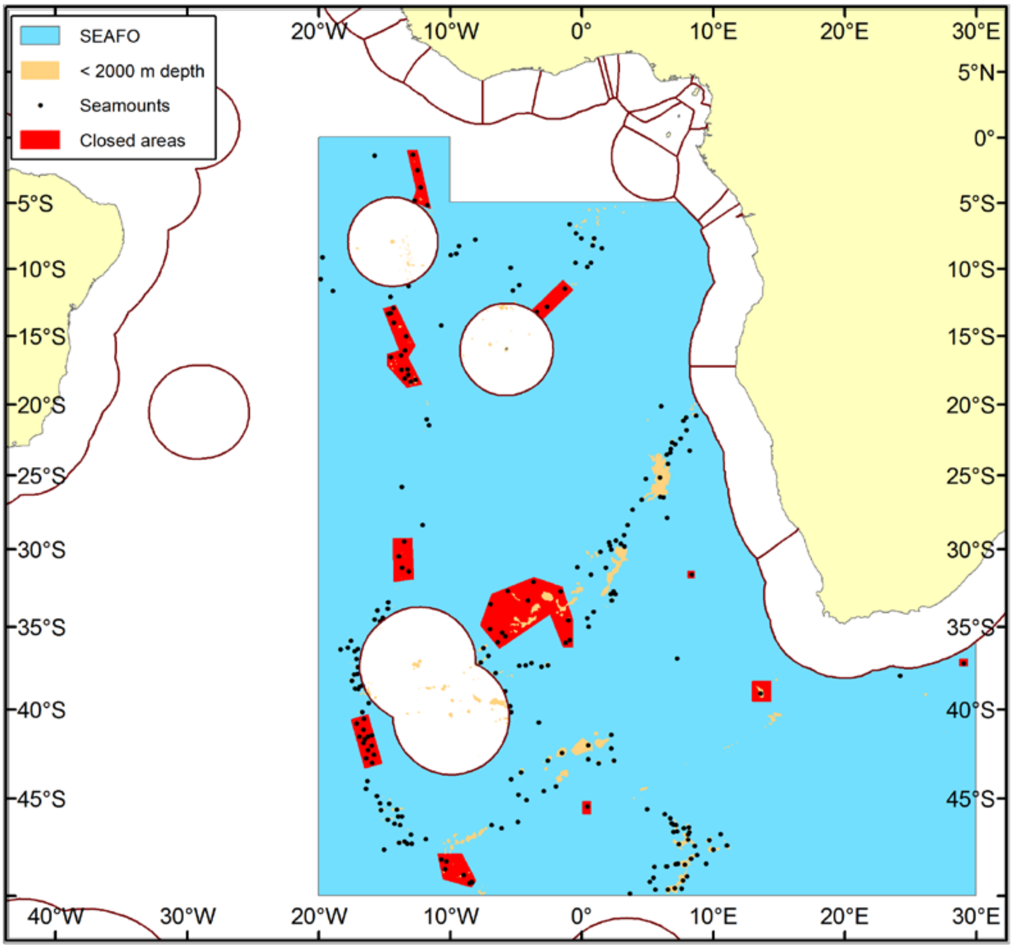


Figure 1. The SEAFO Convention Area (blue) showing seamounts and subareas shallower than 2000m (black dots & orange areas) and the subareas closed to fishing (red polygons) at the time of the cruise.

IV. Scientific crew

The international team of scientists comprised competent scientists from SEAFO Contracting Parties (CPs) supplemented by invited experts and a representative from FAO who strengthened the competence on benthos and fish taxonomy and identification (see Table below). Five of the seven SEAFO CPs were represented, i.e. Namibia. Angola, the European Union, South Africa and Norway.

Participants:	*Institution*:	*Country*
Odd Aksel Bergstad (cruise leader)	IMR	Norway
Åge S Høines (scientist)	IMR	“
Jan F Wilhelmsen (Head of scientific engineering team)	IMR	“
Jan Vågenes (scientific engineer)	IMR	“
Reidar Johannesen (scientific engineer)	IMR	“
Edoardo Mostarda	FAO	Italy
Paul Clerkin	Cal. St. Univ.	USA
Erich Maletzky	NatMIRC	Namibia
Larvika Singh	DAFF	South Africa
Miguel André António	INIP	Angola
Francisco Ramil Blanco	Univ. Vigo	Spain
Marta Gil Gonzales	“	“
Roberto S Vizuete	IEO	“ (and EU)

List of acronyms; IMR- Institute of Marine Research, Norway; FAO – United Nation Food and Agricultural Organization; DAFF – Department of Agriculture, Forestry and Fisheries, South Africa; NatMIRC – National Marine Information and Research Centre, Namibia; INIP- Instituto Nacional de Investigação Pesqueira , IEO – Instituto Español de Oceanografía, Spain; EU – European Union.

V. Study areas, tasks, and survey trajectory

Within the time-frame available (29 days at sea) it was decided to restrict the investigation to the southeastern subarea of the SEAFO Convention Area (mainly the Aghulas and Walvis ridges), i.e. excluding the mid-Atlantic Ridge and also the subareas to the southeast of South Africa.

Tasks to be completed were:

1) Bathymetry survey and benthic video mapping of VME indicators in the fishery closures at Vema, Wüst, and Schmitt-Ott (SEAFO Fishing Closures 6, 7, and 9), as well as in ‘existing fishing areas’ of Valdivia and Discovery seamount complexes.
2) Acoustic survey on the Valdivia Bank and Vema seamount to determine abundance and distribution of armourhead and other benthopelagic fishes.
3) Bathymetry mapping and video survey of selected seamounts of the ‘existing fishing area’ where longline fisheries for Patagonian toothfish is being conducted. (Discovery Seamount complex).

Figure 2 shows a provisional planned trajectory of the vessel and the study locations. Detailed work plans for each of the study locations were developed prior to and during the cruise. As anticipated, in view of the time-constraint (29 days at sea), underway modification of the cruise plan were necessary.

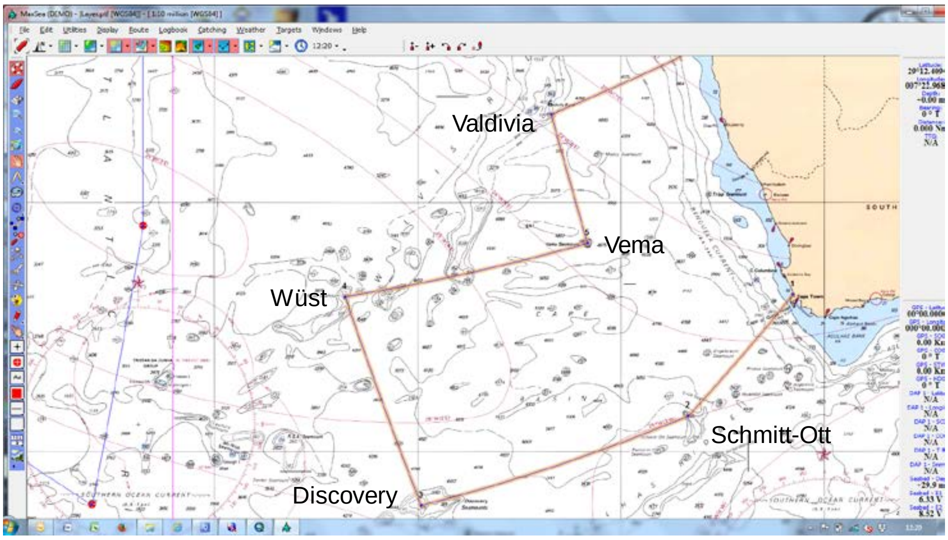


Figure 2. The proposed trajectory of the R/V Dr F Nansen between target areas. Unfavourable weather prevented the vessel from operating in Discovery. The survey track actually accomplished is shown in Figure 3.

Arriving at the first study area (Schmitt-Ott seamount), the weather forecast for the following week were unfavourable in the southern subarea around Discovery. In all probability repeated gales passing from west to east would prove limiting or even prevent any planned activity. In the northern areas, the forecast was good. It was therefore decided to abandon Discovery and head directly towards Wüst after finishing at Schmitt-Ott. Figure 3 shows the resulting trajectory completed during the cruise. Near the end of the cruise there was sufficient time to add a visit to the Ewing Seamount north of Valdivia.

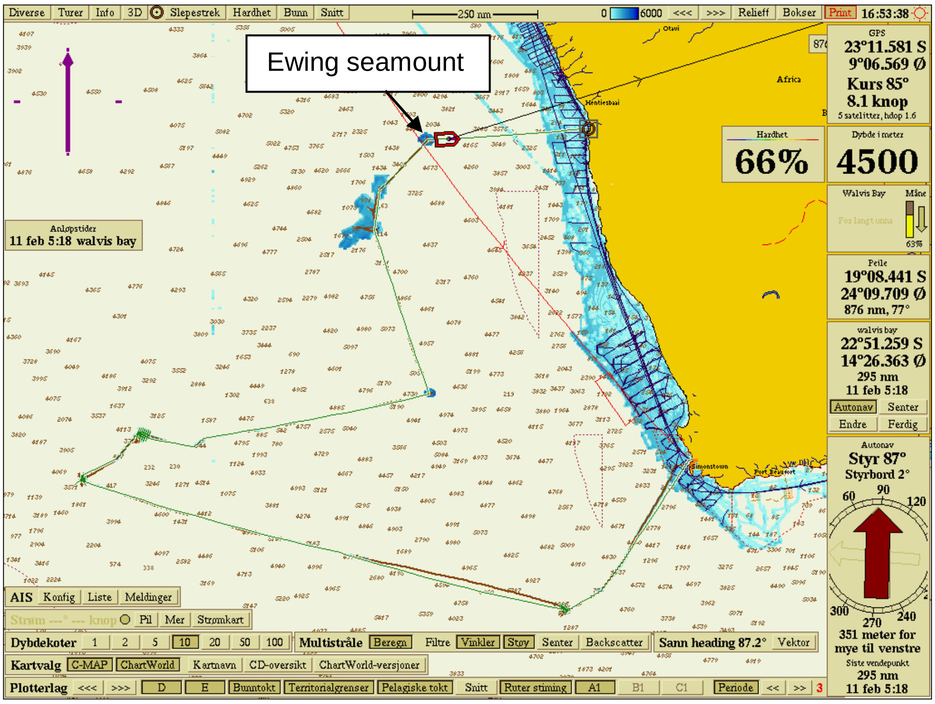


Figure 3. Track of the R/V Dr Fridtjof Nansen on the Cruise 2015402 in the SEAFO Convention areas (green line). As a final study site Ewing seamount was added to the subareas visited. Discovery was abandoned due to unfavourable weather.

VI. Methods and Technology

The R/V *Dr Fridtjof Nansen* is a 57m custom-designed research vessel for fisheries research and oceanography. Rigged as a stern trawler, she can operate large midwater and bottom trawls to 1200m, as well as carry out many other types of sampling with biological samplers. On the SEAFO cruise sampling with the midwater trawl, and the bottom trawl was conducted. Towing speed was 3 knots but towing distance varied with conditions. Midwater trawling was made when echograms showed concentrations of sound-scatterers that would need to be identified and sampled.

The vessel is not well equipped for sampling rough and hard seabed. Safe bottom trawling can only be conducted on level and soft seabed, and such habitat is limited on seamounts. In order to sample bottom habitats, a van Veen Grab was used in selected sites. Grabs were mainly deployed in sites first explored with the towed video system in an attempt to recover some of the megafauna observed visually.

The CAMPOD towed video rig (Fig. 4) consists of a tripod frame with a centrally placed pan-tilt HD camera, two 400W strobe lights, 10x10cm lazer pointers, and a backward-looking camera mainly to monitor performance and avoid snagging. The rig is towed at 0.5-1.5 knots, preferably uphill, and kept at a preferred distance of 1-2m off the seabed by the winch operator constantly monitoring the video stream. The operation is sensitive to vessel motion and could only be performed in low swell. Furthermore, the vessel did not have a dynamic positioning system, hence safe navigation and towing was restricted to calm seas. Uphill transects of distance ranging from 0.5 to 0.9 nautical miles (0.9-1.7km) were run along paths determined after the full bathymetry mapping had been conducted. The maximum depth range of the CAMPOD is 2000m, but the operating range during the SEAFO cruise was restricted to around 1000m.

Figure 4. The CAMPOD towed video rig being launched from the RV Dr Fridtjof Nansen.

The vessel has a full complement of SIMRAD multibeam (EM 710) and single-beam (ER 60) echosounders, and all were used in the SEAFO study to map bathymetry and midwater sound scatterers such as fish and zooplankton. Mapping was restricted to depth shallower than 1500m. Bathymetry data were continuously fed to and updating OLEX charts (http://www.olex.no/) used for navigation and further planning of sampling.

At each seamount, vertical hydrographic profiles were sampled with a Sea-Bird Electronics (SBE) conductivity-temperature-density (CTD) profiler to 1000m. The profiler also had oxygen and fluorescence sensors. Before running acoustic surveys on a new location, the sound velocity data derived using the CTD-data were used to adjust the sound velocity profile settings of the echosounders.

All raw data, video records and metadata were deposited with SEAFO and the Institute of Marine Research, Norway. As agreed between the parties, biological samples were labeled and preserved in accordance with standard procedures and sent to the IZIKO South African Museum in Cape Town, South Africa for conservation and curation.

The following strategy was adopted on individual seamounts/locations:

1) Multibeam bathymetry mapping and ER60 survey (38 KHz, 18 KHz). Primary focus was placed on the shallower hills, i.e. less than 1000m. These constitute rather minor subareas of the total seamount complexes but were assumed to represent main areas of distribution of fish resources and potential VMEs. Raw data from the acoustics were logged and deposited in the NMD database at the IMR Norway. Bathymetry data were fed to the OLEX system to facilitate real-time updating of charts.
2) CAMPOD dives. Several uphill replicate dives of ca. 1 hour were conducted on most selected hills. Enumeration of major taxa observed by 5-min intervals throughout the dive was carried out during or soon after the dive. HD videos were recorded throughout the dives, and for most dives typical clips and stills were extracted for presentation purposes.
3) Bottom and midwater trawl sampling and grabs. Bottom trawling was restricted to safe even areas, and midwater tawling was aimed at sound scatterers observed by echosounders. Benthos and sediment samples were collected with a van Veen Grab.
4) Hydrographic sampling (CTD). A 1000m vertical CTD cast was taken at each site and prior to initiating bathymetry mapping.

VII. Data collected

Bathymetry

Extensive bathymetry mapping was conducted in all seamounts that had never been mapped and in those that had been insufficiently mapped. New maps were generated for Schmitt-Ott, two locations at Wüst, and the shallower parts of Vema. The slopes of the Vema had been mapped previously by the R/V *G.O.Sars* (in 2008), but that mapping did not include the flat summit area. Valdivia and Ewing had been mapped in a Spanish-Namibian investigation in 2010, hence good bathymetry was already available for those areas.

A remarkable finding was that for the previously unmapped seamounts the new summit depths deviated very significantly from depths expected based on the presumed best bathymetry data available to the SEAFO Scientific Committee (compiled in a SEAFO contract with the National Oceanography Centre, UK, in 2010. Bathymetry data compiled were mainly derived from GEBCO http://www.gebco.net/). In all cases, except the Erica seamount (just east of Schmitt-Ott) and Ewing, the actual depth was several hundred metres deeper than anticipated (Fig. 5).

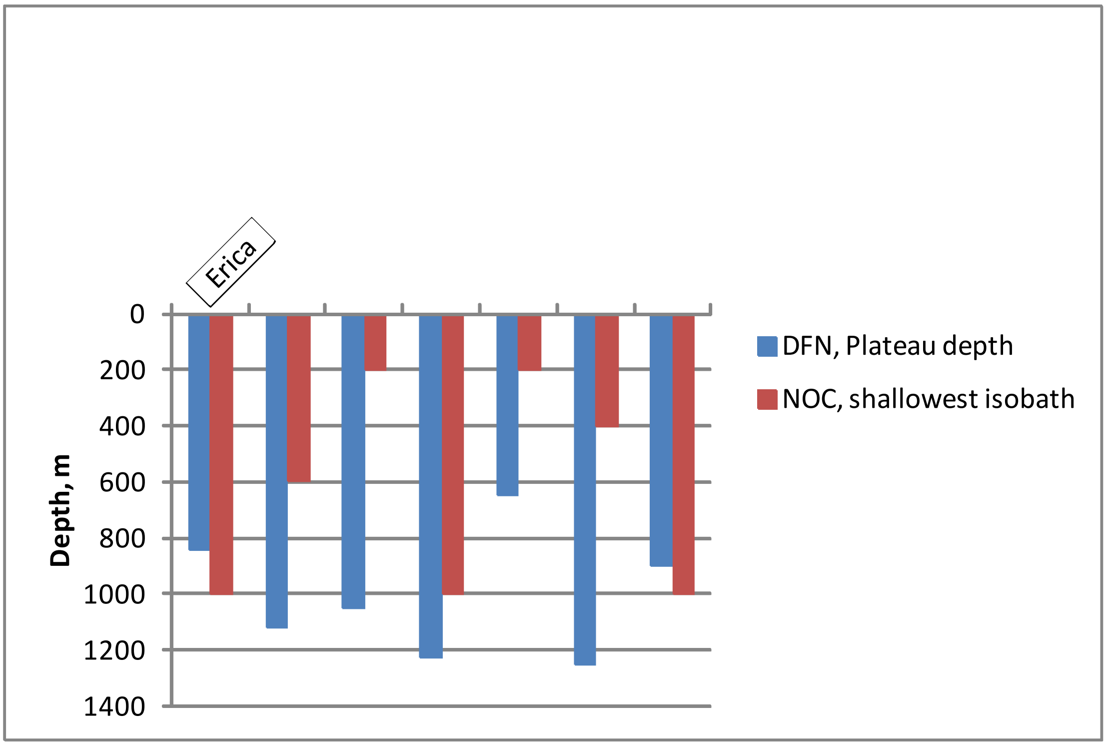


Figure 5. Comparison for a range of SE Atlantic seamounts between expected summit depths based on published bathymetries (mainly GEBCO http://www.gebco.net/) (red bars) and measured summit plateau depths observed by R/V Dr Fridtjof Nansen 2015 (blue bars).

Video observations

In total, 41 CAMPOD dives were completed on the 5 seamounts investigated. The full list of dives is provided in Table 1. The number of dives was highest in the more extensive seamount complexes with several summits, i.e. Wüst and Valdivia, where two or more locations were selected for further study. In a given location, most dives started at the base of summit slopes and ended at the summit or plateau (shallowest point). In conical seamounts, an effort was made to distribute transect in order to approach the summit from the North, South, East and West. Additional dives were made within narrower depth ranges on e.g. summits and level plains to investigate particular features. For each dive a continuous HD video record corresponding to the dive duration was generated.

Table 1. List of CAMPOD dives conducted during the 2015 SEAFO cruise to southeastern Atlantic Seamounts, R/V Dr. Fridtjof Nansen, Cruise 2015402.

Seamount & Location	**Dive # by location**	**Date**	**Olex depth and dist. measurements**			**Duration (min)**	**Comments**
			Start	**Stop**	**Dist. (m)**		
Schmitt-Ott	Dive 1	19.01.2015	975	930	1037	62	
Schmitt-Ott	Dive 2	19.01.2015	995	935	963	59	
Wust, Loc. 1	Dive 1	24.01.2015	1040	1000	926	49	Slope of knoll on plateau
Wust, Loc. 1	Dive 2	24.01.2015	1050	975	926	27	Slope of knoll on plateau
Wust, Loc. 2	Dive1	26.01.2015	708	572	1241	71	Southwestern slope, 700m -
Wust, Loc. 2	Dive2	26.01.2015	650	590	926	21	Knoll on plateau
Wust, Loc. 2	Dive3	26.01.2015	890	670	1685	83	Northern slope, 800-670m
Wust, Loc. 2	Dive4	26.01.2015	590	530	1111	24	Knoll on plateau, 530m
Wust, Loc. 2	Dive5	27.01.2015	765	640	1667	85	Western slope, 770-640m
Vema	Dive1	31.01.2015	750	145	1667	70	Western slope
Vema	Dive2	31.01.2015	708	108	2222	76	Southern slope
Vema	Dive3	31.01.2015	935	71	2037	49	Eastern slope
Vema	Dive4	01.02.2015	95	91			Interrupted, snagged in rope
Vema	Dive5	01.02.2015	91	42	369	12	Plateau knoll
Vema	Dive6	01.02.2015	72	43	1167	40	Plateau knoll
Vema	Dive7	01.02.2015	911	100	2704	109	Northern slope
Valdivia	Dive 1	03.02.2015	903	230	2741	95	Central Valdivia. Western slope of main plateau
Valdivia	Dive 2	03.02.2015	805	230	3185	109	Central Valdivia. Western slope of main plateau
Valdivia	Dive 3	03.02.2015	580	650	860	97	Central valdivia. Knoll southeast of main plateau.
Valdivia	Dive 4	03.02.2015	552	250	1204	44	Central Valdivia. Slope of main plateau, southeast.
Valdivia	Dive 5	03.02.2015	562	655	2019	55	Central Valdivia. Knoll southwest of main plateau
Valdivia	Dive 6	04.02.2015	640	595	1333	40	Western Valdivia
Valdivia	Dive 7	04.02.2015	875	470	1574	60	Western Valdivia
Valdivia	Dive 8	04.02.2015	934	490	2111	65	Western Valdivia
Valdivia	Dive 9	04.02.2015	705	505	1296	41	Central Valdivia. Knoll southeast of main plateau.
Valdivia	Dive 10	04.02.2015	660	452	926	44	Central Valdivia. Tongue of central plateau.
Valdivia	Dive 11	05.02.2015	735	550	1111	46	Mid-Valdivia. Knoll south of main plateau.
Valdivia	Dive 12	05.02.2015	715	515	1185	40	Mid-Valdivia. Western slope of main plateau. (interrupted)
Valdivia	Dive 13	05.02.2015	775	475	1741	81	Mid-Valdivia. Western slope of main plateau.
Valdivia	Dive 14	05.02.2015	871	877	610	6	Mid-Valdivia. Sandy plain dive (after trawling)
Valdivia	Dive 15	06.02.2015	906	450	1630	44	Mid-Valdivia. Northeastern slope.
Valdivia	Dive 16	06.02.2015	585	417	1185	41	Mid-Valdivia. Southern summit.
Valdivia	Dive 17	06.02.2015	850	560	2000	85	Northern Valdivia. Southern slope.

Valdivia	Dive 18	06.02.2015	655	570	1574	61	Northern Valdivia. Eastern summits.
Valdivia	Dive 19	07.02.2015	880	885	1833	30	Northern Valdivia. Western plain.
Valdivia	Dive 20	07.02.2015	730	555	1648	41	Northern Valdivia. Northern slope, Western summit.
Ewing	Dive1	08.02.2015	1021	787	1796	61	Ewing, southern slope
Ewing	Dive2	08.02.2015	916	792	1167	45	Ewing, western slope
Ewing	Dive3	09.02.2015	1002	1003	580	25	Ewing, western deep plain (trawl area)
Ewing	Dive4	09.02.2015	893	792	700	39	Ewing, northern slope
Ewing	Dive5	09.02.2015	923	833	600	40	Ewing, northeastern knoll

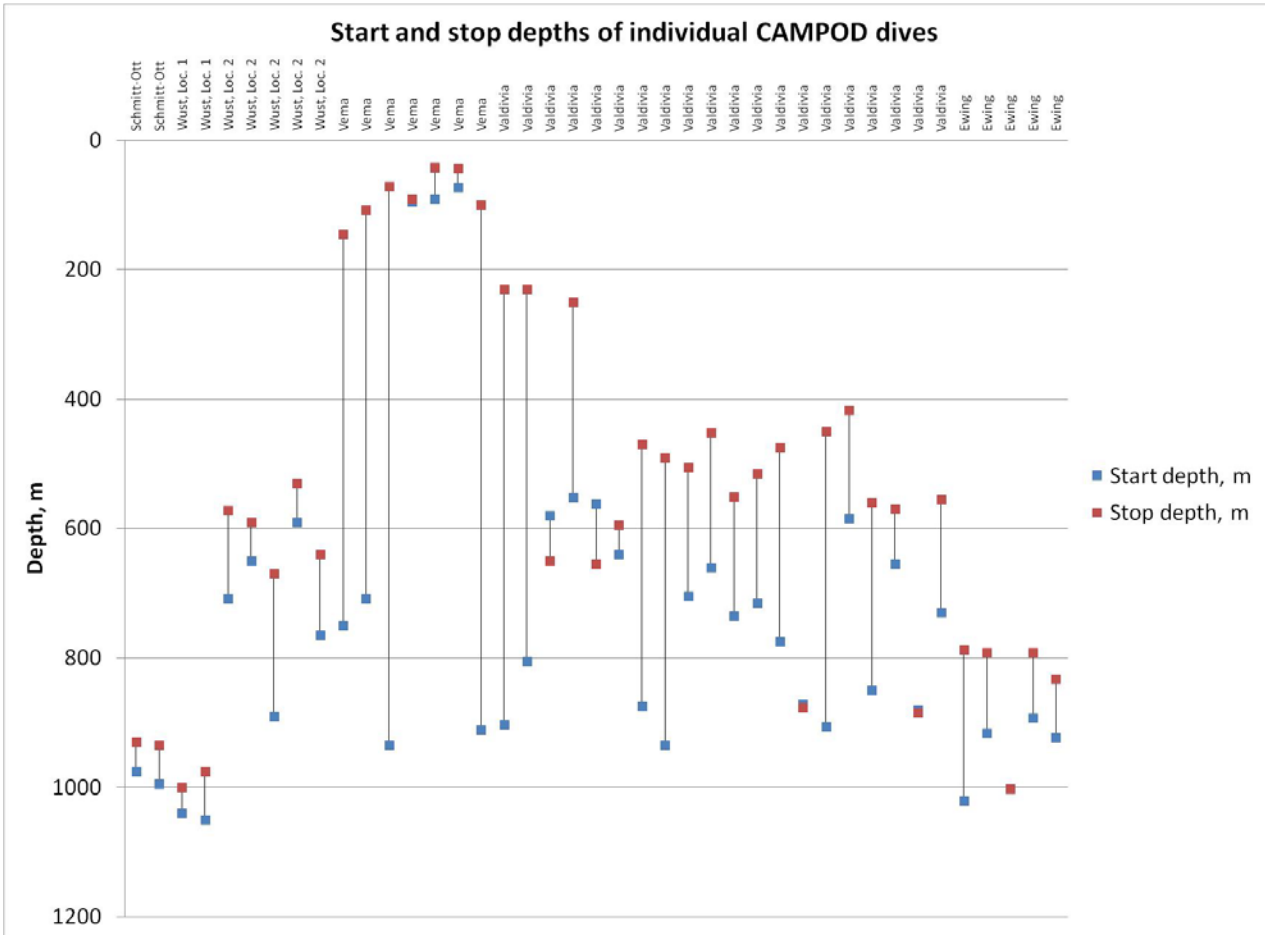


Figure 6. Depth range, start and stop depths of the CAMPOD dives on the seamounts in the SEAFO area. (When no start depth is provided the dive was made on a level plain at the indicated stop depth.)

The depth range of individual upslope dives was determined by the 1000m depth capability of the vehicle and the summit depths of the different locations. Thus deep seamounts (Schmitt-Ott and Ewing) were investigated with relatively short uphill dives, while shallow seamounts (e.g. Vema) could be studied over a much wider depth range (Fig. 6). In Valdivia and Ewing adjacent flat sedimentary areas were also visited in association with trawl sampling, and this is reflected in very narrow depth ranges of individual dives.

Identification of organisms observed during the CAMPOD dives is constrained by various factors, and only rarely is identification to species level possible. Normally organisms can only be identified to higher taxonomical levels. Numerical data for higher taxa were recorded either during the dive or in reviewing sessions examining the video. Numbers of e.g. scleractinian corals, gorgonians, echinoderms, fish observed per 5 min interval of the transect was determined by a team of qualified observers, normally with each person being responsible for counting a specific taxon.

A constraint was that the available version of CAMPOD did not provide continuous information on vehicle depth. A SCANMAR depth sensor was mounted on the vehicle, and the captain recorded depths every 5 minutes. From these data it was possible to derive approximate depths of numerical observations of organisms along the transects.

Trawl and grab sampling

In total, 14 trawl stations were conducted, and the list of stations is given in Appendix 1. The conditions for bottom trawling were generally poor due to steep slopes and rugged hard substrate, hence only 5 trawls were made of which two were partially or entirely unsuccessful due to snagging. Exceptions were trawls on flat sedimented areas at the base or adjacent to the main shallowest summits of the seamounts. Trawling was generally impossible in slope areas where most of the CAMPOD dives were made. Midwater trawling (9 stations) was mainly carried out to identify echosounder recordings assumed to reflect fish concentrations near the summits or slopes of seamounts, but this also proved difficult or unsuccessful. The trawling efforts did, however, generate the bulk of the samples for the specimen collection resulting from the cruise.

In all seamounts van Veen grab stations were carried out in attempt to sample sediment and benthos. In total 60 grabs were deployed, but many were replicates in roughly the same position. Only 11 of the grabs generated material, and the samples were included in the museum collection (Appendix table 2).

Biological samples

Two hundred and forty invertebrate samples from trawls were collected, 25 from grabs (incl. sediment samples), and 212 fish samples from trawls. In addition, a few samples were obtained (by accident) from the CAMPOD, including during an encounter with an old pot rope. Samples were also collected of fauna attached to a pot captured in the bottom trawl.

In total, 74 species and 22 genera belonging to 34 families of teleosts were identified, whereas the chondrichthyans were represented by 6 species of sharks belonging to two families. Among the invertebrates, both crustaceans (43 species and 13 genera) and molluscs (13 species and 4 genera) were well represented, while other groups such as bryozoans, annelids, echinoderms and sponges showed a lower diversity; ten species and 7 genera of corals were identified. A large number of fragments of the latter groups were collected and preserved for further investigation.

A full inventory of retained samples is not included in this report, but is available from the Iziko Museum, SEAFO data manager, and IMR. The collection contains taxa from 8 phyla. For many taxa, especially of benthic invertebrates, identification of specimens should be regarded as provisional pending further study. Appendix 3 and 4 provide lists of identified taxa in the collection, comprising fishes and invertebrates, respectively.

Fish acoustics

In all locations, and in conjunction with the bathymetry mapping, recording of sound scatterers was obtained from 38 and 18 KHz single-beam sounders. In general, the more pronounced feature is the ubiquitous deep pelagic scattering layer created by mesopelagic fish and micronektonic crustaceans. A classical diurnal migration was observed in the entire area.

Near-bottom scatterers on the seamounts were generally sparse, and/or difficult to detect because of disturbance of the recordings by the rugged bathymetry including very steep slopes. In some seamounts, however, schools probably representing bentho-pelagic fish such as alfonsino, armourhead and orange roughy occurred (e.g. in Erica, Valdivia and Ewing), however sampling was exceedingly difficult and essentially failed.

The conclusion from these investigations, not entirely unexpected, is that quantitative abundance estimation of seamount fishes by acoustics remains very. The surveys were conducted in the austral summer. It may be easier to obtain better acoustic data during the winter when e.g. orange roughy aggregates to spawn.

VIII. Observations from individual study locations

Erica and Schmitt-Ott Seamounts

The Erica and Schmitt-Ott seamounts are neighbouring features located southwest of the Cape and individually surrounded by abyssal depths (3000-5000m).

Erica was not studied in any detail, but *en route* to Schmitt-Ott the vessel passed across the summit to determine summit depth and record near-bottom sound scatterers (Fig. 3). The shallowest point observed was around 770m surrounded by a wider area of 800-850m. A school of fish, resembling alfonsino schools described in the literature, was observed near the summit (Fig. 7), but no fishing was carried out to determine its identity. Figure 7 also illustrates the occurrence of a mesopelagic scattering layer at 400-500m which was prominent across the study area.

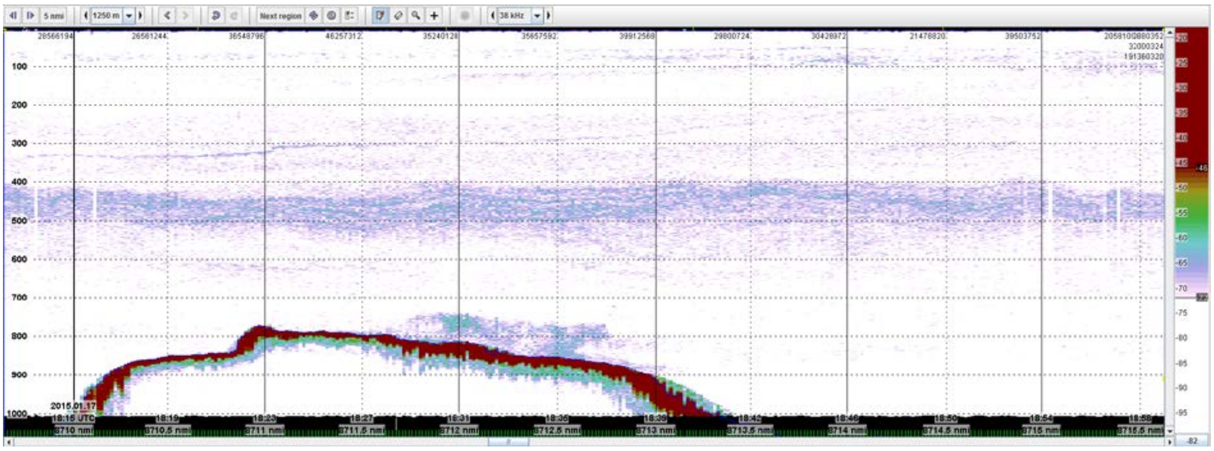


Figure 7. Echogram from passage of the summit of Erica

The following concerns only the Schmitt-Ott seamount:

Locations, bathymetry, hydrography

A bathymetry survey running the multibeam echosounder was planned based on GEBCO bathymetry maps (NOC-compilation for SEAFO, 2010), and it was found that while the location and general shape of the seamount was correct, the summit and summit plateau depth was deeper than expected (Fig. 5). Figure 8 shows the bathymetry survey and the resulting relief map generated. The seamount is elongated in the southeast to northwest direction, with a distinctive summit with a shallowest point of 923 m in the northwestern end. There are, however deeper knolls in other locations of the surveyed area, as also shown in the 33.7 km depth profile running from the southeast to the northwest across the summit. The indication from the sounders ‘hardness index’ is that the seamount has little sediment, particularly along the shallowest ridge leading up to the summit. The main single summit is located at 38^{o} 41.662 S, 13^{o} 24.618 E. The subarea designated by SEAFO as a fishing closure extends well beyond the area surveyed, i.e. to 2000m or even into abyssal depths in all directions.

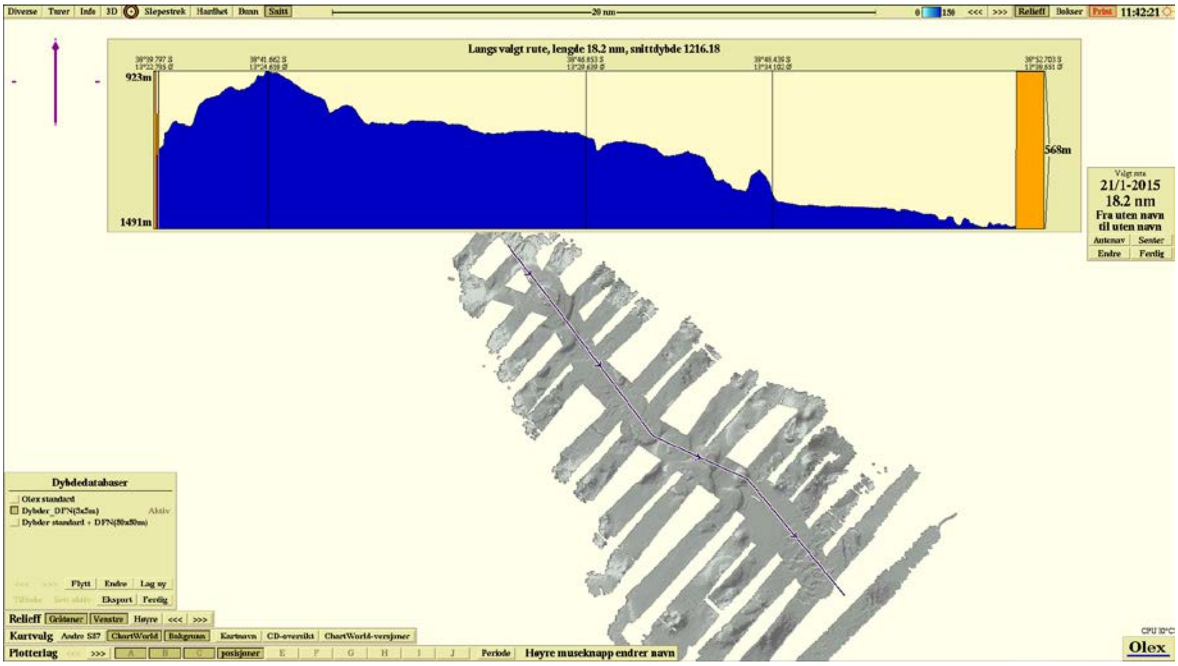


Figure 8. Relief and depth profile (along arrowed solid line) of the Schmitt-Ott Seamount, SE Atlantic. Data generated by multibeam mapping by the RV Dr. Fridtjof Nansen, 2015.

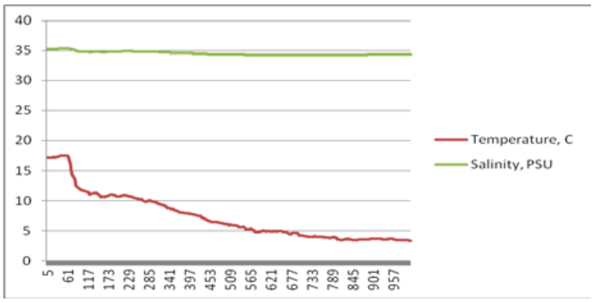


Figure 9. Depth profile (surface to 1000m) of temperature and salinity at Schmitt-Ott Seamount. (38º 49.86 S, 013º 43.65 E, 18 Jan 2015).

The hydrographic profile from the surface to 1000m showed a decline in temperature from 17.2ºC in the near-surface 100m to 3.4 ºC at the depth of the summit of the seamount at 920m and deeper (Fig. 9). The near-summit salinity was 34.41 PSU.

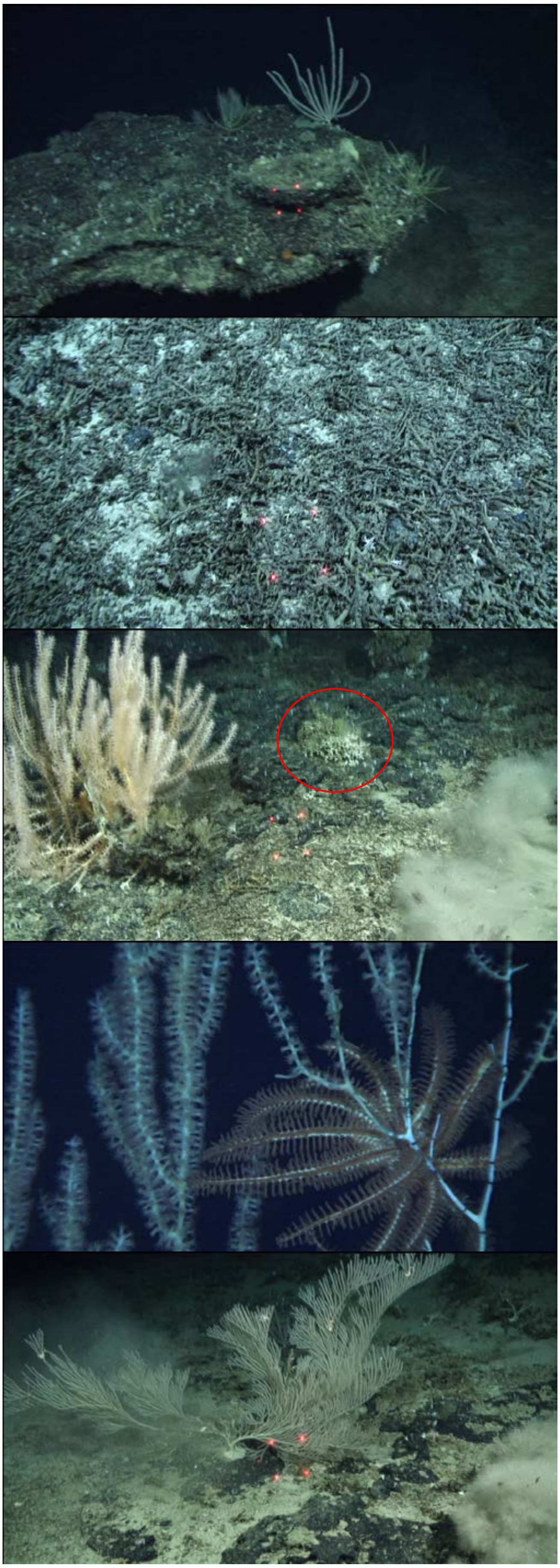


Figure 10. Selected images from CAMPOD Dives 1 and 2 on Scmitt-Ott Seamount. (Note the centrally placed 4 red lazer lights, forming a 10x10cm square)

Part of mushroom-shaped basaltic rocky outcrop.

Scleractinian coral rubble

Gorgonian colony (left), and small scleractinian colony (encircled)

Bamboo coral (a gorgonian) with a crinoid (Echinodermata) attached

Fan-shaped gorgonian coral frequently observed on the Schmitt-Ott seamount. White cover on the black basaltic rock is biogenic sediment (foraminifera, pteropod shells a.o.).

Substrate and VME indicator observations (video, trawl and grab samples)

Two CAMPOD transects, from the NW and SE, respectively, were run uphill from 1000m to the 920 m summit of the shallowest feature of the Schmitt-Ott (Fig. 11). Each transect lasted about 50 minutes, and the distance travelled in each was roughly 1000 m. Selected images from the dive transects are shown in Figure 10.

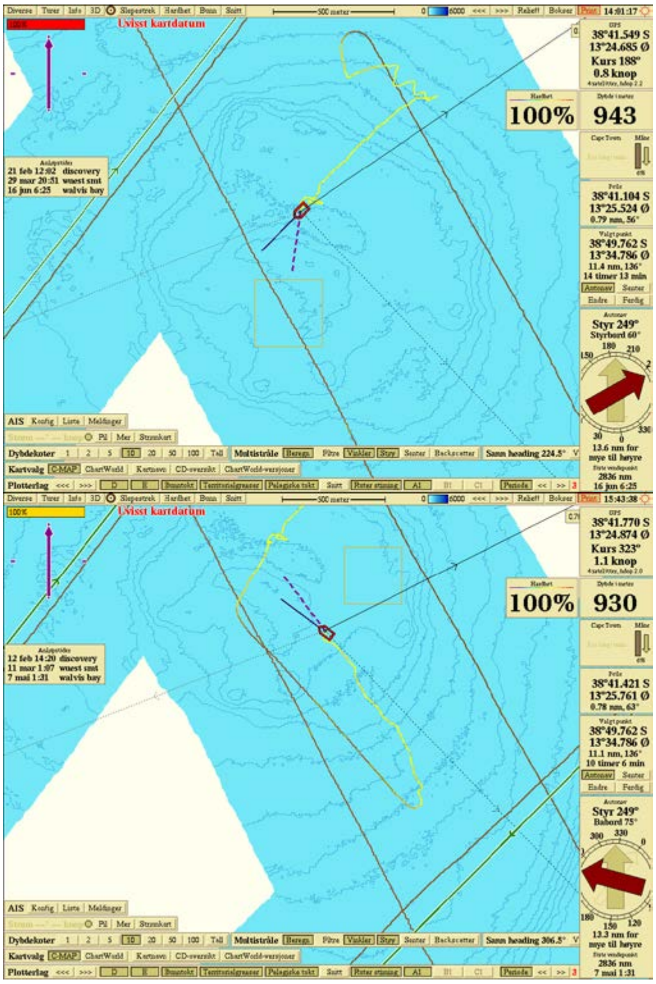


Figure 11. Vessel track during the CAMPOD Dives 1 (upper) and 2 (lower) up the NW and SE slope of the summit of Schmitt-Ott Seamount. The position of the vessel symbol is at end of yellow uphill track line. Distance between isobaths is 10m.

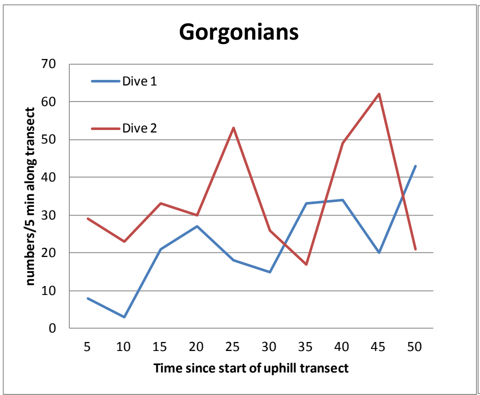
The substrate was bare basaltic rock and plains with variable but apparently limited cover of biogenic sediment. The sediments were unconsolidated and easily disturbed. In addition to rocky outcrops, the prominent feature was coral rubble occurring at all depths across wide areas (Fig. 10). This rubble appeared old. On Dive 2 the sediment cover appeared especially thin, and extensive areas of bare rock were observed, including spectacular mushroom-shaped basaltic structures.

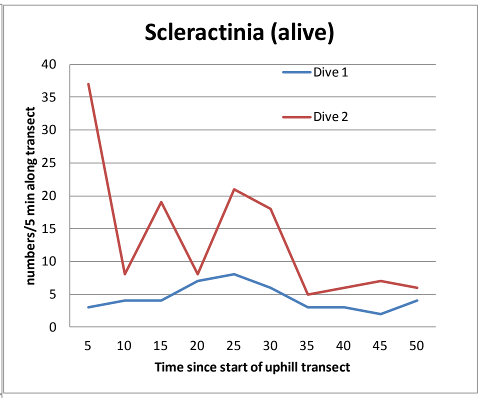
The live fauna observed comprised sessile megabenthos and fish, and amongst megabenthos corals were most frequent and widespread. Gorgonians (trivial name for octocorals formerly named Gorgonacea, but according to the World Register of Marine Species, the accepted name is currently Alcyonacea) were common and prominent amongst the coral taxa, and at least 4-5 types were observed, however, identification to species remains impossible based on video images. Particularly in Dive 1 (NW), gorgonian numbers appeared to increase towards the summit (Fig. 12). However, the wide variation reflects rather patchy distributions of colonies. Scleractinians (stony corals, order Scleractinia), represented by small colonies (Fig. 10), were frequent but insignificant compared with the extensive cover of dead skeletons that would seem to be evidence of past extensive scleractinian presence. Only few certain observations were made of other coral taxa than gorgonians and scleractinians. However, small (1-2 cm high) white colonies attached to hard surfaces were very frequent and widespread, and it was assumed that these were hydrocorals.

Sponges (Porifera) were infrequent. Other invertebrates observed in small numbers were echinoderms (Echinoids, crinoids, ophiurids, asteroids) of which most occurred attached to gorgonian corals. Crustaceans observed were unidentified crabs and shrimp, but only a handful of specimens were observed.

The single grab sample collected (at 1176m) contained a hydrozoan (Stylasteridae indet.) and sediment containing pteropod shells.

Fish taxa observed by video were *Neocyttus rhomboidalis*, Macrouridae (grenadiers), the shark *Etmopterus* sp., a single specimen of what appeared as *Allocyttus guineensis*, and a few unidentified specimens that were definitely different taxa. The oreo (*Neocyttus rhomboidalis*) showed increasing abundance uphill towards the summit of the seamount (Fig. 12) but numbers were overall low. Observations of other fishes were too few to facilitate analyses of abundance patterns.





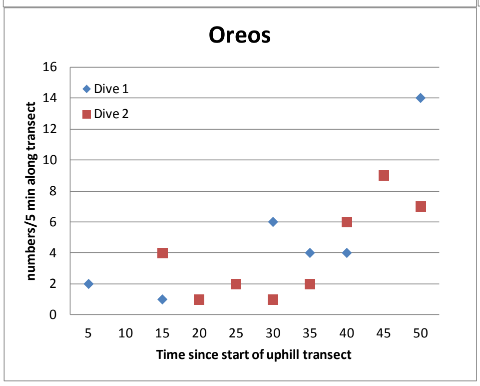


Figure 12. Counts (numbers/5 min intervals) of selected organisms along uphill CAMPOD transects (1000m to 920m) on Schmitt-Ott Seamount.

Fisheries resources observations

No indications of SEAFO target species were found on Schmitt-Ott, neither by video or echosounders. Due to rough ground, the summit appeared untrawlable with the bottom trawl and no echosounder observations were made of fish to be targeted with the midwater trawl.

Indications of fishing impacts

No observations of lost gear or other footprint of fishing were made.

Wüst Seamounts

The Wüst seamount complex lies on the Walvis Ridge and is very extensive. Most summits are included in the largest of all the SEAFO fishing closures. The two presumed shallowest summits were selected for this study, Location 1 and 2 (Fig. 13), and these are centrally placed within the fishing closure. Expected depths of the selected summits were less than 400m (probably 200m), but observations with the multibeam sounder showed that real summit depths were several hundred metres deeper (Fig. 5). Plateau depths of the summits of Loc. 1 and 2 were rather around 1000m and 600m, respectively. Similarly, the summit marked in the charts as 'Wüst Seamount', located in between Loc.1 and 2, was observed to be around 1200m deep where bathymetries based on GEBCO data indicated 1000m.

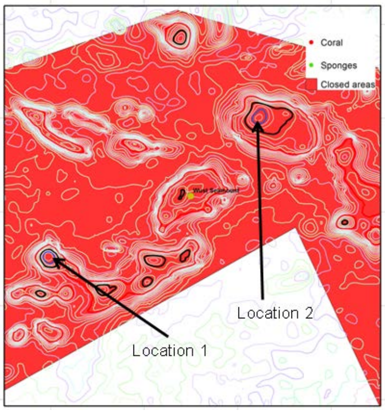


Figure 13. The two locations on the Wüst seamount complex (section of Walvis Ridge) selected for further study. Red area is closed to fishing by SEAFO. Blue isobaths are 400m, black 1000m. Bathymetry is based on GEBCO (NOC compilation for SEAFO).Coral and sponge records previsously reported to SEAFO are included.

Location 1

Locations, bathymetry, hydrography

Figure 14 shows the bathymetry results from Location 1 on the Wüst. A central almost circular flat summit with a depth of 1050m (roughly 4.6 km in diameter) was found. On the western edge of the plain, a group of shallower rugged knolls occurred, and summit depths of these were around 950m (Fig. 14 b).

The hydrographic profile from the surface to 1000m showed a decline in temperature from around 20^{o}C in the near-surface 100m to 3.2 ^{o}C at the depth of the summit of the seamount at 920 m and deeper (Fig. 15). The near-summit salinity was 34.41 PSU.

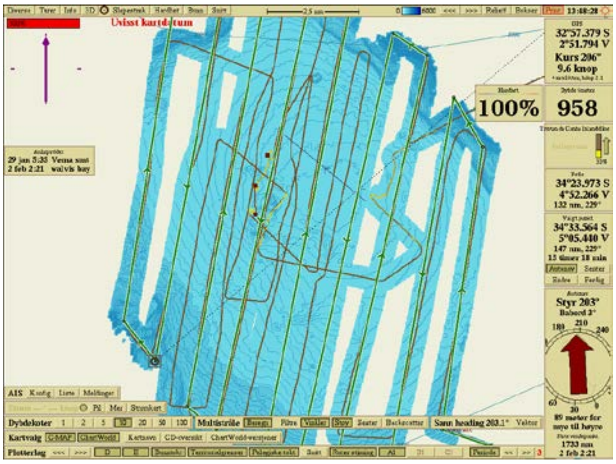


Figure 14a). Wüst seamount, Location 1 (western), showing surveys track and isobaths of the summit and adjacent slopes (10m depth contours). The shallowest central plateau is ca. 1050 m. Notice rugged knolls to the west of the central plateau.

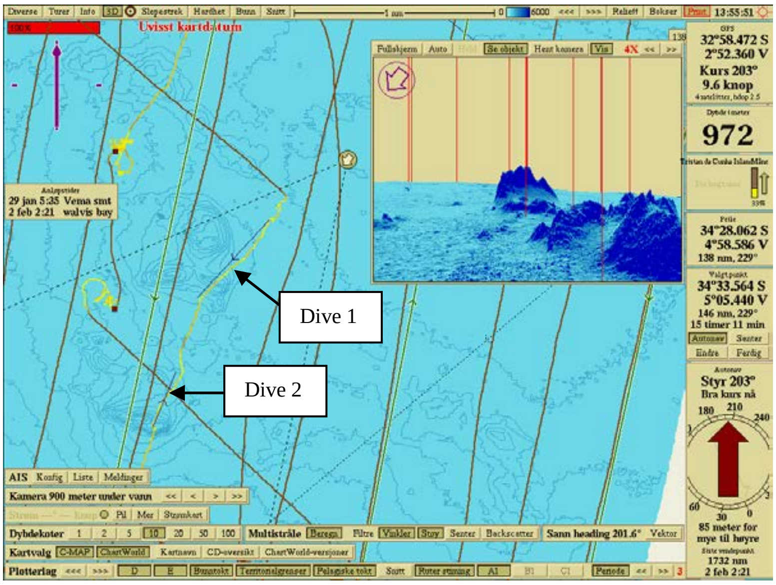


Figure 14b). Central plateau of Wüst, Location 1, with relief of the shallowest hills from the surrounding plains forming the main summit, viewed from the northeast.

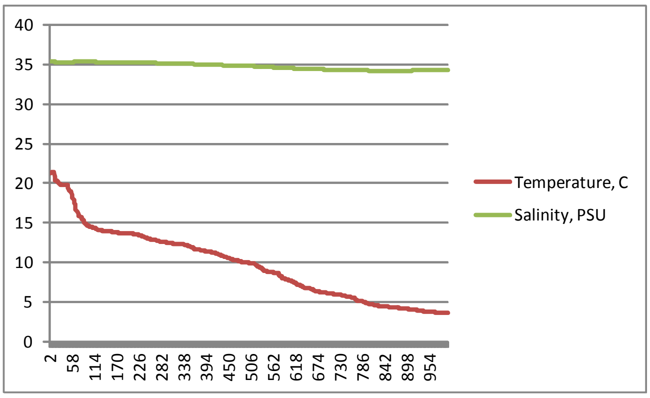


Figure 15. Depth profile (surface to 1000m) of temperature and salinity at Wüst Location 1 (34^{o} 35.26 S, 004^{o} 56.27 W, 23 Jan 2015).

Substrate and VME indicator observations (video, trawl and grab samples)

Two CAMPOD dives (Table 1, Fig. 14 b) were carried out up the slope from the main plateau towards the summits of two of the adjacent summits. At the start of the dives on the near level plateau the substrate was fine white sand with ripples presumably maintained by near-bottom currents (Fig. 16). Judging from the hardness index of Olex and direct observations from the CAMPOD, the sedimentary layer was superficial on hard rock. On the slopes of the knolls the same sediments were found but often only as a thin uneven cover on basaltic rock (Fig. 16). In the grooves of the sandy ripples and in troughs on the slope, coarser particles were observed, probably primarily pteropod shells.

In both dives, the presence of sessile macrobenthos was limited to a few whip-like gorgonian corals, and in Dive 2 which was the shallowest (975m as opposed to 1000m in Dive 1), the number of gorgonians increased towards the summit. Only in Dive 2 did a few small scleractinian corals appear towards the summit. Fishes comprised grenadiers (Macrouridae), which appeared most abundant at the base of the knolls, and a few unidentified specimens (alepocephalid, synaphobranchid, shark). Numerical data are summarized in Figure. 17.

Bottom trawling was attempted on the summit plateau at 1060 m, but resulted in an interrupted haul and torn net. Grab deployments were made in two locations west of the knolls, but despite several replicate grabs only a few minor samples were retained (decapoda hexactinellida, polychaeta, scaphopoda, bryozoa, hydrozoa). Identification requires further work in the collection.

Fisheries resources observations

No indications of SEAFO target species were found on the Wüst Location 1, neither by video or echosounders. Due to rough ground, the summit knolls appeared untrawlable with the bottom trawl and no echosounder observations were made of fish to be targeted with the midwater trawl. The rather plain plateau at about 1050m seemed trawlable but was evidently hard rugged ground below a thin layer of sediment.

Indications of fishing impacts

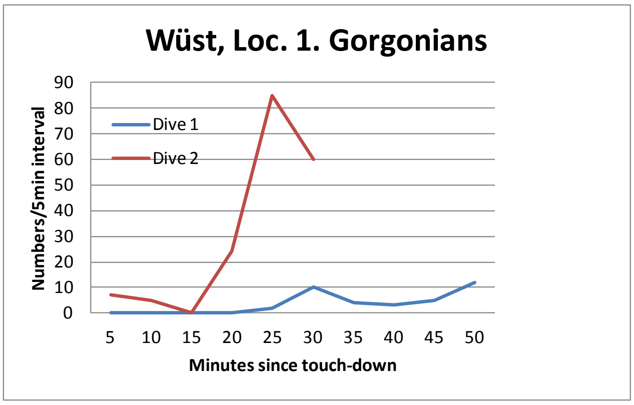
No observations of lost gear or other footprint of fishing were made.

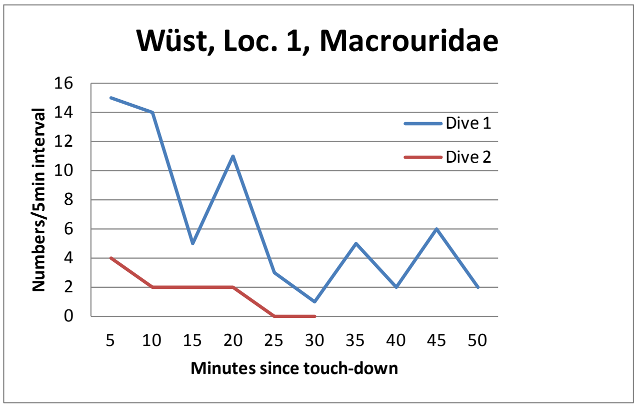
Figure 16. Example images from Dive 1 at Wüst, Location 1.

Rippled sand at base of summit knolls.

Basaltic outcrop with thin sandy cover. To the right, whip-like gorgonian coral.

Small macrourid fish (grenadier) on the rippled substrate. Note black hard surface beneath thin sedimentary cover.





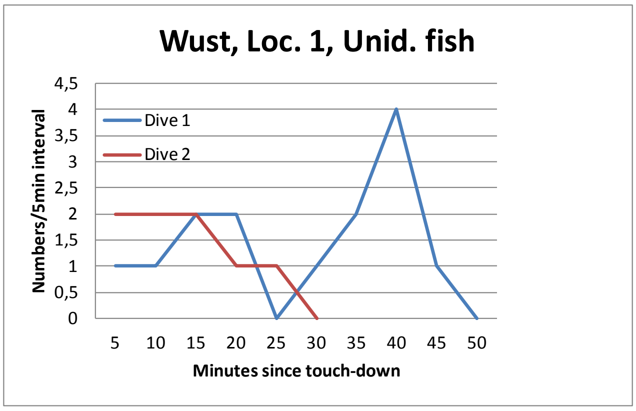
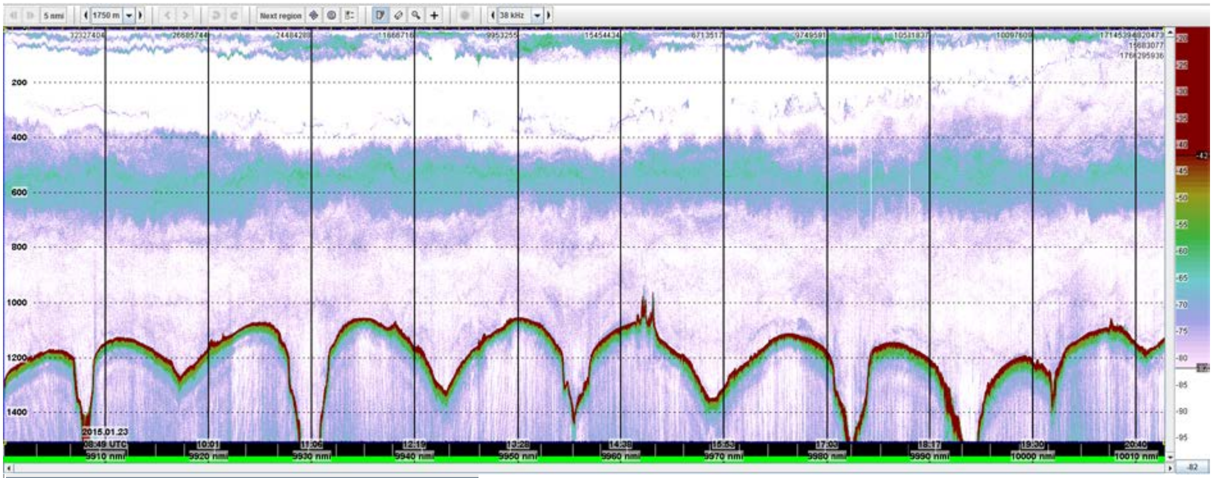


Figure 17. Counts of gorgonian coral, macrourid fish, and unidentified fish along upslope transects on Wüst, Location 1.

Figure 18 Shows results from a 24 hour acoustic survey in which multiple crossings of the summit were conducted. The mesopelagic scattering layer comprising small fish and zooplankton at 400-700m was very prominent, but even in daytime, that layer never impinged on the 1050 m deep seamount summit.



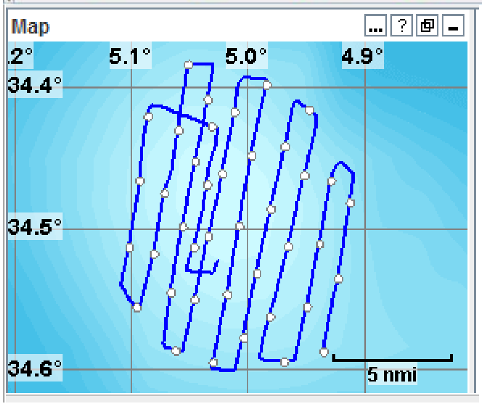


Figure 18. Echograms from acoustic survey of the Wüst Location 1. The map to the left shows the track of the vessel during multiple crossings of the seamount during a 24 hour period. Echograms show results the 38 KHz transducer.

Location 2

Locations, bathymetry, hydrography

Wüst Location 2 is rather flat-topped with plateau depth of around 650m, and a few plateau knolls peaking at 550-600m (Fig. 19, 21). At the plateau depth 650m, the summit is roughly ellipsoid and 27.8x18.5 km wide. In both profiles shown in Fig. 19, there are indications of marginal shallower features which may reflect ridges along the outer perimeter of the plateau. Location 2 was too large to map completely with the time available.

The hydrographic profile from the surface to 600m showed a decline in temperature from 23^{o}C in the near-surface layer to 8.2 ^{o}C near the seabed off the summit (Fig. 20). The temperature curve was declining at the deeper end, hence it is likely that the surrounding deeper slopes would have a somewhat lower temperature. The near-summit salinity was 34.61 PSU.

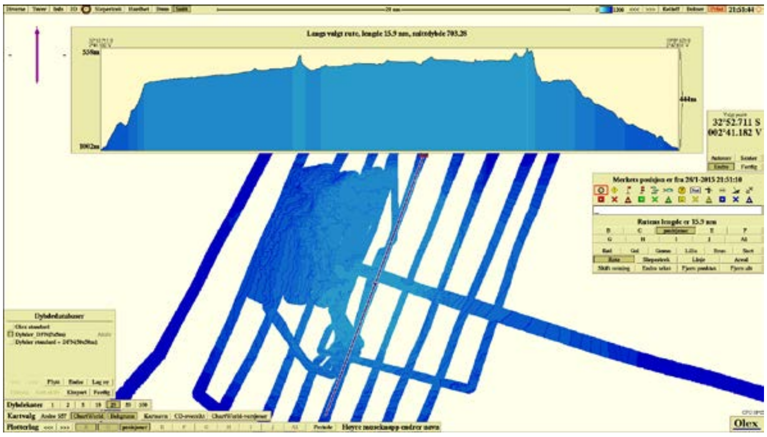


Figure 19a). Bathymetry of Wüst, Location 2, showing a bathymetry profile of the flat-topped summit along the arrowed solid line.

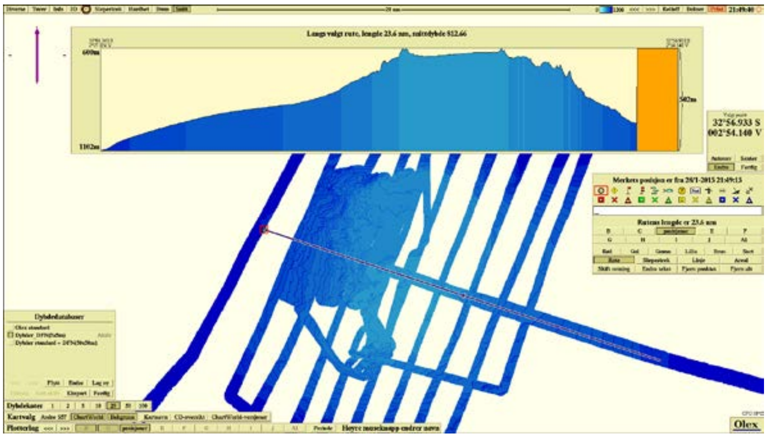


Figure 19b). Bathymetry of Wüst, Location 2, showing a bathymetry profile of the flat-topped summit along the arrowed solid line.

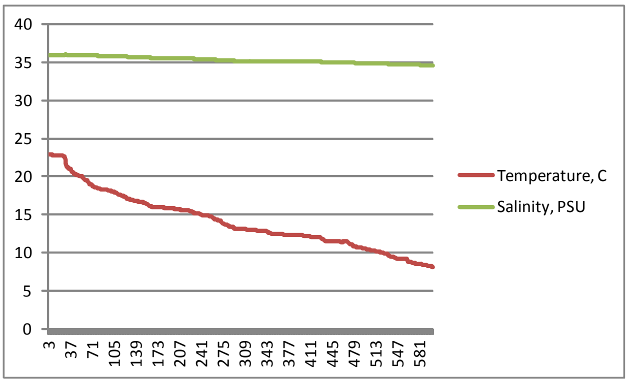


Figure 20. Depth profile (surface to 600 m) of temperature and salinity at Wüst Location2 (33^o 03.10 S, 002^o 45.89 W, 26 Jan 2015).

Substrate and VME indicator observations (video, trawl and grab samples)

In total, 5 CAMPOD dives were made in Wüst Location 2 (Table 1). Of these three were upslope transects starting on the slope at 708-890m and approaching the main plateau from the southwest, west and north, reaching plateau depths of around 600m. The remaining 2 dives were transects up the slopes of two central summit knolls, i.e. the shallowest points of the seamount.

On the lower western slope at 775 to 755 m the sandy and gravelly sediment formed large sharply crested dunes, in subareas rippled dunes. Further up the slope, hard substrate occurred and appeared as a mixture of consolidated coral framework (sheets, broken up fragments) and coral rubble (Fig. 22). Corals were common at depths shallower than 740m and

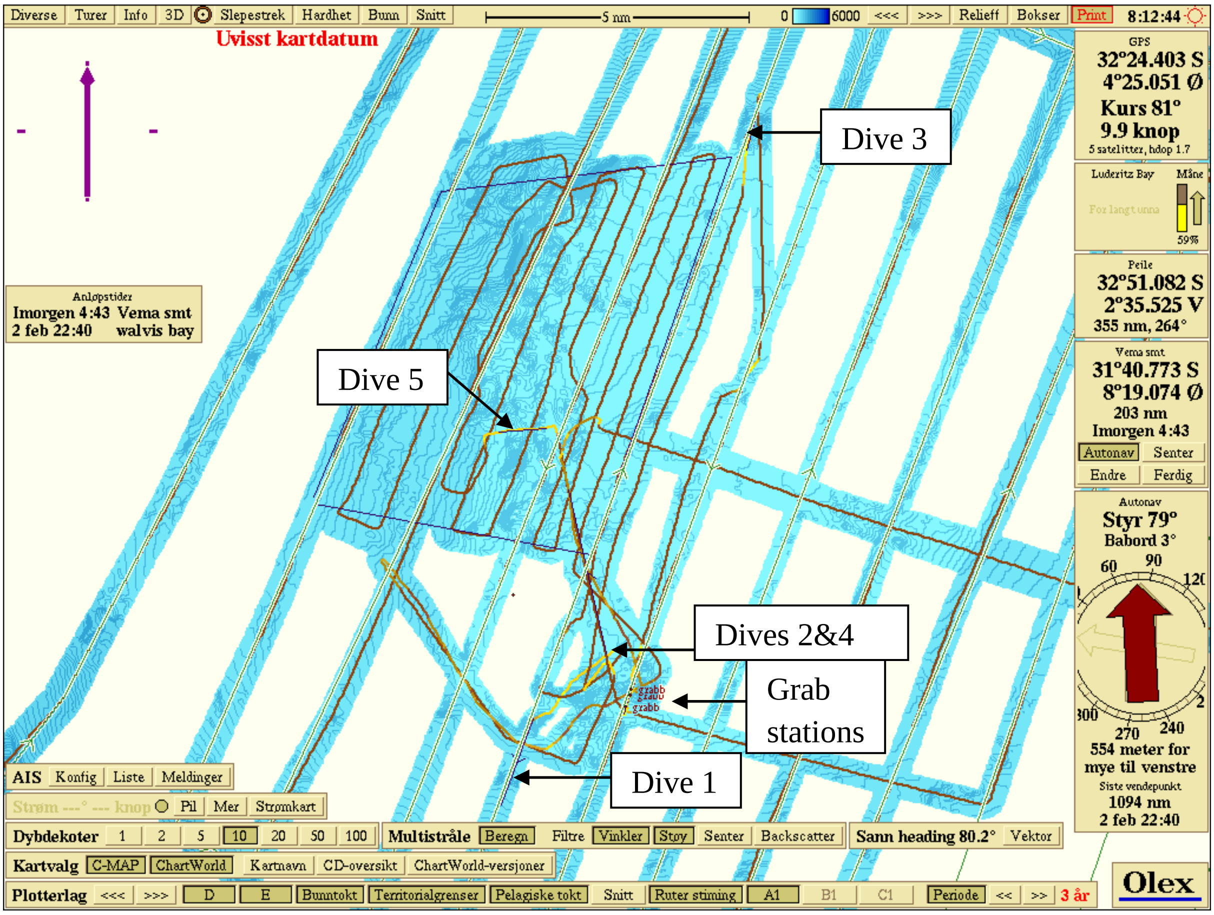


Figure 21. Locations of CAMPOD dives and grab stations (3 sites), on Wüst Loc. 2.

comprised whip-like gorgonians, black corals (antipatharia), and scattered small colonies of scleractinians. On neither of the slopes did the corals form 'gardens' or reefs, but the abundance was high compared with that on the previous seamounts. Counts along the transects are shown in Figure 24. Gorgonians increased up the slope, but seemed to reach a maximum and then declined towards the summits. Abundance was highest on the southern slope. The scleractinians, probably mostly *Enallopsammia rostrata*, also increased in density up the slopes, but then declined towards the summit. Many colonies were yellow, i.e. live colonies, or white. On the northern slope the first live scleractinians appeared at about 850m, on the southern slope at around 700m, and to the west at 730m, but in all cases colonies were scattered and few compared with the widespread coral rubble and consolidated coral framework. Exposed bedrock was not common.

The two knoll dives (Dives 2 &4) were used to explore the shallowest areas of Wüst Location 2, and transect depths ranged from around 620 to 550m. At the base the substrate was patches of hard substrate (provisionally regarded as ancient coral framework), and big flats of coral rubble, i.e. unconsolidated dead scleractinian coral. On the hard substrate, whip-like gorgonians were very numerous. Live scleractinians occurred as scattered colonies, and as on the summit slopes, the species appeared to be *Enallopsammia rostrata* (Fig. 22). Also scattered on hard substrate were colonies of antipatharians (black corals, order Antipatharia), and the counts were particularly high on the knoll visited in Dive 2 (Fig. 24). The density of coral was highest on the slopes of the knolls and declined at the summits, but the distributions were everywhere patchy. The terrain became very rugged in the shallower parts.

Three grab was operated on the plateau and upper slope at depths of 700, 630, and 560m. These grabs produced a range of samples (Appendix Table 2), including coral rubble identified as dead *Enallopsammia rostrata*.

Fisheries resources observations

Single specimens of alfonsino (*Beryx* sp.) and pelagic armourhead (*Pseudopentaceros richardsoni)* were observed in several of the dives, but towards the summit of the plateau knolls (Dives 2 & 4) both species were very numerous and occurred as aggregations near the rough seabed (Fig. 23). These aggregations were small and not visible on echograms from the area, perhaps because of the rugged terrain and the positions of the fish near the seabed. Other fish species that were common in the video record were grenadiers (*Tripterophycis* sp.), bluemouth (*Helicolenus* sp.), and *Centriscops* sp..

Two midwater trawl stations were made above plateau depths (St. 2 and 3 in Appendix Table 1). In St. 2 the trawl was deployed at 460-750m above bottom depths of 750-800m, and the catch comprised 20 specimens of splendid alfonsino (*Beryx splendens*), some other demersal fish, mesopelagic fishes, and at least four species of cephalopods. The second trawl at 450-570m about 100 m off the seabed produced only small numbers of mesopelagic fish.

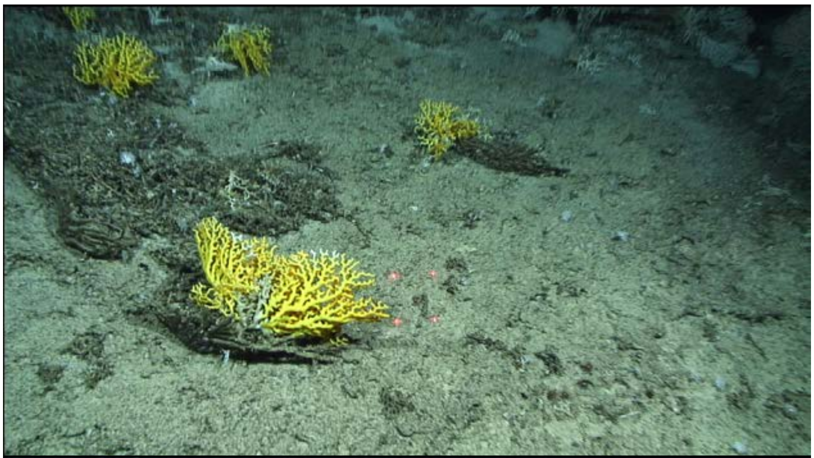
A 24 hour acoustic survey was conducted across the seamount as shown in Figure 25. The echograms show the prominent mesopelagic scattering layer impinging on the summit of the seamount throughout the day. During the night a portion of the layer migrated into near-surface waters, and this migration is particularly well reflected in the 18 KHz echogram (Fig. 25, top graph).

Indications of fishing impacts

No observations of lost gear or other footprint of fishing were made.

Figure 22. Example observations from upper slope dives on Wüst Location2.

Scleractinian coral colony (partly dead) on hard ground, which may be ancient consolidated coral framework.



Live scleractinian corals, probably *Enallopsammia rostrata*

Probably ancient coral framework forming sheets.

Whip-like gorgonians attached to consolidated substrate (left), scleractinian colony with echinoids attached (central), and coral rubble (right hand side).

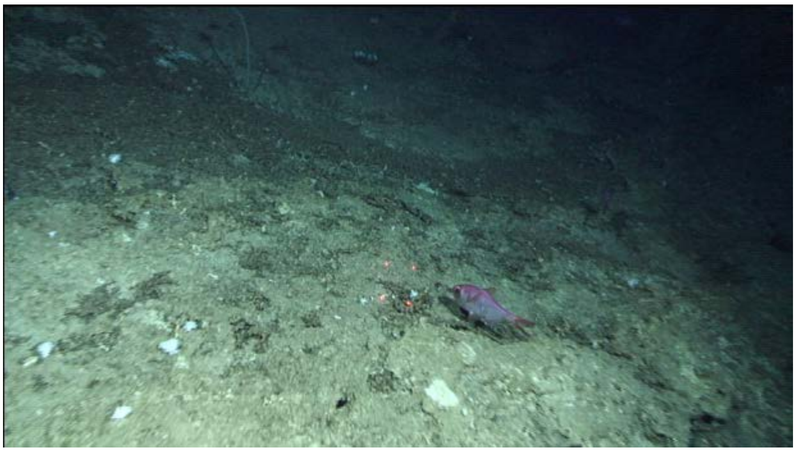
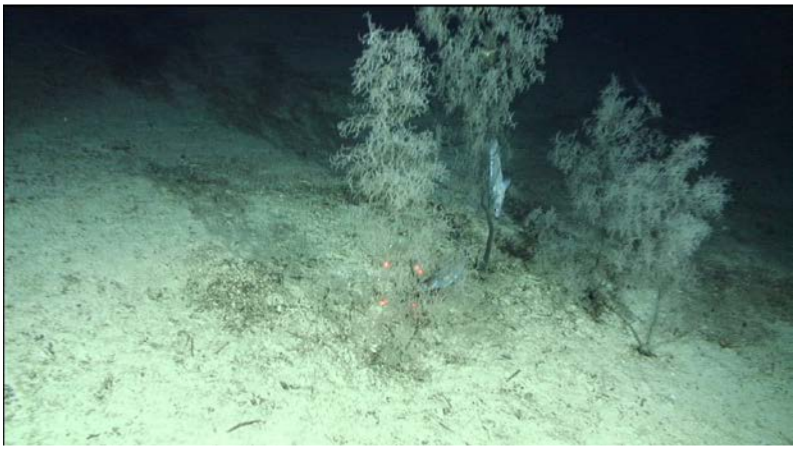


Figure 23. Example observations from knoll dives on Wüst Location2 (Dives 2&4).

Alfonsino above hard ground.,

Alfonsinos observed in midwater in the near-bottom layer.

Pelagic armourhead (boarfish) aggregations near summit of knoll.



A fish (Tripterophycis sp.) associated with black coral colonies (Antipatharia), probably Leiopathes sp..

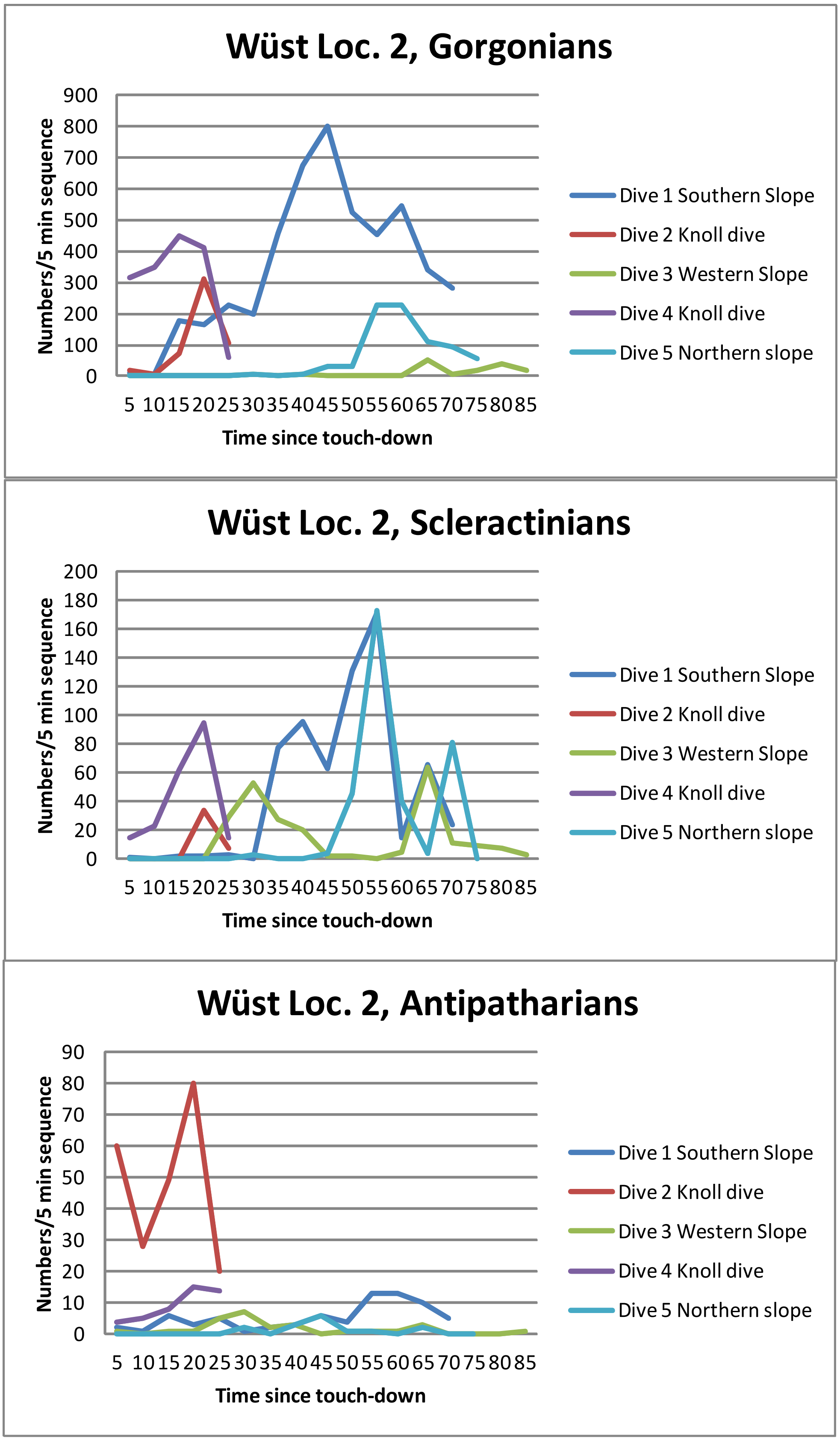
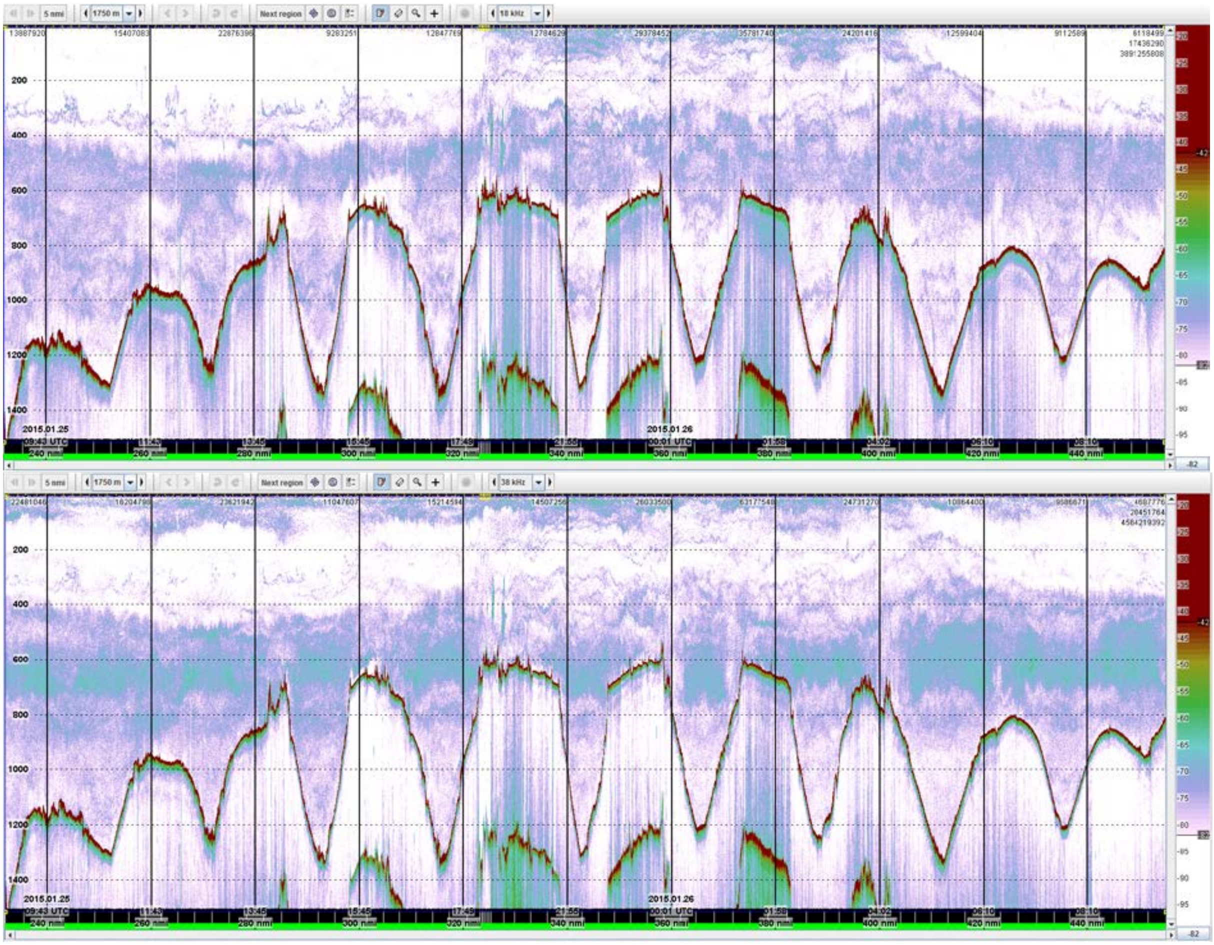


Figure 24. Counts of coral taxa along transects up the slope of the summit (Dives 1, 3, 5) and summit knolls (Dive 2 &4) of Wüst Location 2.



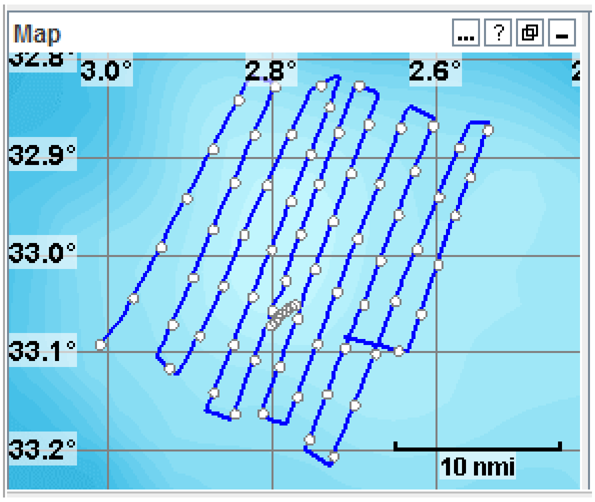


Figure 25. Echograms from acoustic survey of the Wüst Location 2. The map to the left shows the track of the vessel during multiple crossings of the seamount during a 24 hour period. Echograms show results from 18 KHz (top) and 38 KHz (bottom) transducers.

Vema Seamount

Locations, bathymetry, hydrography

In contrast with Wüst Seamount being associated with the Walvis Ridge, the Vema lies isolated in the middle of a deep abyssal plain at 31° 38 S, 008° 20 E. It is a spectacular conical feature rising from the abyssal plain with depths exceeding 3000m. Vema is closed to fishing by SEAFO, and the square closure area extends in all directions to abyssal depths.

Multibeam acoustic mapping by the R/V *Dr. Fridtjof Nansen* complemented mapping conducted in 2008 by the R/V *G.O.Sars* (Data curated by the Norwegian Marine Data Centre at IMR, Norway). The now fully mapped seamount summit (Fig. 26, 27) was determined to be rather flat with depths of 90-100m. The relief map (Fig. 27) illustrates the subareas shallower than 150m and show several summit hills with the shallowest estimated to 21.5m. The flat summit is about 11 km across in the E-W direction and 8.5 km in the N-S direction. Figure 28 shows the currently observed bathymetry of the seamount from different angles. The hardness index derived by Olex suggests mostly hard substrate across the summit and on the upper slopes.

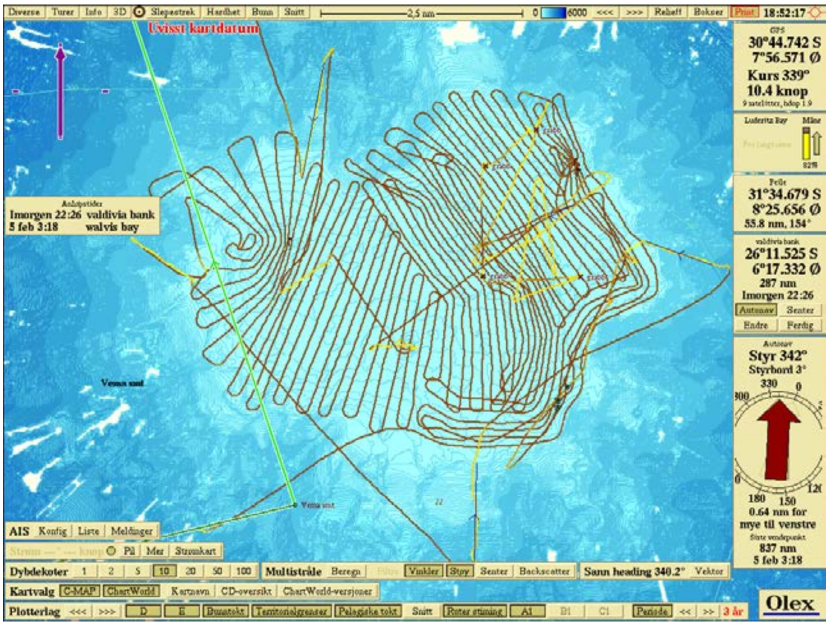


Figure 26. Track of the RV Dr. Fridtjof Nansen during bathymetry mapping and sampling on the Vema Seamount, 2015.

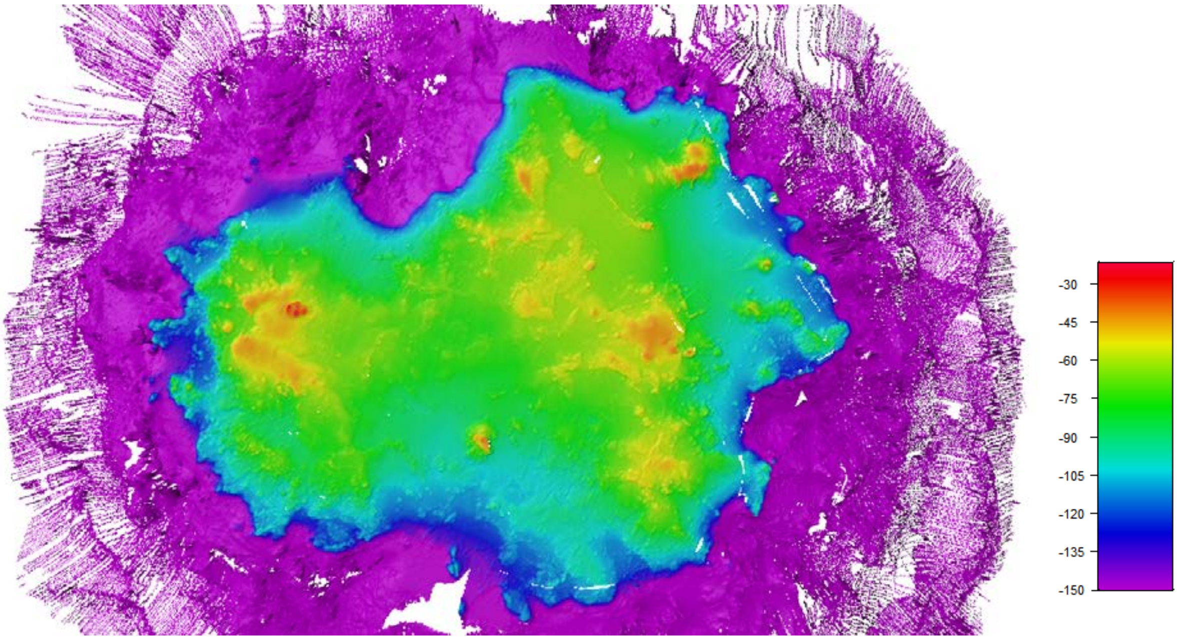


Figure 27. Bathymetry of the summit of Vema resulting from the mapping conducted by the RV G.O.Sars in 2008 and completed in 2015 by the RV Dr Fridtjof Nansen. Colour scale shows depths in metres, and areas beyond 150m are violet.

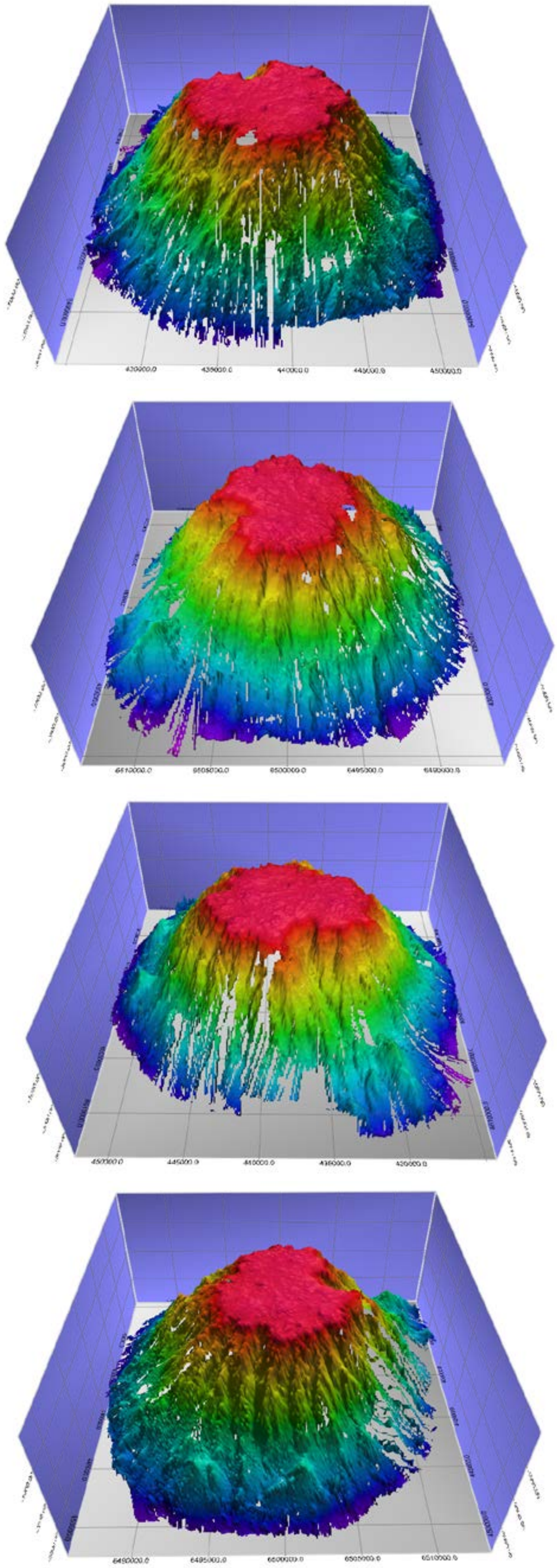


Figure 28. Reliefs of the Vema seen from the South (top graph), West, North and East (bottom graph).

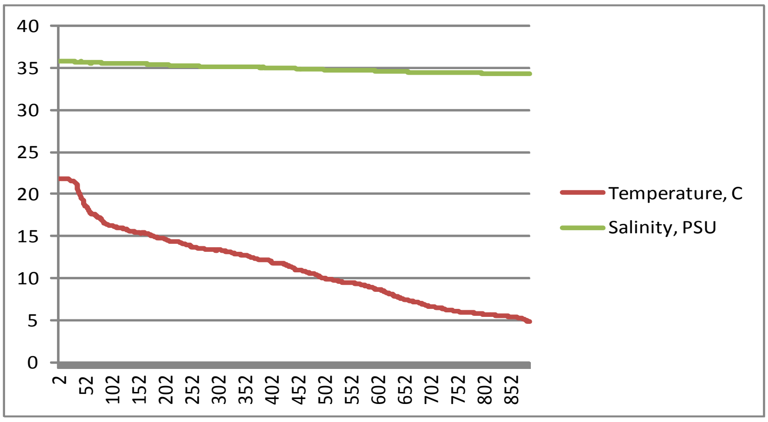


Figure 29. Depth profile (surface to 900 m) of temperature and salinity at Vema (31° 41.10 S, 008° 17.77 E, 30 Jan 2015).

The hydrographic profile from the surface to 900 m showed a decline in temperature from 21.8°C in the surface to 16-18°C at the depth of the summit (<100m) of the seamount (Fig. 29). Down the slope the temperature declined to about 5° C at 900m and probably somewhat further with depth. The near-summit salinity was 35.6 PSU.

Substrate and VME indicator observations (video, trawl and grab samples)

Seven CAMPOD dives were made on the Vema (Table 1, Fig. 30), but Dive 4 on the summit was interrupted because the vehicle snagged in an old pot rope. Dives 1, 2, 3, and 7 were upslope transects approaching the summit from different directions, and the remainder were comparatively short transects on the summit plateau and on summit knolls. Since Vema is shallow (summit <100m) the slope transects starting at 708-935m spanned a wider depth range than dives in other locations described thus far.

At the deeper end of all the slope transects, the substrate was white to yellow sand and gravel, but in many cases covered with coarse near spherical pebbles with diameters of 5 cm or less (Fig. 31). These pebbles were patchily distributed near rocky outcrops that appeared as consolidated coral framework. A suggestion was that the pebbles were abraded broken-off fragments of consolidated coral framework. On the western slope coral framework was the dominant habitat on the upper slope, on the other slopes exposed black bedrock (presumably) basalt was also present.

Live coral comprised colonies of fans-shaped gorgonians, antipatharians and scleractinians (Fig. 31) which appeared more prominent when approaching the summit (Fig. 33). Only the antipatharians formed large aggregations (gardens) (Fig. 31). The scleractinians were small yellow colonies, but not the same species as seen in deeper seamounts (e.g. Wüst). For all the coral taxa, the numbers declined with depth on the slope.

At the summit (rim) of the plateau the substrate was rocky outcrops and sandy and gravelly plains, the latter also with coralline algae. The summit is in the euphotic zone, and sessile macroalgae were also observed in the shallow knoll dives (Fig. 32) in which also prominent kelp forests occurred. The knolls were rugged and rocky, with intervening plains covered in coralline algae sometimes overgrown with green and/or brown macroalgae. A prominent feature of the summit was also extensive antipatharian gardens (Fig 31).

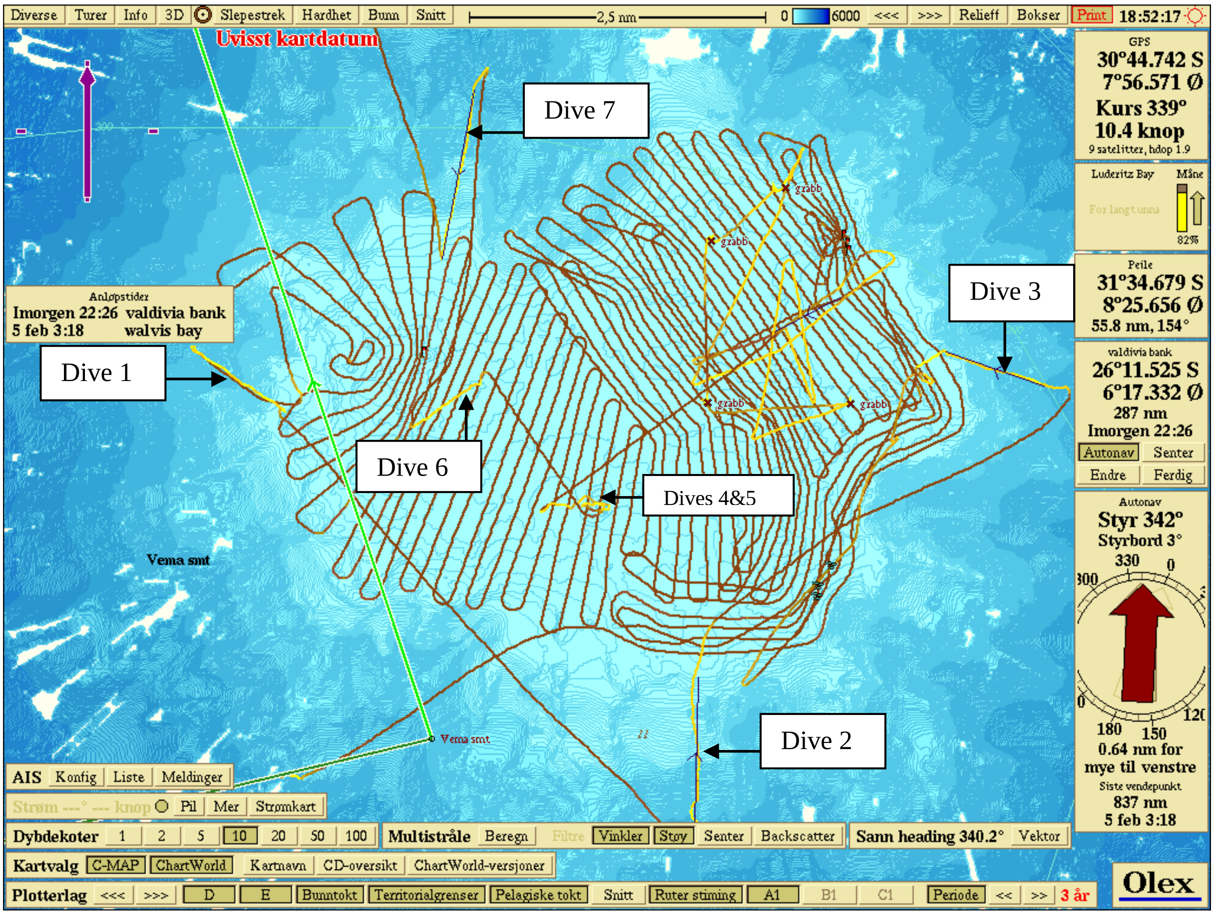


Figure 30. Vessel track and distribution of CAMPOD Dives and grabs (denoted 'grabb') on Vema. Midwater trawls were made in the vicinity of the grab positions.

Other relatively prominent invertebrate phyla in Vema were sponges (Porifera) which were comparatively common in deeper parts of the slope transects 2, 3, and 7. Echinoderms were widespread, in particular echinoids, and on the summit flats holothurians were common. Crustaceans were often observed, including few scattered individuals of deep-sea red crab (*Chaceon* sp.). Grabs were used extensively in four summit locations (Fig. 30) but did not produce samples, presumably because the substrate was too hard.

Fisheries resources observations

Low numbers of the SEAFO target resources pelagic armourhead, alfonsino and deep-sea red crab were present on the Vema upper slope but not the summit. Only armourhead showed a rather consistent pattern in all slope transects with increasing numbers towards the summit depth and then disappearance at the shallow end of the dives (Fig. 33). Shoals of epipelagic species were observed over the summit and the fish diversity in the kelp gardens was apparently high. The summit species assemblage resembled those described from similar habitats in adjacent African shelf waters (Ramil, pers. comm.). Unfortunately, the summit habitats could not be sampled adequately to describe the species composition.

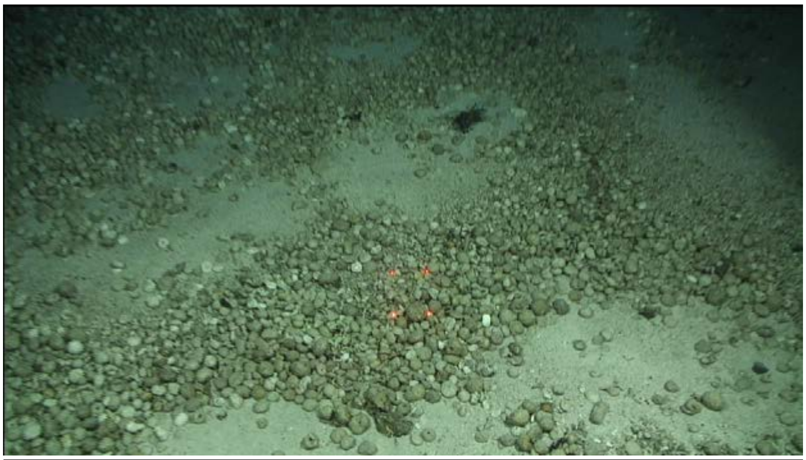
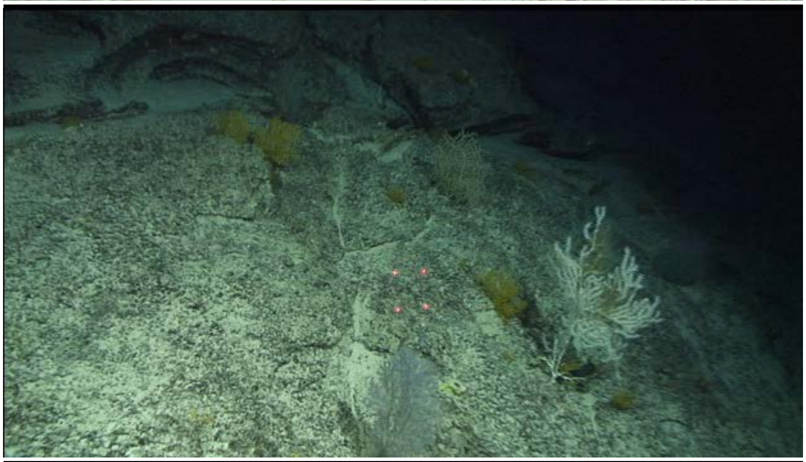
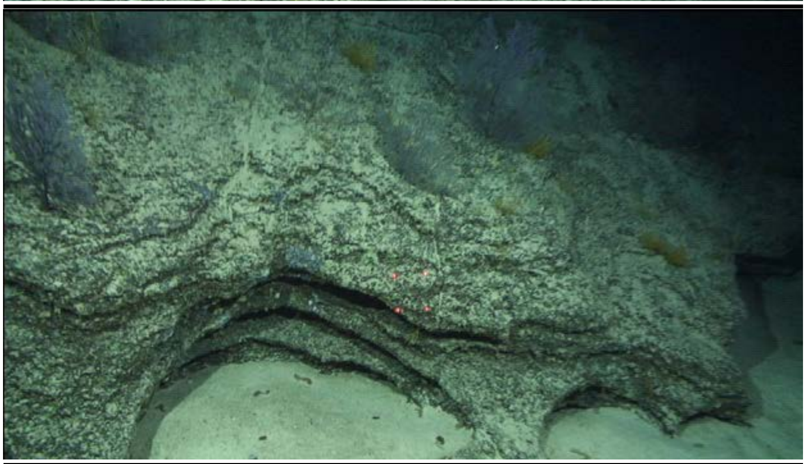


Figure 31. Images from CAMPOD dives up the slopes of Vema.

Spherical pebbles partly covering white sediment on the slopes.



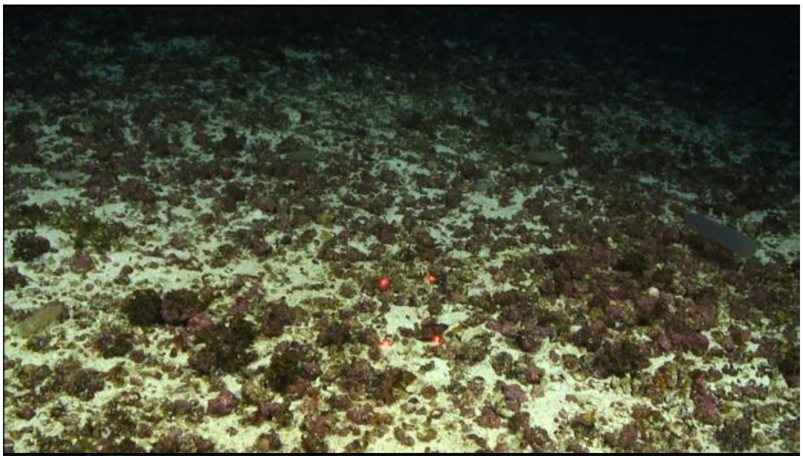
Gorgonian (white) and scleractinian (yellow) coral colonies



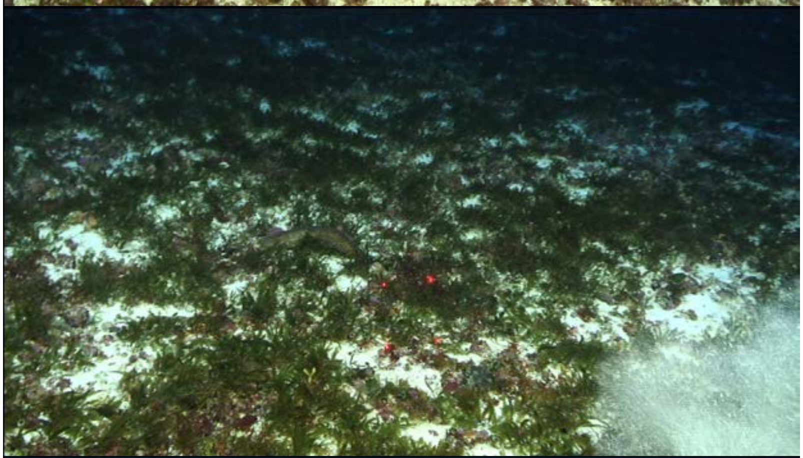
Rock ledge with colonies of antipatharians (black coral)

Black coral garden on the rim of the seamount.

Figure 32. Images from CAMPOD dives on the summit of Vema, i.e. knoll dives 4, 5, 6 in waters less than 100 m.



Encrusted (coralline) red algae on white biogenic sand.

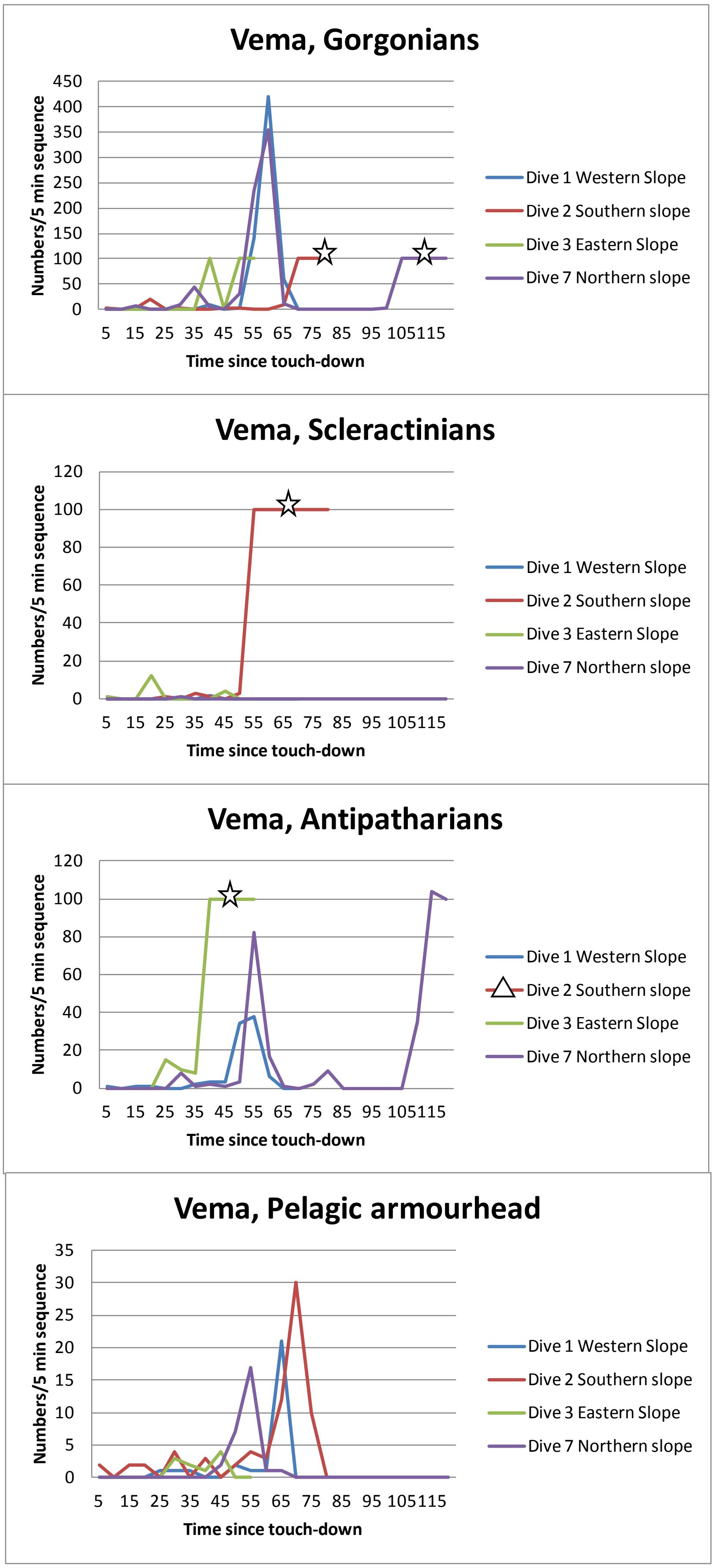


Green algae probably growing on encrusted red algae. Note the holothurian in middle of picture.

Kelp 'forest'

Kelp, green algae and yellow wrasses. White floating tube is a pyrosome.

Figure 33. Counts of selected taxa along upslope transects on Vema.

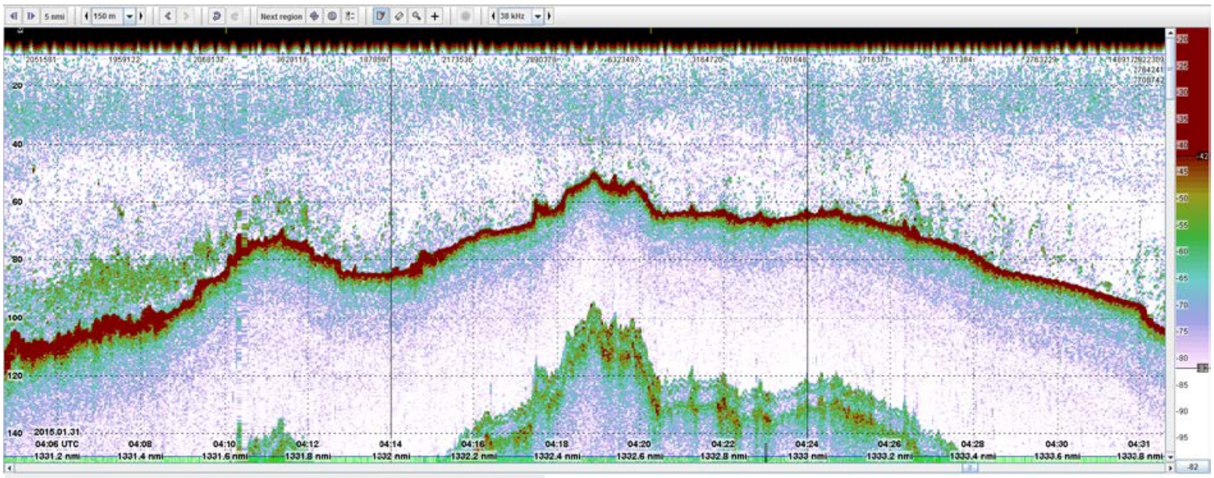


☆ counts too high to be recorded

△ Antipatharians were also common in the transect up the southern slope (Dive 2), but formed dense gardens where individuals could not be counted.

Figure 34. Images of lost fishing gear on the Vema.

Acoustic transects were run across the summit (Fig. 35) and near-bottom shoals of fish were observed off the rough untrawlable ground. These shoals may be produced by epipelagic species observed occasionally during the CAMPOD dives. Two trawls were deployed, one 45 minute midwater tow, and one 10 min bottom trawl tow (Appendix Table 1). The former snagged and the trawl was ripped. The midwater catch was small (1.55kg), comprising numerous pyrosoma and a few mesopelagic fish. The bottom trawl also contained numerous pyrosomes and holothurians (*Holothuria* sp.), a single octopod (*Octopus magnificus),* 20 specimens of the eel *Gnathophis capensis,* and single specimens of bluemouth *(Helicolenus dactylopterus),* and a sparid.



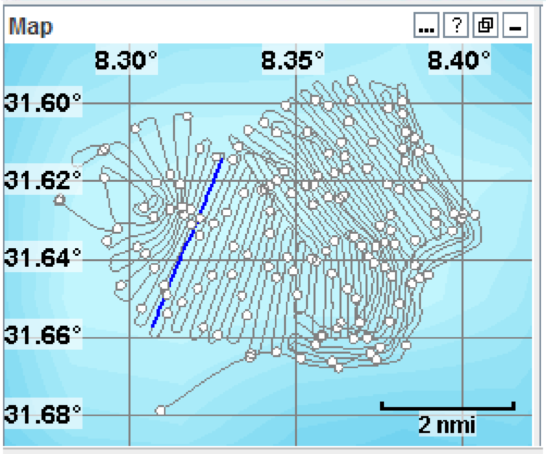


Figure 35. Echogram (38 KHz transducer) from a nighttime transect crossing the Vema summit from SW to NE. Shoals of fish were observed near the rather rugged and hard seabed. The transect is shown as a blue line in the map to the left.

Indications of fishing impacts

Footprints of past fisheries and other human activity were widespread on the upper slope and on the summit of Vema. Lost and apparently old lobster or crab pots and rope were commonly observed in the video transects (Fig. 34). As mentioned above, the CAMPOD snagged in an abandoned rope during Dive 5 on the summit. No evidence of trawling activity was found.

The abundance of lost pots may be illustrated by the following records from individual upper slope CAMPOD dives:
Dive 1: 7 pots, 4 ropes. Incidence (number/km transect length): 6.6
Dive 2: 2 pots, 2 ropes. Incidence: 1.8
Dive 3: 2 pots, 6 ropes. Incidence: 3.9
Dive7: 0 pots, 2 ropes, 3 other human items. Incidence (number/m transect): 1.9

Valdivia Bank and associated seamount complex

Locations, bathymetry, hydrography

The Valdivia bank and surrounding seamounts lie on the northeast Walvis Ridge. Compared with the other seamounts visited, this is a complex area and four widely spaced subareas were visited (Fig. 36). Valdivia is open to fishing, and has been the main fishing area for trawl fisheries for alfonsino and pelagic armourhead (boarfish) as well as deep-sea red crab.

The extensive Spanish-Namibian exploration of the same area in 2007 and 2010 on the R/V *Vizconde de Eza* generated multibeam acoustics data that were available to SEAFO and the *Dr Fridtjof Nansen* cruise. Thus only supplementary bathymetry data were collected.

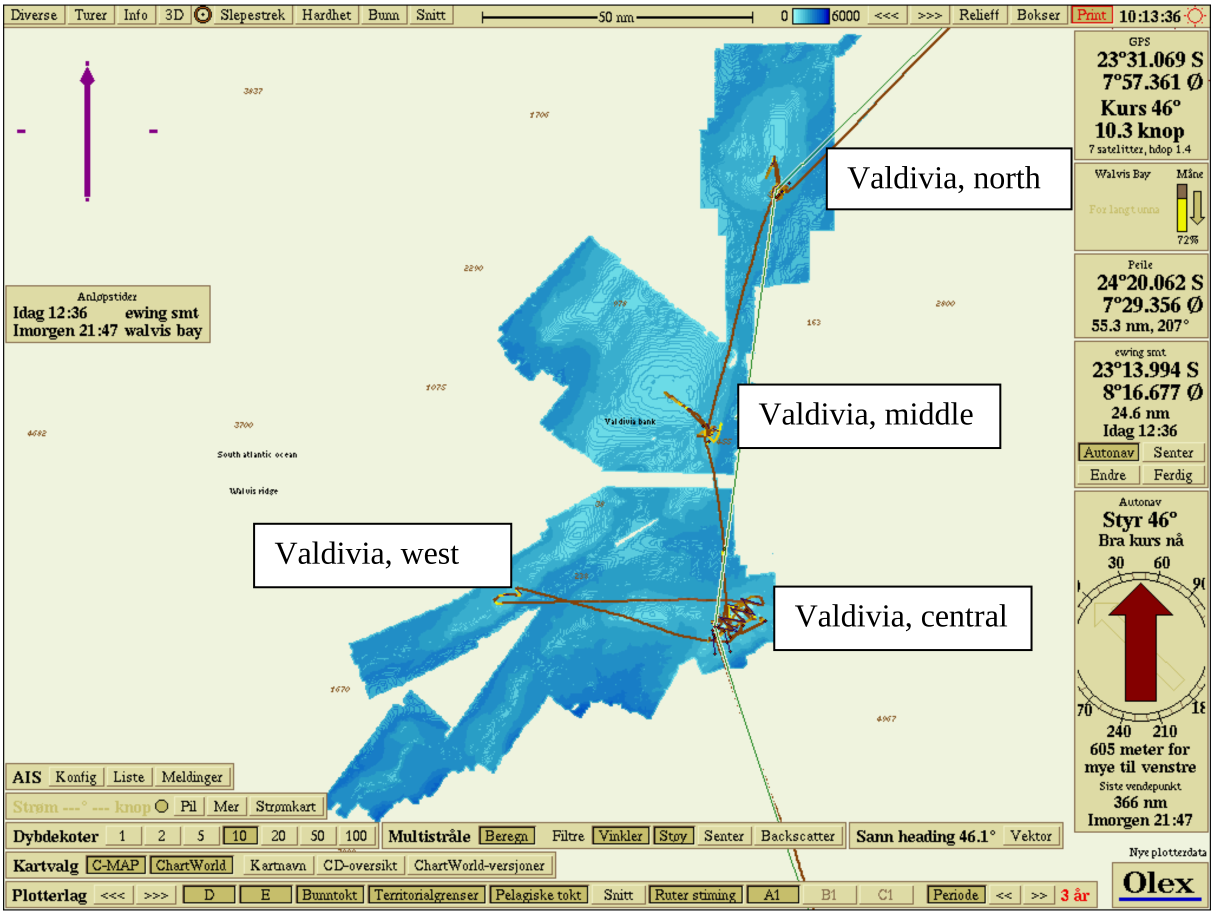
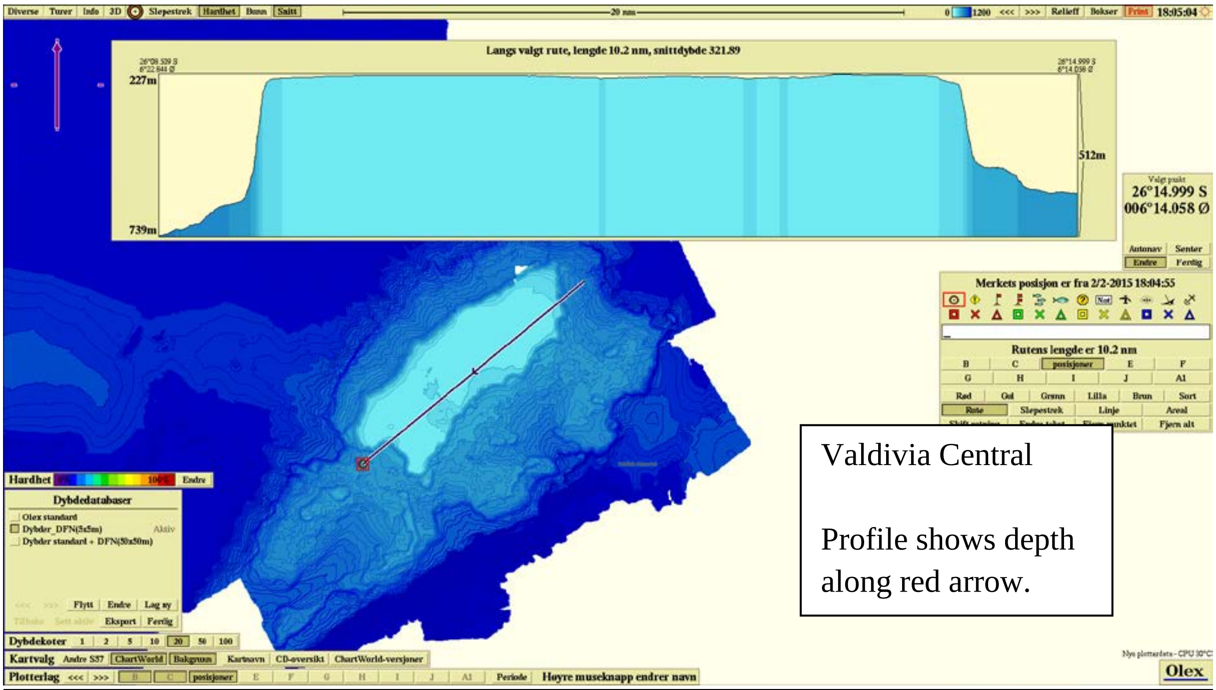
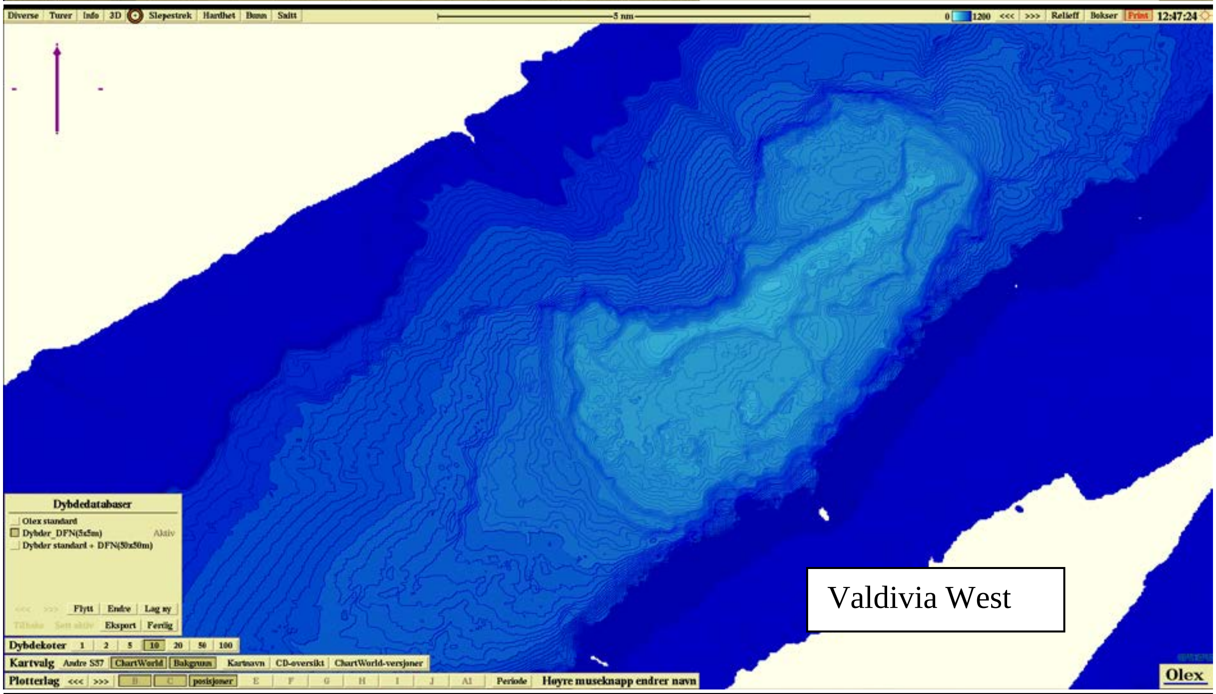


Figure 36. Valdivia Bank and surrounding seamounts on the Walvis Ridge. The RV Dr Fridtjof Nansen (DFN) visited the four subareas as indicated (subarea names shown are those adopted by this investigation for practical purposes, not names established by any public authority). Detailed bathymetries of each subarea are provided in Figure 37. Blue area with isobaths had previously been mapped by multibeam echosounders (see text). Red lines are tracks of the RV DFN.


Langs valgt rute, lengde 10.2 nm, snittdybde 321.89
227m
512m
739m
26°14.999 S
006°14.058 Ø
Valdivia Central

Profile shows depth along red arrow.
Olex


Valdivia West
Olex

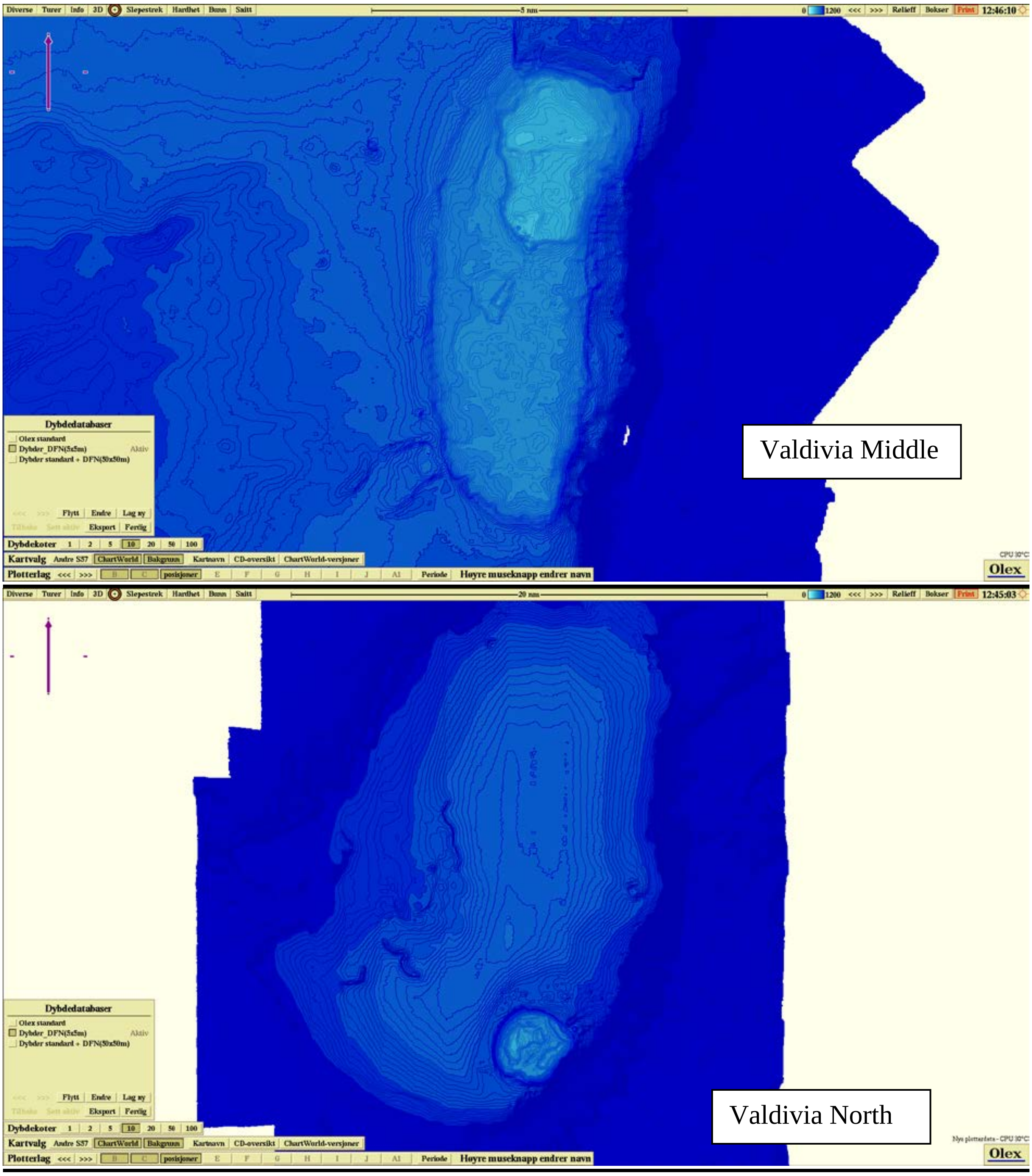


Figure 37. Bathymetry of the four subareas indicated in Figure 36.

The subarea denoted Valdivia Central (Fig. 37, top image) comprises the prominent almost flat Valdivia bank with a plateau depth of 227-235 m and surrounding complex areas of small knolls and big deep flat areas (to the north). The elongate Valdivia Bank plateau is about 46.3 km long and 5.8 km wide.

Valdivia West is smaller and more complex, and the shallower hills are around 470m. Valdivia Middle and North are elongate in the north-south direction with single more or less circular summits in the north and south, respectively. Both have adjacent broad 1000m deep plains.

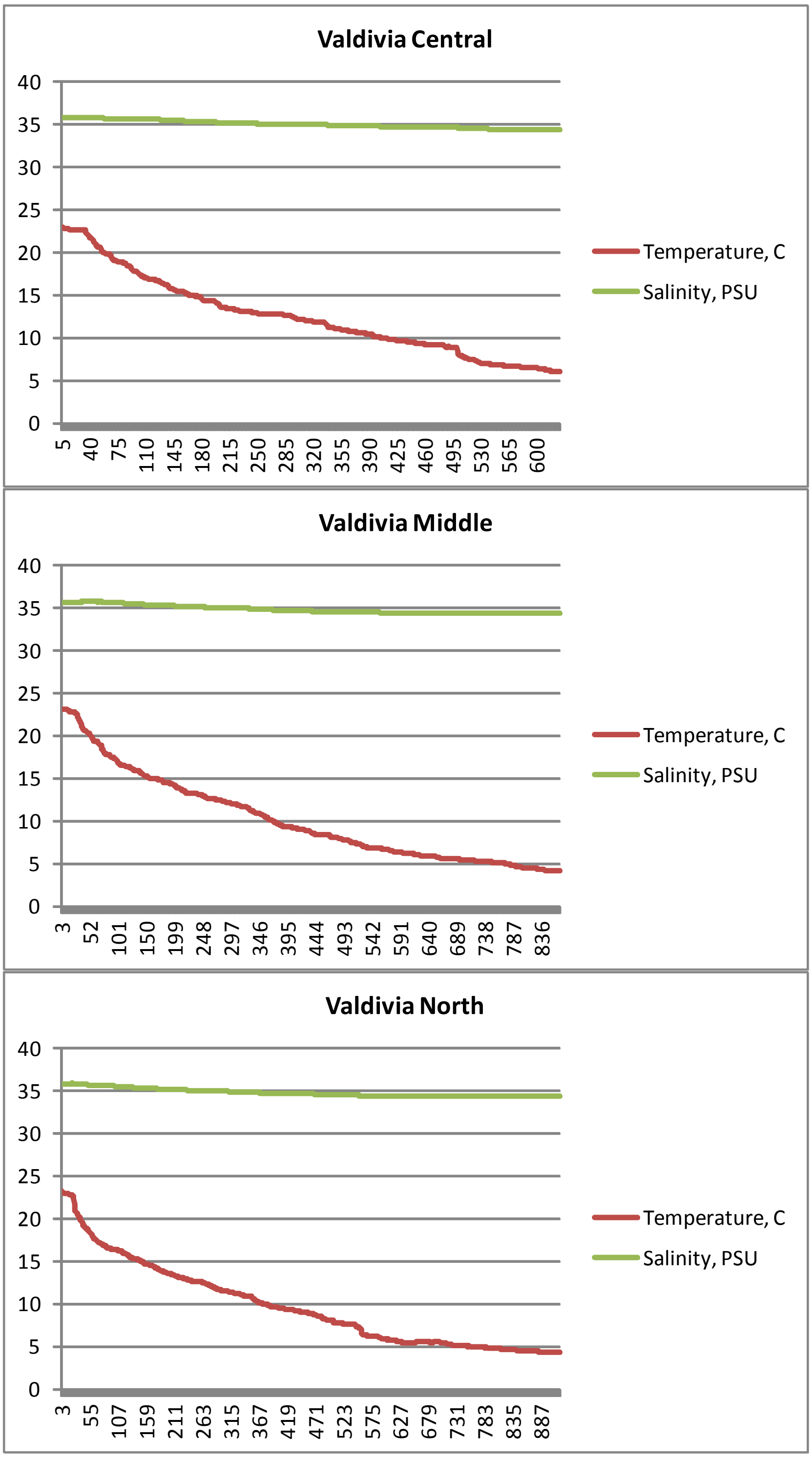


Figure 38. Depth profiles of temperature in different subareas (Fig. 41) of Valdivia. Note difference in depth scale.

Profiles of temperature and salinity by depth are shown in Figure 38. The profiles are very similar in the different subareas sampled.

Substrate and VME indicator observations (video, trawl and grab samples)

Valdivia Central

Valdivia Central was explored with 7 CAMPOD dives up the slope of the flat bank (Table 1, Fig. 39, Dives 1, 2, 4) and on smaller and deeper knolls to the southeast and southwest of the bank (Dives 3, 5, 9, 10).

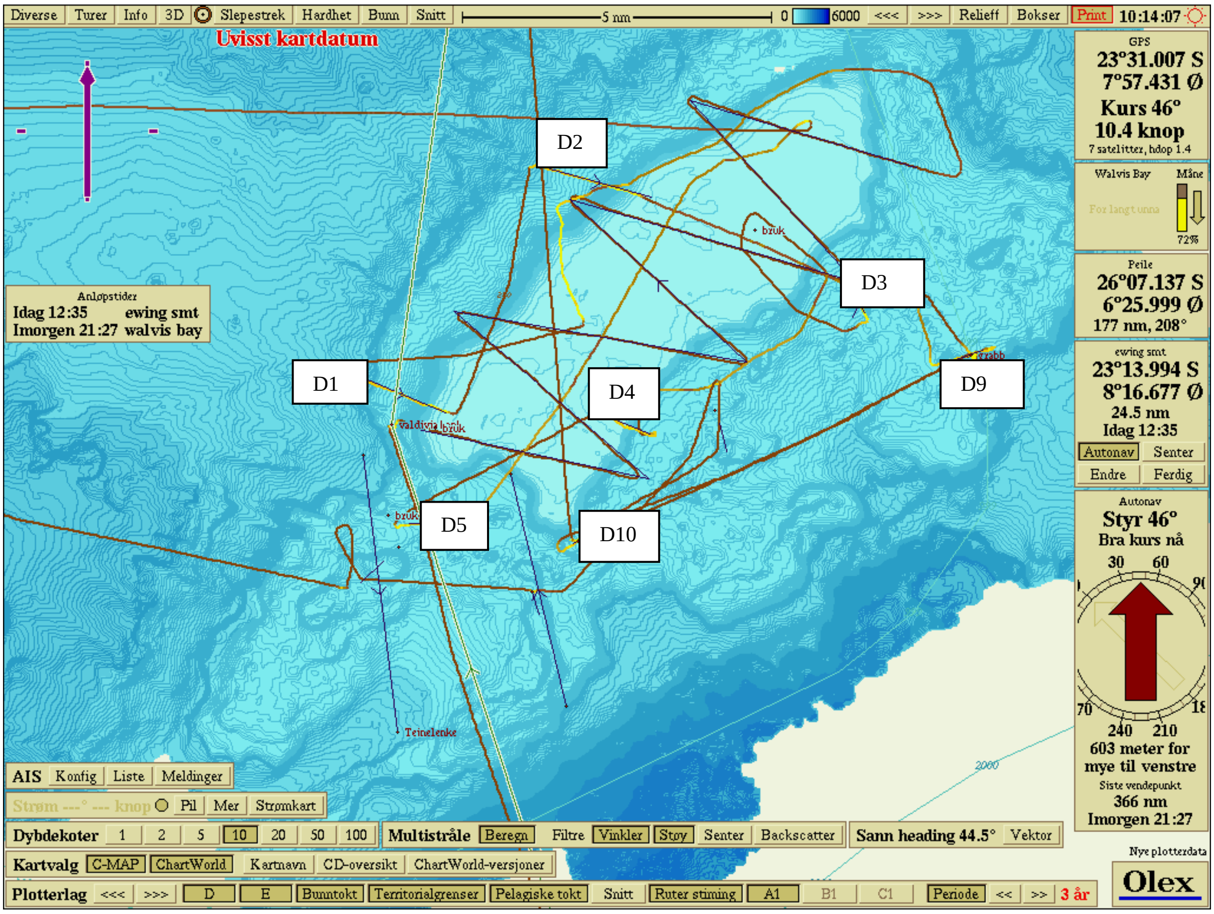


Figure 39. Vessel track and distribution of CAMPOD dives (D1-10) in the Valdivia Central subarea.

The slope dives started on adjacent sedimentary flats at 800-900m on the northern side, and 550m on the southeast side of the bank, and ended on top of the bank at 230-240 m. At the base the sediment was rippled sand and coral rubble. Up the steep slopes and on the flat plateau the substrate was bare rock (Fig. 41).

Figure 40 shows counts of corals and deep-sea red crab in the upslope dives on the northern and southeastern side of the Valdivia Bank. (The depth range on the northern side is much wider than on the southeastern side, hence the durations of the dives are very different.) Live corals were very patchily distributed, and with the exception of numerous soft gorgonians on the summit in the southeast, the numbers declined markedly at the end of the dives when the vehicle reached the flat plateau. Live scleractinians were mainly observed in crevices of the steep rocky slope, but colonies were small and scattered. In addition to the taxa displayed in

Fig. 40, seapens (Pennatulacea) were quite abundant on relatively soft ground on the southeastern slope, but not on the much steeper northern slope. Many other invertebrate taxa were also recorded, but they were scattered and occurred in relatively small numbers.

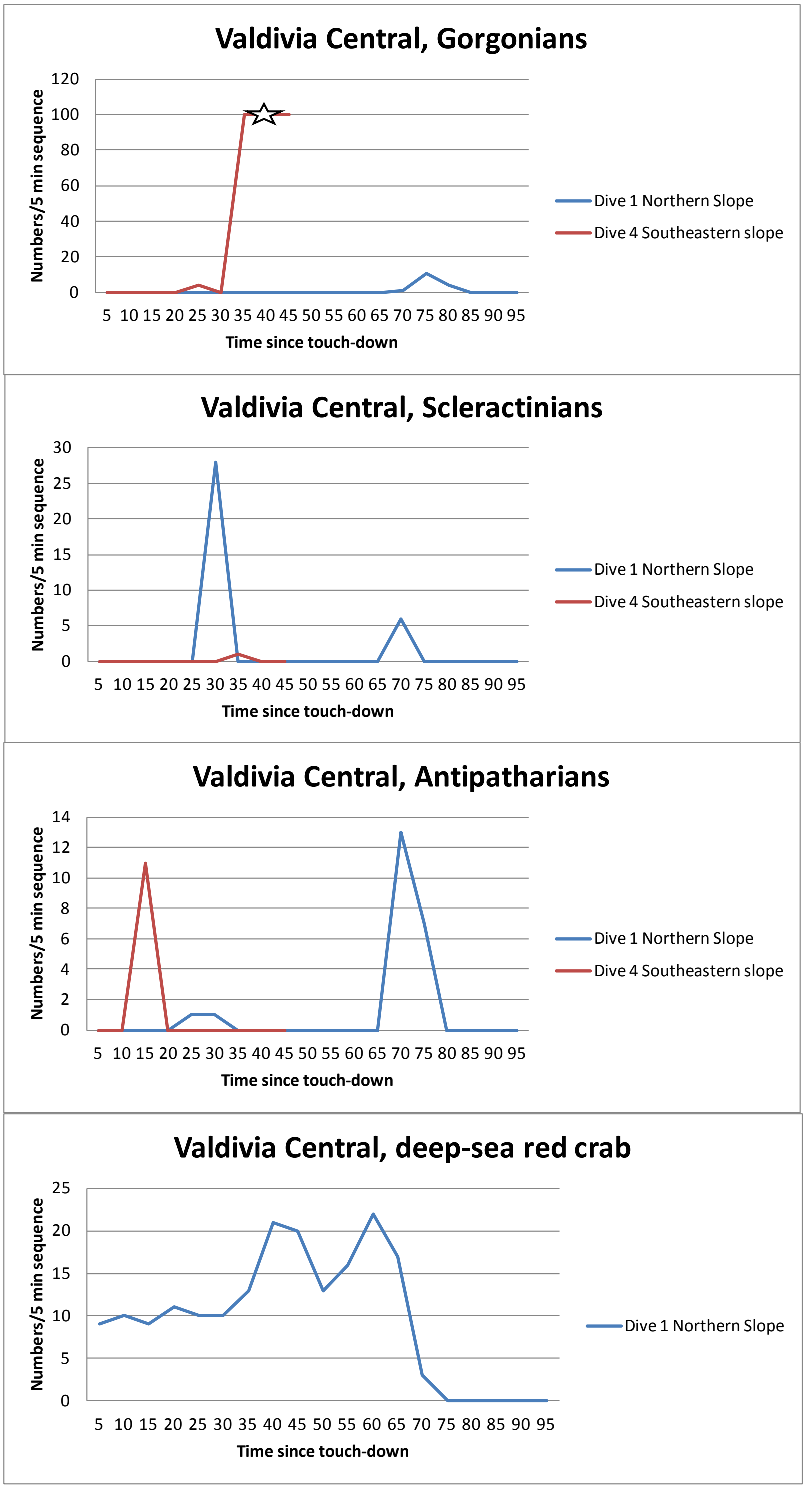


Figure 40. Counts of selected VME indicators (corals) and deep-sea red crab in slope dives of the Valdivia Bank in the Valdivia Central subarea.

Deep-sea redcrabs (*Chaceon* sp.) were numerous at the base and up the slope of Valdivia bank, but not on the bare rocky plateau of the bank.

The dives on the deeper knolls to the south of Valdivia Bank (Dives 3, 5, 9, and 10 shown in Fig. 39 and 42) revealed a rather different fauna and habitat. On all the lower slopes of the knolls, coral rubble, i.e. dead scleractinian fragments, was common. Up the slopes the density of live coral of several taxa (gorgonians, antipatharians and scleractinians) became denser, and particularly in Dives 5 and 9 the abundance was so high that the entire substrate was covered in live coral (Fig. 43). A common term used for such features are 'coral gardens'. The abundance of corals on these knolls was too high to facilitate enumeration. The depth range of highest coral density differed between knolls, i.e. in Dive 5 it was 575-625m and Dive 9 rather 460-475 (near summit) (Fig. 44).

Grab sampling was carried out in the locations of Dives 9 and 10. Only the Grab 14B at 622m in dive location 9 resulted in a significant catch (Appendix Table 2), including bryozoans, polychaetes, isopods, and the scleractinian coral *Enallopsammia rostrata*.

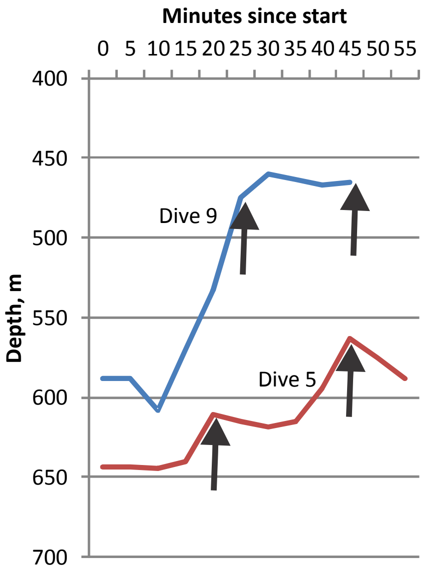


Figure 44. Distribution by depth and dive duration of coral gardens observed during Campod Dives 5 and 9 south of Valdivia Bank. Coral density was highest between the black arrows.

Valdivia West

Three CAMPOD dives were made in the subarea denoted Valdivia West (Fig. 37), i.e. Dives 6, 7, and 8 in Table 1. All were upslope dives, but only Dive 7 reached the shallowest summit at 460m. The patterns were similar to those in the Valdivia Bank slope dives with soft sediments at the base of the hills, increasing coral rubble on the slopes and then exposed coral framework/bedrock towards the summit. Densities of corals of all taxa were low and no features would be described as coral gardens as in the knolls adjacent to Valdivia Bank in Valdivia Central subarea. On the shallowest seamount explored in Dive 7 the summit was bare rock as on Valdivia Bank.

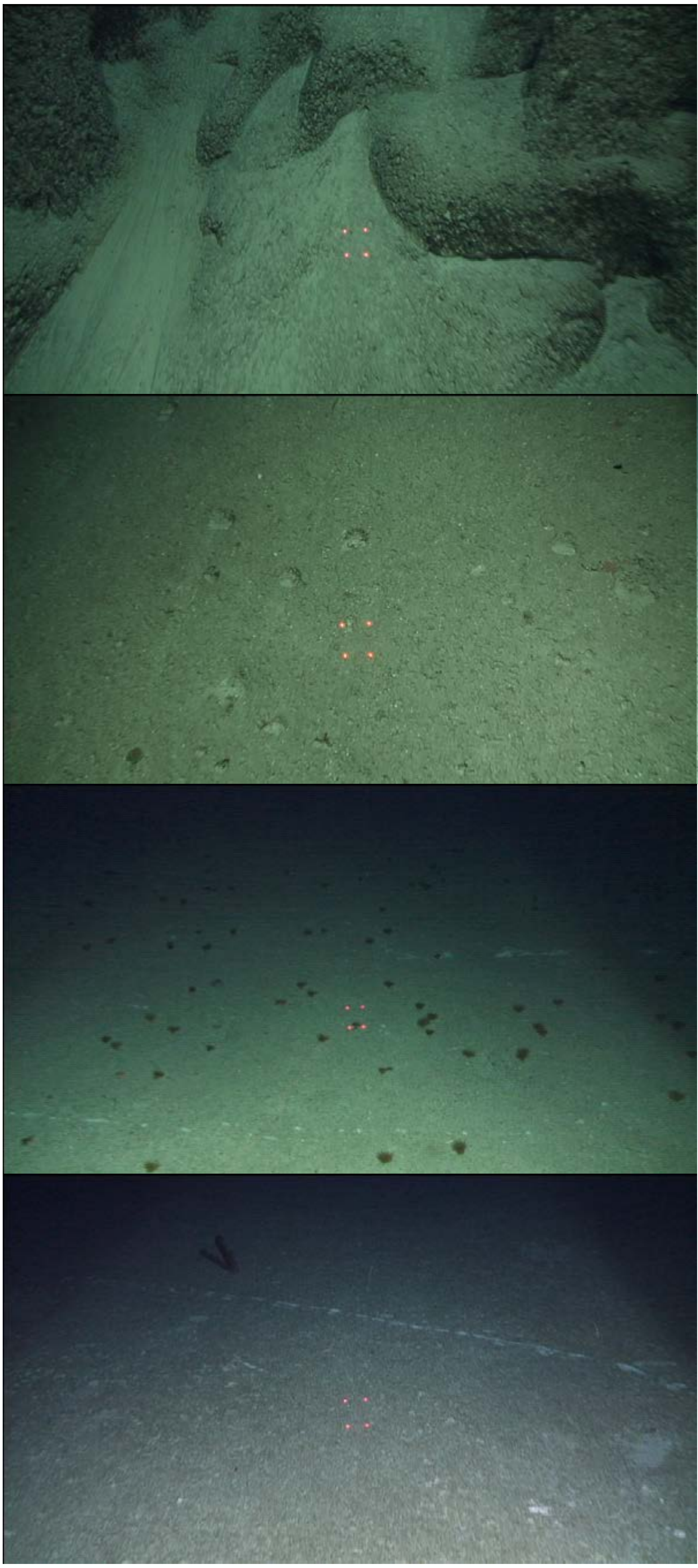


Figure 41. Images from Campod Dive 1 up the slope of the Valdivia Bank.

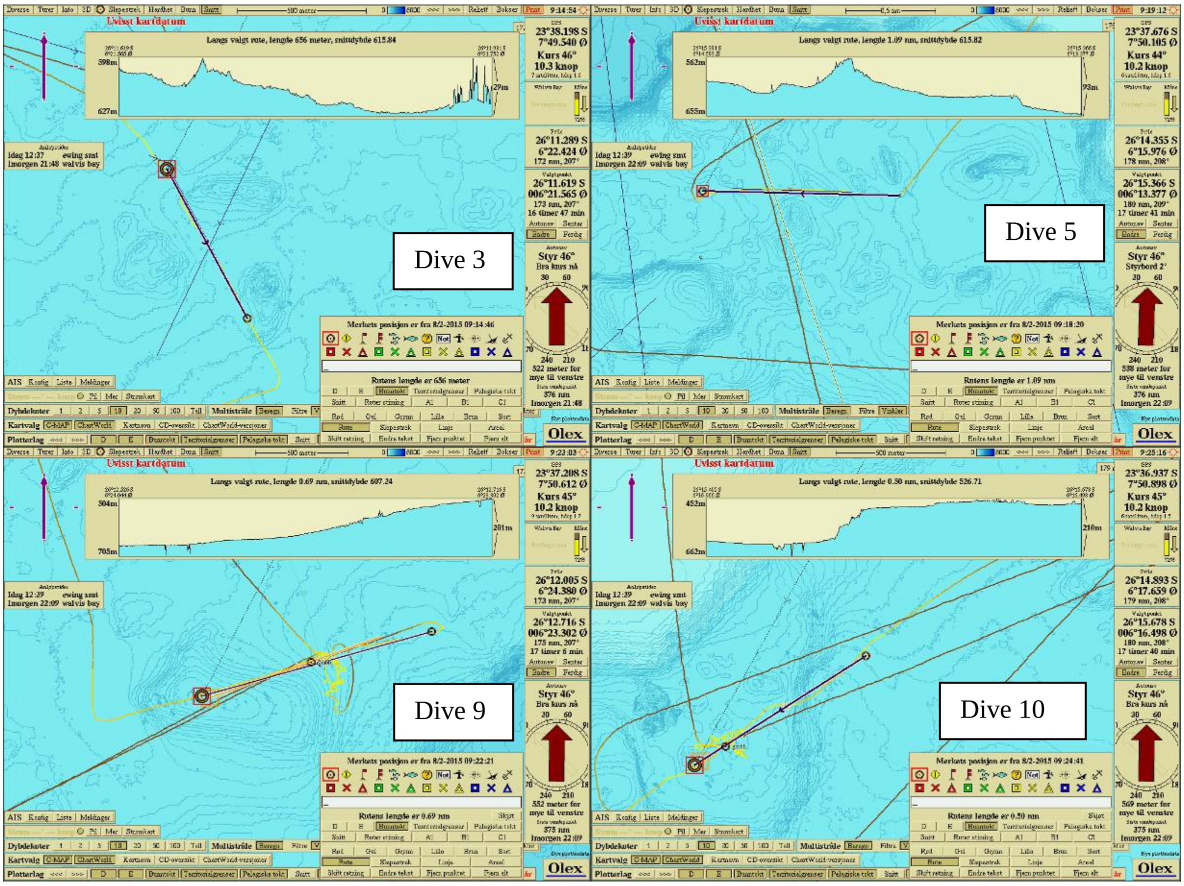


Figure 42. Tracks of the CAMPOD dives on the knolls south of Valdivia Bank. (Depth information is provided in Table 1).

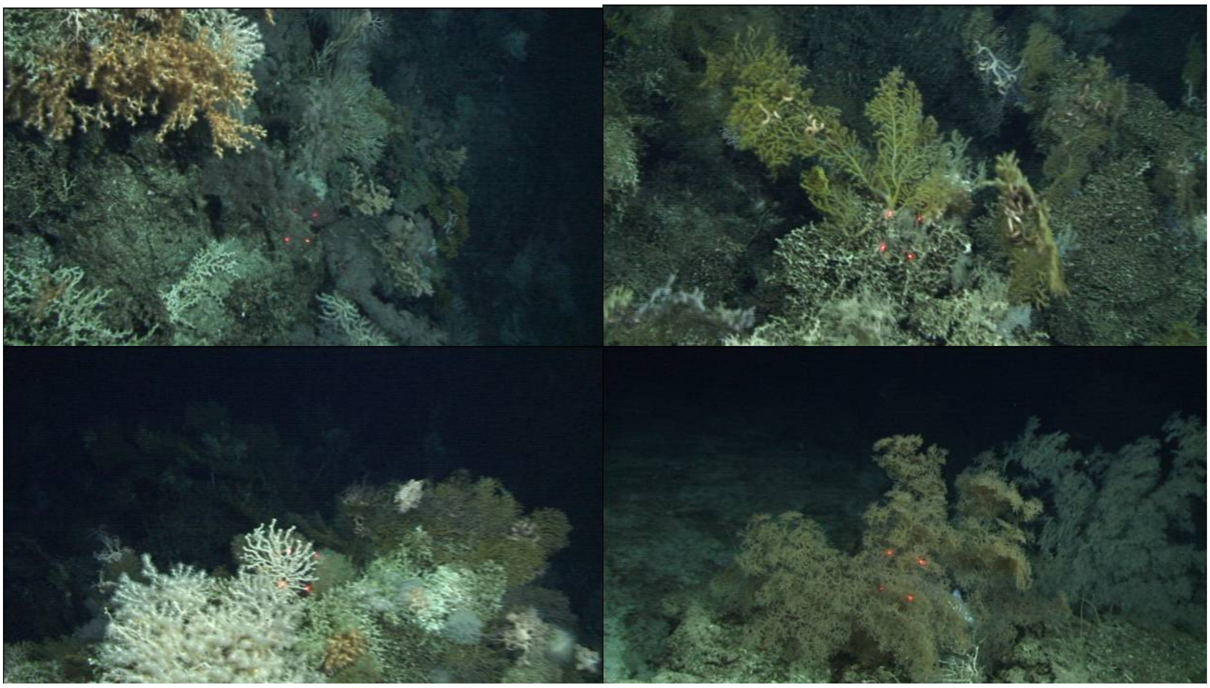


Figure 43. Images of coral gardens from a knoll adjacent to the Valdivia Bank (CAMPOD Dive 5).

Valdivia Middle

Valdivia Middle is elongate in the north-south direction with the shallowest subarea in the northern end (Fig. 37). The northerly shallow area has several knolls, of which the shallower is around 415m. To the west of the elongate shallowest area, there is a large plain with a plateau depth of 875-880m.

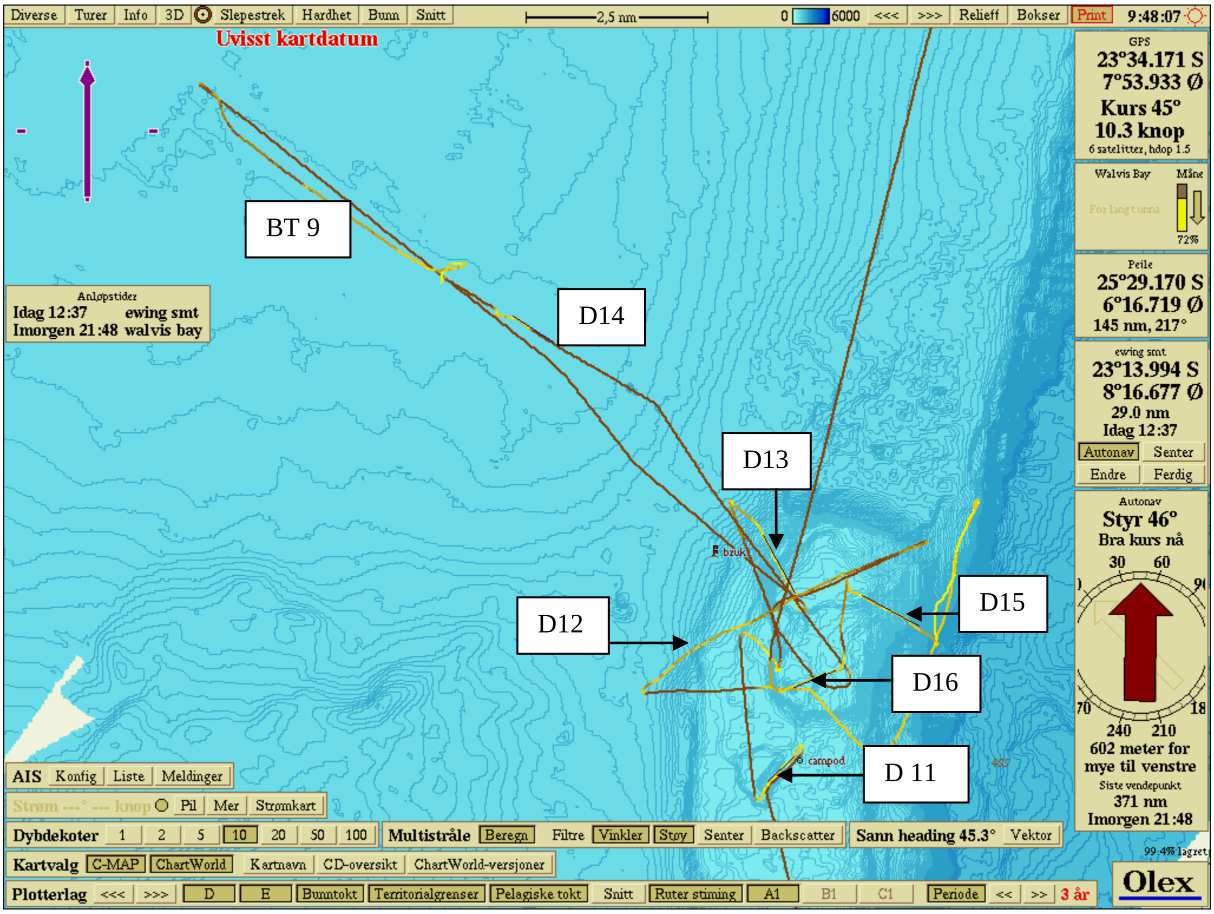


Figure 45. Vessel track, CAMPOD dives and trawls in the Valdivia Middle subarea. Details on uphill summit dives are provided in Fig. 51.

Five CAMPOD dives were made on the shallower part of the seamount (D11, 12, 13, 15, 16, Fig. 45) and one on the flat adjacent plateau (D14) at 865m. The adjacent flat plateau is sandy (Fig. 46). The slope dives revealed sandy bases of the hills and hard substrates on the

Figure 46. Image from CAMPOD Dive 14 on the flat plain adjacent to the Valdivia Middle summit. Image shows hermit crab and deep-sea red crab.

slopes, including a lot of coral rubble and broken up coral framework. On the slopes scleractinian coral was common and the abundance was rather high on the slopes deeper than 500m. The exception was the knoll south of the main summit visited by Dive 11 where a rich coral garden occurred comprising primarily scleractinian corals. At depth shallower than 600m in that dive the percentage cover with corals was 50% or more, and the summit depth was 555m. On the shallower summits (depths <500m, Dives 13 and 15, Fig. 45) to the north of this knoll the density of coral declined towards the summit and the summit substrate was rather bare rock faces without coral.

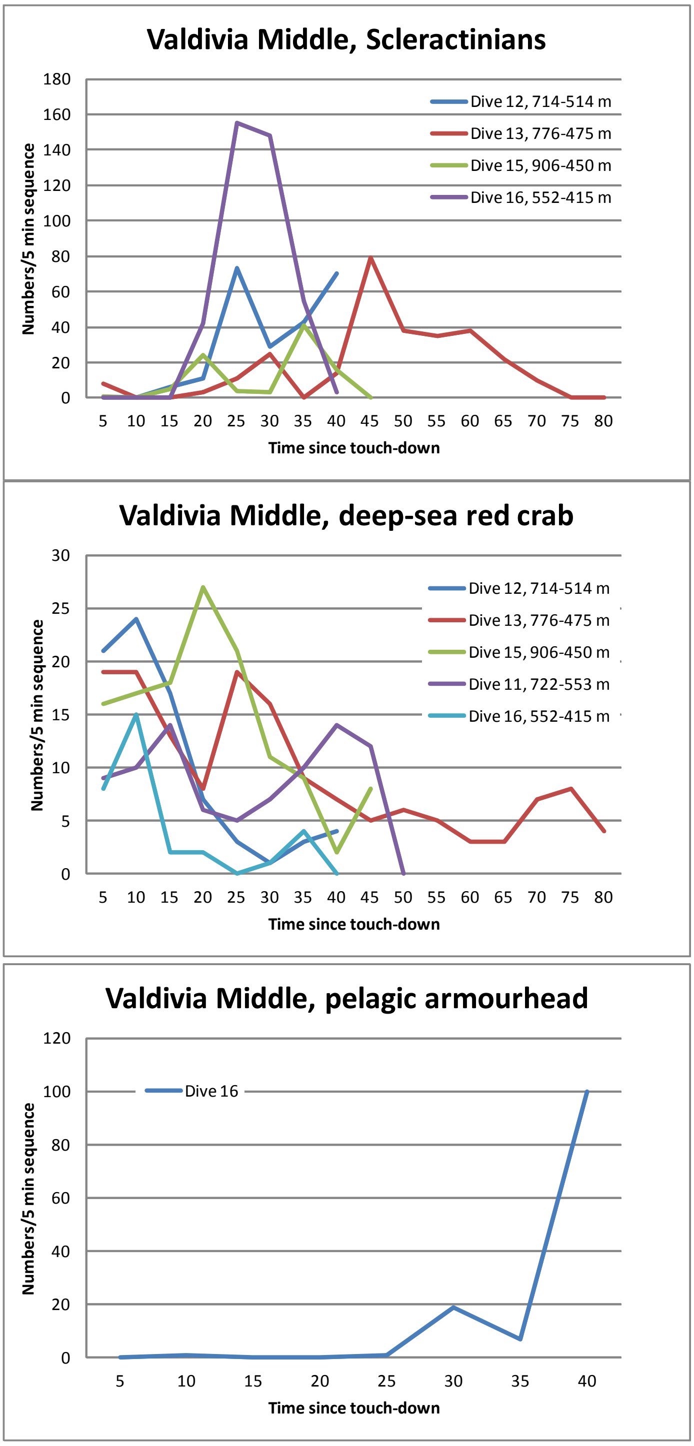


Figure 47. Counts of scleractinian coral colonies, deep sea red crab, and pelagic armourhead in CAMPOD dives in the Valdivia Middle subarea. (NB: In Dive 11 the coral abundance was too high to record, hence data for that dive is not included).

Valdivia North

In Valdivia North the circular summit with a diameter of around 4.7 km lies to the southeast of a wide shallow area (Fig. 37). On the summit, 3 CAMPOD dives were carried out (Fig. 49), of which Dives 17 and 20 were upslope dives. The shallowest knoll is at near 550 m. The Dive 18 was made on the summit within a narrower depth range than the slope dives. Dive 19 was placed in the flat deep area to the west of the circular summit, at around 890m.

In the two slope dives, rich scleractinian coral areas were observed (Fig. 50), and in Dive 20 on the eastern side of the summit, also rather high concentrations of gorgonians. In some areas seapens (Pennatulacea) were also abundant. However, the corals seemed to disappear at the very summit of the seamount. In a grab station associated with Dive 18 (3 replicates) at 570m only black corals were retrieved (Appendix Table 2).

In the deep sandy plain to the west (885-890 m), no corals were observed but a rather diverse fauna of invertebrates and fishes.

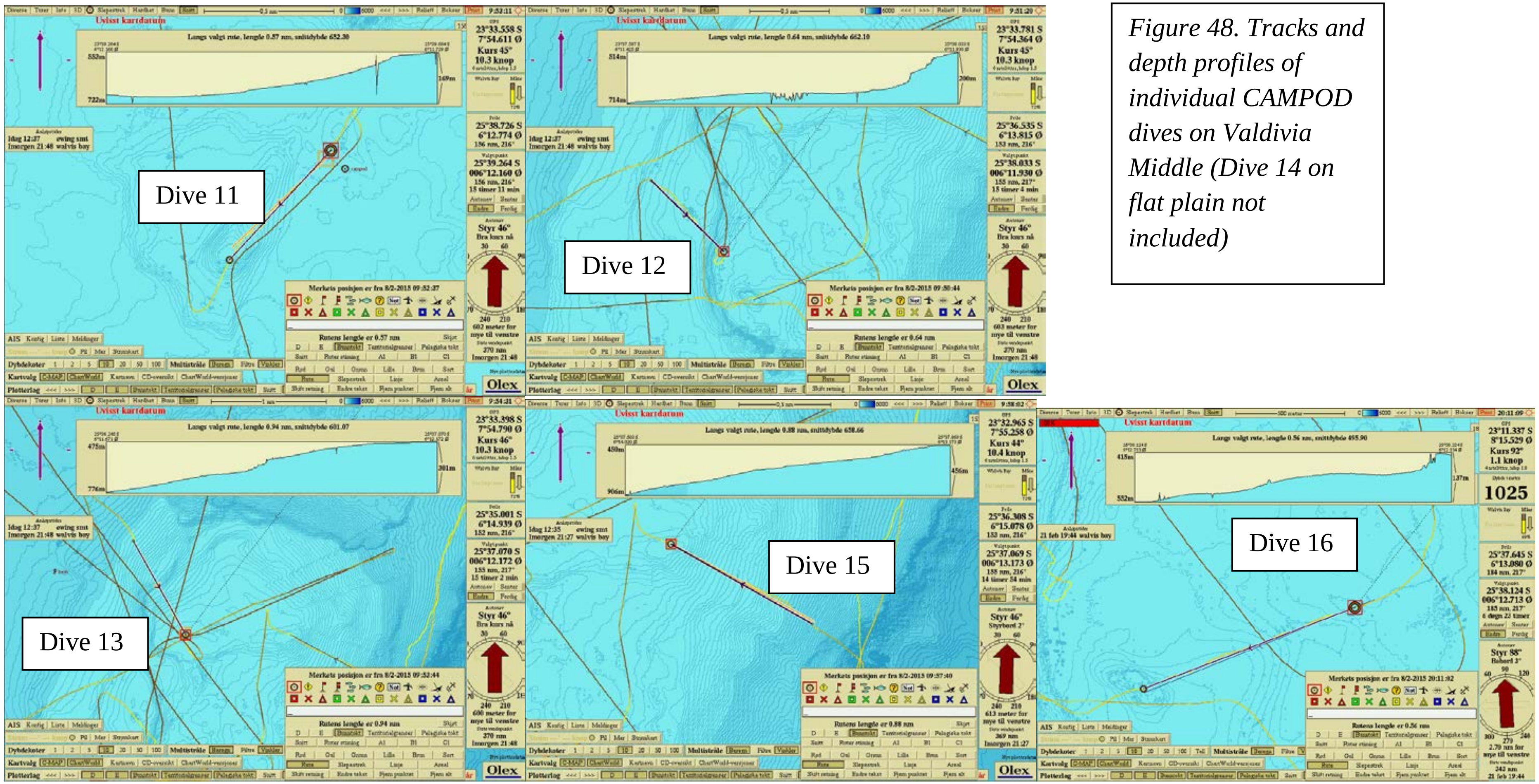


Figure 48. Tracks and depth profiles of individual CAMPOD dives on Valdivia Middle (Dive 14 on flat plain not included)

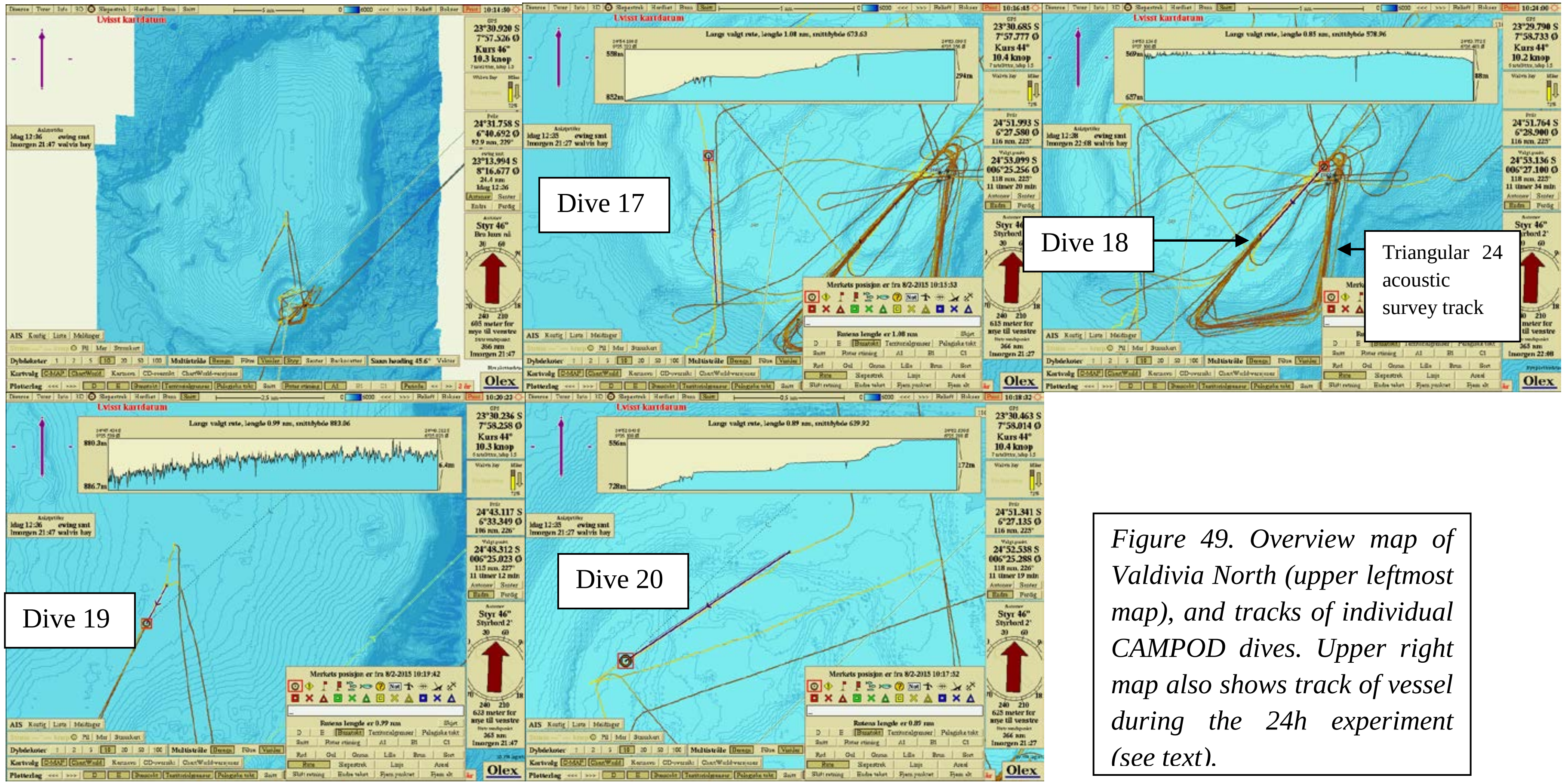


Figure 49. Overview map of Valdivia North (upper leftmost map), and tracks of individual CAMPOD dives. Upper right map also shows track of vessel during the 24h experiment (see text).

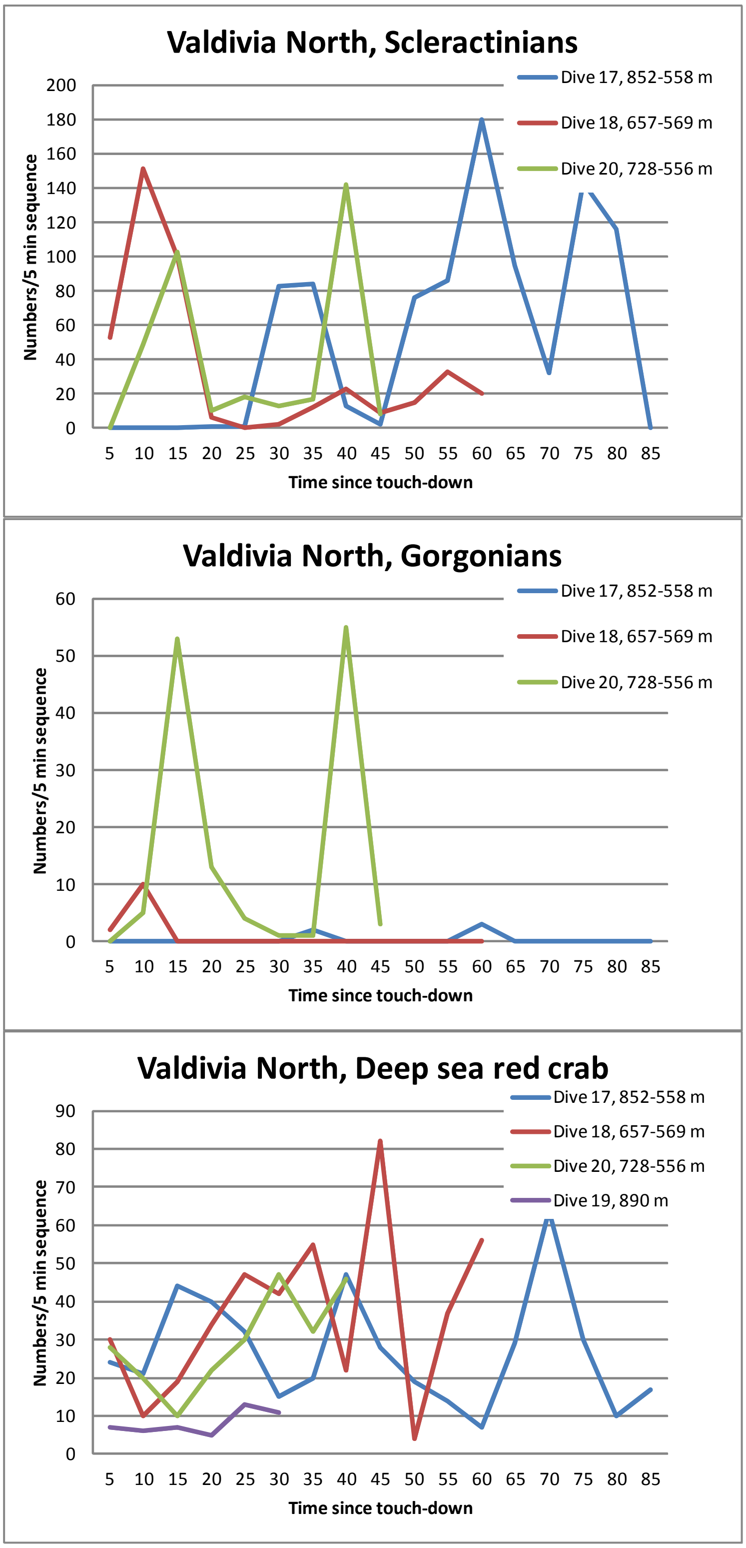


Figure 50. Counts of scleractinian and gorgonian corals, and deep sea red crab, in CAMPOD dives on Valdivia North.

Fisheries resources observations

Valdivia Central

The Valdivia Bank was until recently a primary target area in trawls fisheries for pelagic armourhead and alfonsino (Ref. SEAFO Stock Status reports). A zig-zag hydroacoustic survey was conducted across the bank but no shoals or aggregations were observed. In the

CAMPOD dives aggregations of armourhead were observed on the southeastern corner of the bank in Dive 10 at around 500m depth and in Dive 9 at the summit (465m), but elsewhere only single individuals occurred. No aggregations of alfonsino were observed, only a few scattered specimens.

Three midwater trawls were conducted above (Appendix Table 1, St. 8) and adjacent to (St. 6 and 7) the Valdivia Bank. None of the trawls produced catches of the SEAFO target resources, only small catches of cephalopods and mesopelagic fish.

Crab fishing with pots was being conducted by a Korean vessel at the time of the scientific investigation, and both sedimented areas, adjacent knolls and the Valdivia Bank appeared to be utilized in the fishery. The CAMPOD dives revealed crab in all transects and across the depth range investigated, but the highest densities were observed in the sedimented adjacent plain and on the lower slope of the Valdivia Bank (Fig. 40). The density appeared much lower in areas of rugged terrain and in coral gardens, but this observation is uncertain because crabs may be difficult to observe and count in such habitats.

Valdivia West

On the summit explored by CAMPOD Dive 7 an aggregation of alfonsino was encountered. The aggregation occurred above bare rocky substrate. The Valdivia West has been utilized in commercial trawl fisheries but as it is a rather rugged area with limited spatial extent, hence it would presumably be secondary to the larger and flatter Valdivia Bank. No fish aggregations were observed by acoustics.

Deep sea red crab was abundant in Valdivia West, at all depths and on all substrates (Fig. 51). The density was particularly high on the shallowest summit (Dive 7).

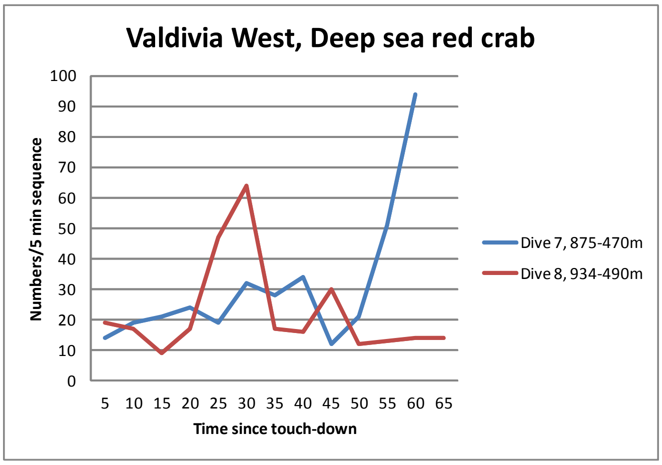


Figure 51. Counts of deep-sea red crab in Valdivia West CAMPOD Dives 7 and 8.

Valdivia Middle

In the subarea Valdivia Middle the deep sea red crab was common on the adjacent 865m deep plain and up the slopes of the shallower slopes (Fig. 47). Density appeared to decline towards the summit of the seamount. It should be noted that the crab density was high even at the lower end of the dives at around 900m depth.

Only scattered alfonsino specimens were observed, but armourhead aggregation were encountered toward the end of the slope Dives 15 and 16. In Dive 16, which was a summit dive targeting the very shallowest knoll, the transect ran up the slope from 515 to 415 m. The density of armourhead increased up the slope from about 530 m and was very high around the very shallowest area at the end of the dive (Fig. 47).

Valdivia North

Deep-sea red crab was common along most dive transects, but declined in abundance towards the summit of the seamount (Fig. 50). Crabs were also common on the deep plain to the west (Dive 19), but in lower numbers than on the summit. A sample of crab (49 specimens) was obtained from the bottom trawl on the plain (St. 12, Fig. 52), and morphological examination of that sample largely confirmed that the identity of the crabs observed on videos were *Chaceon erytheiae.* Tissue samples were collected for confirmation studies using molecular genetics methods.

Scattered single specimens of alfonsino were observed in Dives 17 and 18, i.e. on the summit of the seamount, none on the deep adjacent plain. Along and above the track of Dive 18 a rather prominent daytime aggregation of fish was observed on the echograms, and this was observed repeatedly in an 18-hour experiment where the ship passed along the same track every hour. The echogram from the time-series is presented in Figure 53, and illustrates that the aggregation (shoal) is present throughout the series but that it changes character, configuration and depth distribution with time of day. At dusk the shoal appeared to lift off the bottom, and it stayed rather concentrated in the water column during the night. In the morning the shoal descended to the near-bottom zone and dispersed. To determine the identity of the sound scatterers, two attempts were made to sample the shoal with the midwater trawl; once in the morning (PT 11) and once in the early night (PT 13). Neither of the attempts were successful. Presumably the unidentified fish observed avoided the trawl. The trawl captured some mesopelagic fish, and the echograms showed how a mesopelagic scattering layer impinged on the seamount (Fig. 53).

The bottom trawl St. 12 on the deep adjacent plain (890m) captured around 50 fish species, including orange roughy (*Hoplostethus atlanticus*, 22 specimens), several macrourids, alepocephalids, oreos and some demersal sharks.

Figure 52. Images of selected organisms captured in the bottom trawl station 12 on Valdivia North. Deep sea red crab upper left), macrourids (upper right), orange roughy (lower).

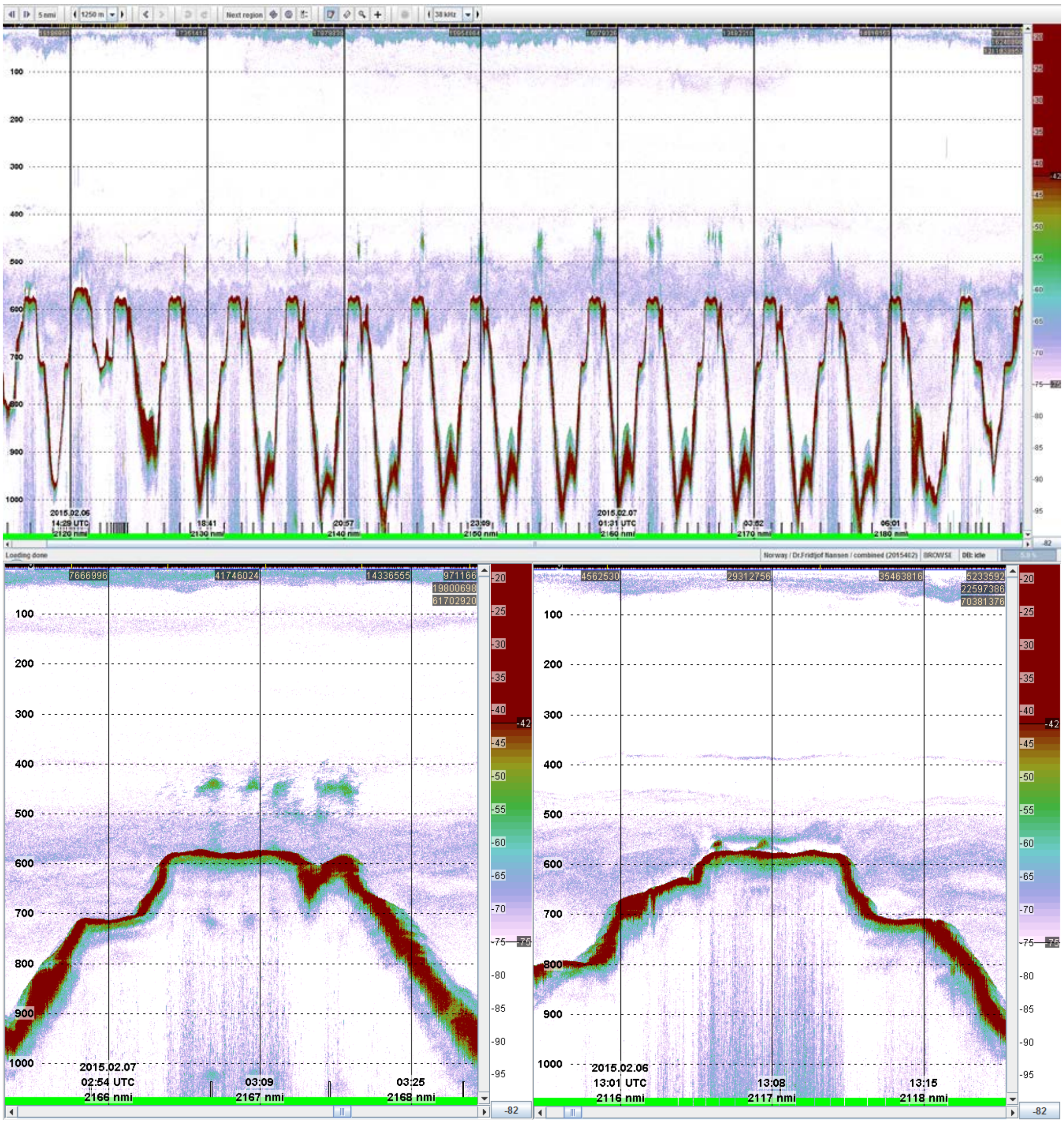


Figure 53. Echograms from 18-hour repeat study of an aggregation of fish above the Valdivia North seamount summit (EK60, 38KHz). Upper figure: full time-series starting at 13:00 UTC (15:00 local time) on 6 February and ending at approx. 07:00 UTC on the next day; Lower left: detailed echogram from nighttime (02-03UTC), Lower right: same from daytime (13:00 UTC).

Indications of fishing impacts

In Valdivia Central footprints of fisheries included lost ropes (1 line in Dive 1; 3 lines in Dive 9), and what appeared as skid marks of trawl gear on the bare rock surface of the Valdivia Bank (Fig. 41). No impacts of fishing were detected on the adjacent knolls, including in the subareas with coral gardens.

Skid marks from trawls were observed on the shallowest summit at depths shallower than 590m (Dive 7) in Valdivia West. No lost gears were encountered.

In Valdivia Middle marks on the bare rock faces at the summit shallower than 525 m (Dive 16) were interpreted as skid marks from trawl gear. At 420m in that same dive, a lost rope was observed. The summits had more or less bare rock and little coral rubble, and the absence of rubble would seem to suggest that corals never (or at least not recently) inhabited the shallowest areas. There was no obvious sign of destruction of coral by past or present fisheries.

A single lost pot was observed in Dive 17 on Valdivia North. No other footprints of fisheries were observed in the remaining dives.

Ewing seamount

Locations, bathymetry, hydrography

Ewing Seamount lies on the northeastern section of the Walvis Ridge at 23^{o}14.7 S, 008^{o}16.0E (Fig. 54). It has an irregular shape, and from the southeasterly summit area there is a rather wide and elongate deep plateau running northwestwards. The latter plateau is around 1000m deep while the shallowest summit is 780m. The relief shown in Fig. 54 illustrates the shape and sizes of the summit area, including depth profiles across the summit in north-south and east-west directions. The summit (<800m) is only around 2.3 km across.

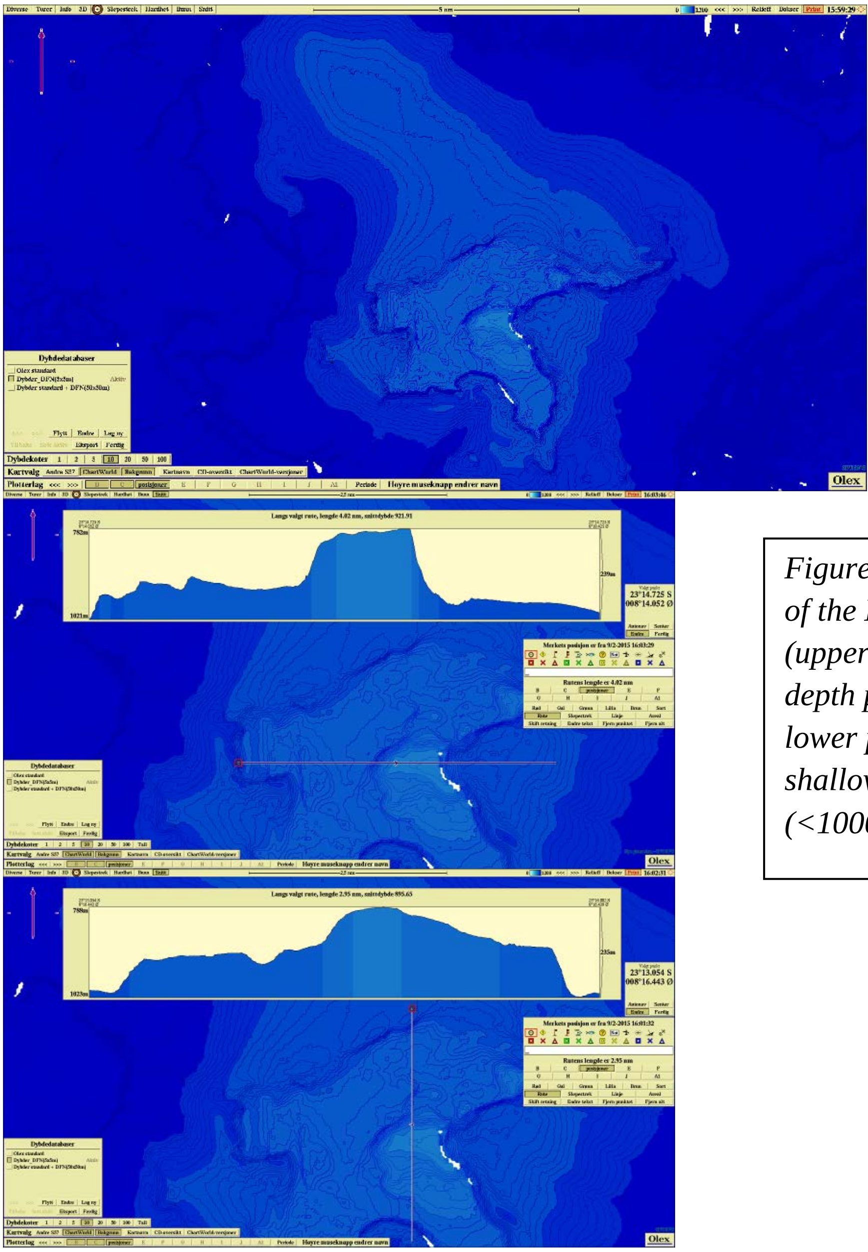


Figure 54. Bathymetry of the Ewing Seamount (upper), and details and depth profiles (two lower panels) of the shallowest summit area (<1000m)

The hydrographic observations showed that the temperature dropped from 23.3 C in the surface to near 5° C at the summit depth and further to 3.7° C at the depth of the adjacent plateau (Fig. 55).

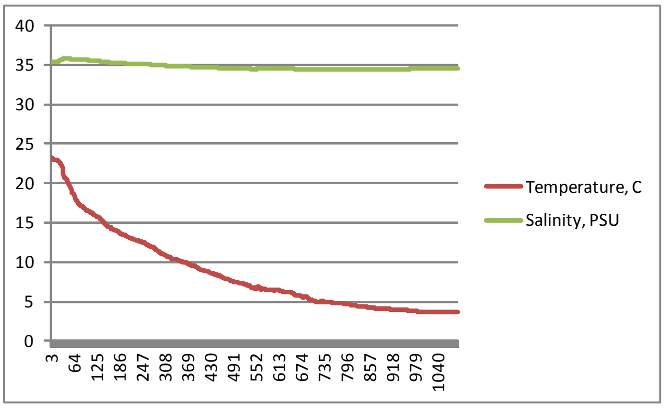


Figure 55. Depth profiles of temperature and salinity at Ewing Seamount, 23°16.50 S, 008°13.97 E on 8 February 2015

Substrate and VME indicator observations (video, trawl and grab samples)

Four CAMPOD dives (Dives 1, 2, 4, 5) were made from different directions up the slope of the shallower parts of the seamount from about 900-925 m, and a further one on the plain to the northwest (Dive 3) (Fig. 56). The latter confirmed that the plain is a flat sandy area.

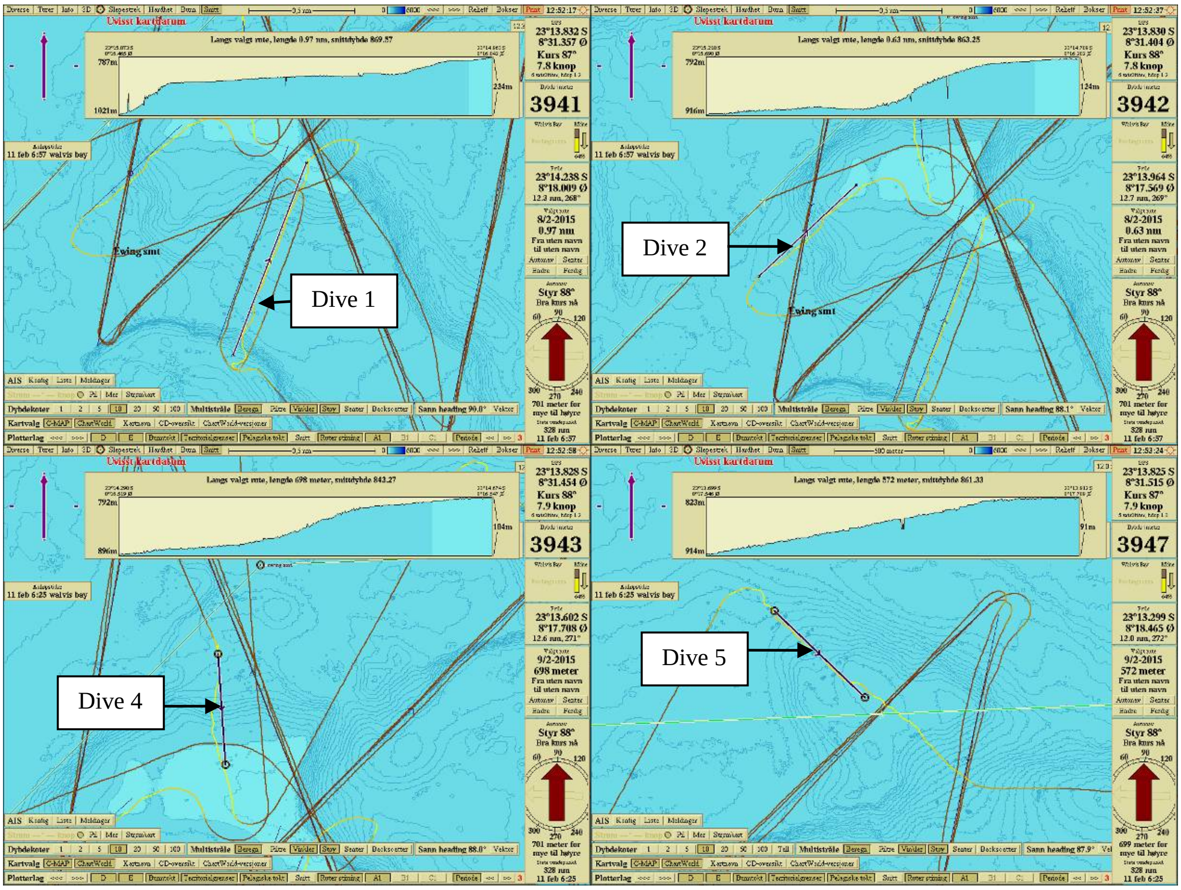


Figure 56. Tracks of the summit CAMPOD dives 1, 2, 4 and 5 on the Ewing seamount.

The base of the summits and lower slopes had rippled sandy sediments but the sediment layer appeared thin and underlying rock was often exposed. On the summit slopes coral framework and dead scleractinian coral and rubble was the dominant substrate. In some parts towards the summit, the terrain was very rugged. Very few live scleractinian colonies were observed, however, but live corals (scleractinians, gorgonians, antipatharians a.o.) were observed in all slope dives (Fig. 57). As in Valdivia, coral density seemed to drop at the very summit of the seamount.

A bottom trawl tow was conducted at 1045 m depth on the adjacent deep plateau along the same track as CAMPOD Dive 3 (Fig. 58, Appendix Table 1). The catch was diverse in terms of both invertebrates and fishes (40+ species). The invertebrate collection is extensive and needs further identification in the museum.

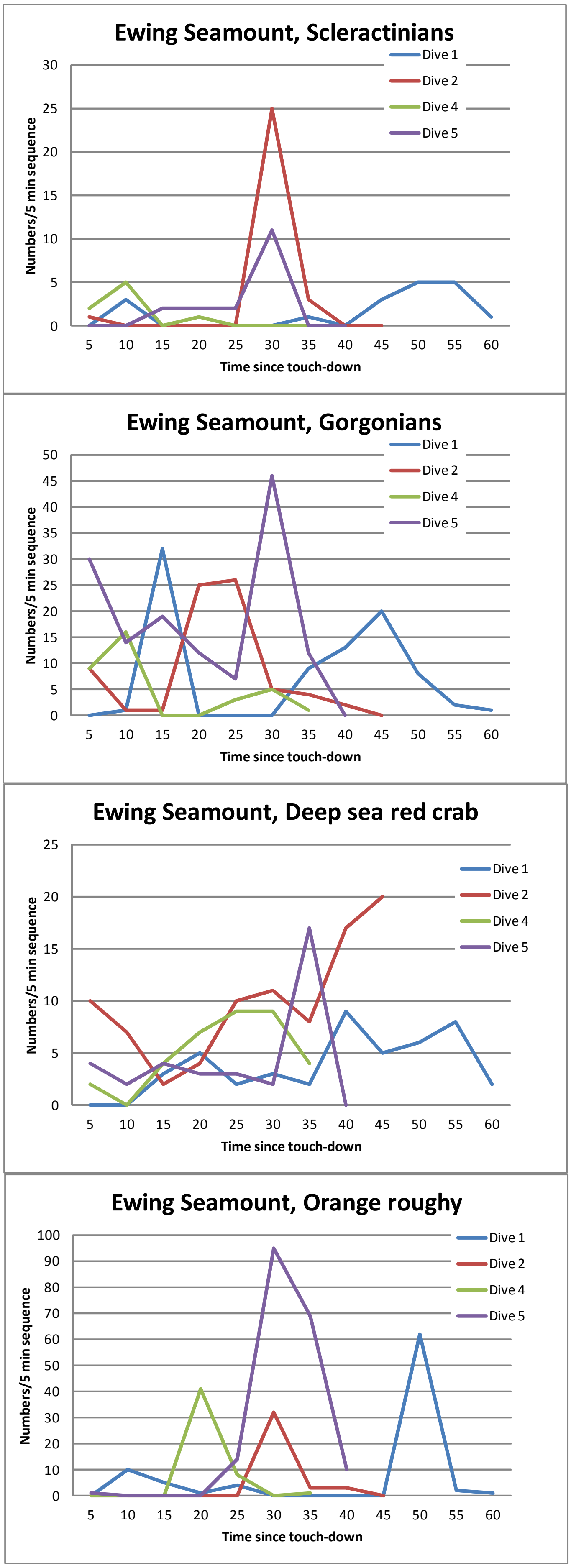


Figure 57. Counts of selected taxa in CAMPOD dives from the slope of the Ewing seamount.

Fisheries resources observations

Orange roughy was observed in all summit dives, from 925 m towards the slopes, but tended to be most abundant midslope (Fig. 57). The density was particularly high in Dive 5. The trawl on the deep adjacent plateau (1023m) did, however, not catch that species.

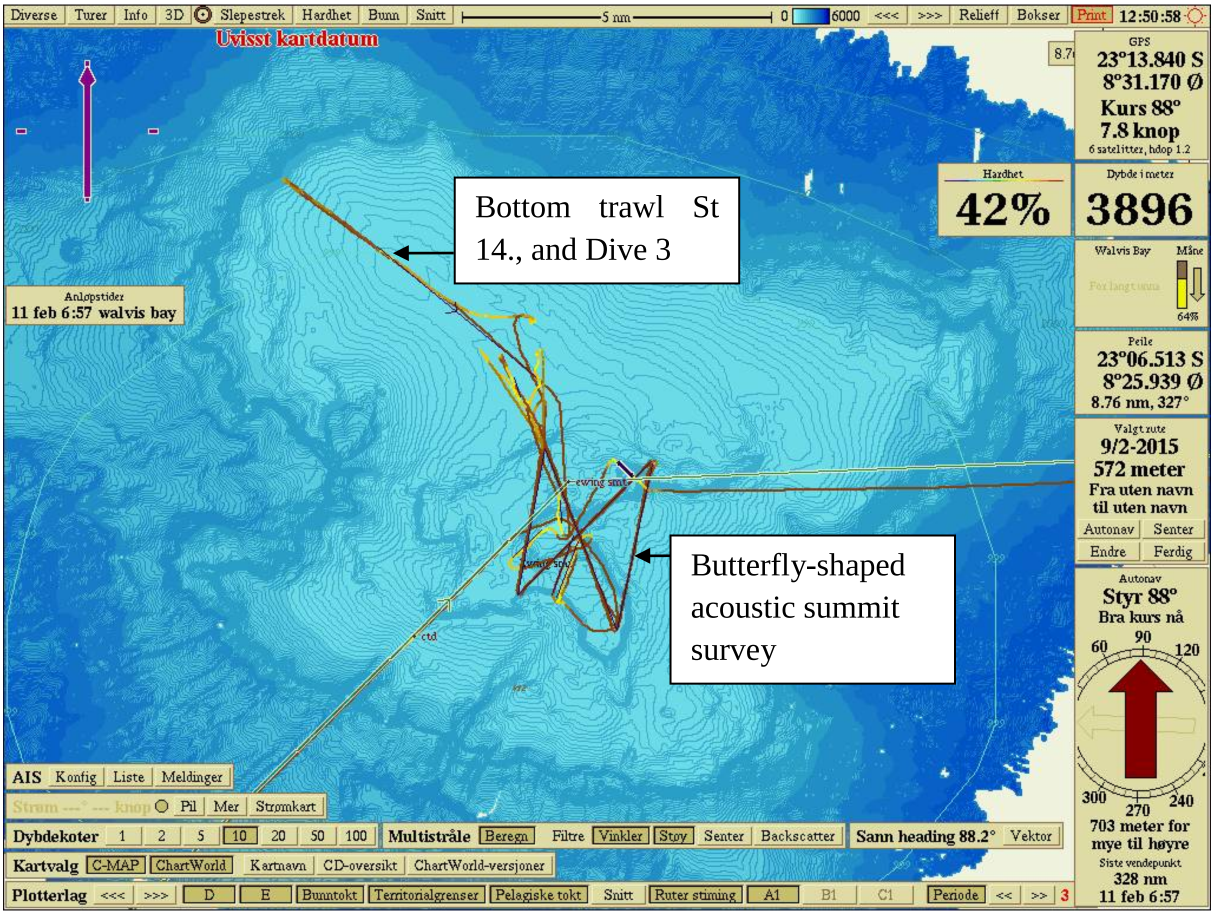


Figure 58. Vessel track on the Ewing Seamount, illustrating dive and trawl tow on the deep northwestern plateau, and the acoustic survey on the shallow summit.

In view of the rather significant observations of orange roughy in the CAMPOD dives on the slopes (Fig. 57), a repeat acoustic survey was run across the summit. Three runs were made of a “butterfly-shaped” track (Fig. 58), starting at local time 23:00, 01:30, 05:30 Hrs, respectively. Near-bottom records of what may have been orange roughy were made on several summit knolls (Fig. 59), and the scatterers seemed to stay close to the seabed during the day and lift off into the pelagic zone at night (Fig 59, lower panels). No attempt was made to trawl above the summit where the risk of snagging was prohibitive.

Alfonsino and pelagic armourhead were not observed in the dives, nor captured in the trawl tow on Ewing.

Deep-sea red crab was present on the slopes and appeared to increase with decreasing bottom depth (Fig. 57). In Dive 3 on the northwestern plateau 1-6 crabs per 5 min. observation period occurred, but the catch in the associated trawl was very low, only 4 crabs in a 31 min tow.

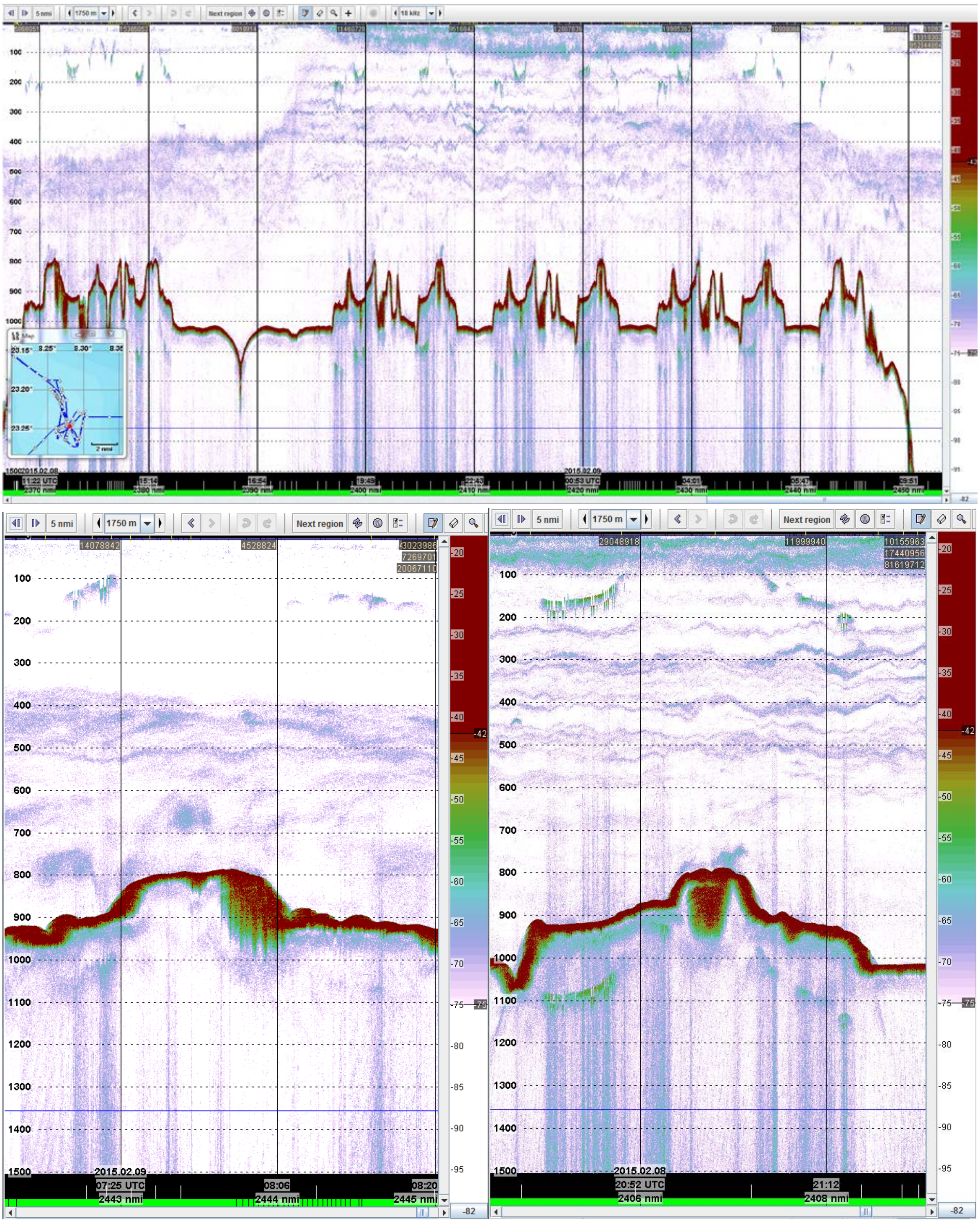


Figure 59. *Echograms from the summit of Ewing seamount (EK60, 18 KHz). Composite from repeat crossings ("butterfly-survey", upper graph), and details from day (lower left) and night (lower right) crossing.*

Indications of fishing impacts

Footprints of fisheries were a rope observed in Dive 1 at 825m and some lost trawl gear at 889m in Dive 2. On the slopes of the summit the density of dead scleractinian coral was very high, and probably higher than on any of the other seamounts visited. On top of the summit there was very little coral and also less rubble. The scleractinians may have died of natural causes. The appearance of the dead colonies and rubble was similar to that observed on other seamounts, and at all depths erect dead colonies were common. Also, the virtual absence of coral on the shallowest parts of the summit may be natural. However, it should not be ruled out that some of the dead coral may reflect trawling impacts. Ewing was fished with trawls in the past (target fisheries for orange roughy), i.e. prior to the SEAFO moratorium. Trawl tracks were not observed but on the rather hard substrate such tracks may have been filled in during the period after the fisheries stopped. Video observations of rippled seabed and small fish struggling to maintain position against the current is evidence that the near-bottom currents may be strong.

IX. Provisional conclusions

The following is a first attempt at drawing inferences from the observations, but should be considered very provisional. Full analyses of all data are pending and will be included in publications from the investigation.

Bathymetry and substrate:

- Many seamounts were appreciably deeper than expected based on bathymetries generated by authoritative sources. In most areas, the potential fishing areas are smaller than previously thought.
- The seamounts visited appeared as very minor "shallow" systems in the vast oligotrophic ocean area of the Southeast Atlantic.
- Vema was completely mapped and the shallowest point was estimated to 21.5m. Vema is very different from all the other seamounts because the summit reaches into the euphotic zone. All others have summits in the mesopelagic zone (but at variable depths).
- Valdivia was found to be very diverse and has four subareas with prominent hills/plateaus shallower than 500-1000m. The other seamounts visited are single-summit features.
- What is provisionally classified as ancient coral framework was the dominant hard substrate (except in Schmitt-Ott), and soft sediments were biogenic, including foraminiferan deposits, pteropod shells, and coral rubble.

VME indicators:

- Most seamounts visited had VME indicators (mainly corals), but the identity, distribution and density of the indicators differed between locations.

- At Schmitt-Ott there was a pronounced dominance of gorgonians. In all others the diversity of VME taxa was greater, and more scleractinians occurred.
- In many cases scleractinians were mainly dead and probably ancient (entirely in Ewing).
- Notably, in Valdivia and Ewing, scleractinians (dead or alive) seemed to be restricted to slopes of knolls. Most notably, on knolls southeast of the Valdivia Bank well developed coral gardens occur on the slopes.
- On the Valdivia Bank, and also on the shallowest summits of Valdivia West, Middle and North, the summit substrate appeared to be bare rock.

Fisheries resources:

- Abundance estimation of SEAFO fish resources was very difficult due to rugged topography and benthopelagic and aggregated distributions of the target organisms. Fishing with midwater trawl and use of hydroacoustics is challenging but has some potential.
- Unidentifiable summit schools were observed in Erica, Valdivia, and Ewing. In Ewing these were likely to be orange roughy, in Valdivia North probably alfonsino. These tentative conclusions were based mainly on observations shoal patterns on echograms and occurrence of the species in video records.
- Bottom trawling was only possible on sandy bottoms on deep plains, not in the main fishing areas on slopes and summits.
- Pelagic armourhead and alfonsino were locally numerous in video records, but absent in the majority of dives and locations which were almost all made in the depth ranges and habitats where the species were expected to occur. Distributions appeared limited and abundances possibly generally low. Very few armourhead were observed in the main fishing area of Valdivia where trawl fisheries were conducted recently. No armourhead were observed in Ewing.
- Orange roughy was common in video records around the summit in Ewing. A few juveniles occurred in a bottom trawl catch on the deep plain in Valdivia.
- In Valdivia, which compared with all the other seamounts has a large area with depths shallower than 2000m (probably the largest of the 'existing fishing areas' in SEAFO), the potential fishing areas are restricted because only minor subareas are shallower than 500-1000m and suitable for the target fish resources alfonsino, armourhead and orange roughy.
- The fishing area for crab is much larger, however, because crabs are distributed across an extensive depth range in Valdivia, Ewing and to a lesser extent Vema. Video records show that Valdivia is a rich area for crabs, much richer than all others. Morphological examination of trawl samples supported that the species was *Chaceon erytheiae* (Macpherson, 1984) as assumed by the SEAFO Scientific Committee.

Human footprint:

- Frequent video observations of lost pots and rope were made in Vema and some in Valdivia. These items could not be aged, but may well have been abandoned or lost many years ago.
- In Ewing, lost trawl gear was observed in one of the summit dives.
- On the main Valdivia Bank and Valdivia West summit what was suspected to be trawl door skid marks were observed. These areas have flat rocky surfaces.
- No evidence of impacts of trawling or pot fishing was observed in areas of soft sediments, including the extensive areas with coral rubble.
- In areas with high densities of live (and dead) coral that may be regarded as candidate VMEs, the impression from the video records is that the benthic communities are intact and not impacted by fishing. However, the widespread occurrence of dead scleractinian coral, probably ancient, makes a full evaluation difficult and this phenomenon deserves further attention.

O.A Bergstad
26 January 2016

X. Appendices

Appendix 1. List of trawl stations. Dr Fridtjof Nansen, Cruise 2015402, to seamounts in the SEAFO Convention Area (Jan-Feb 2015).

Station no.	Date	Position at start of tow (decimal deg.)		Position at end of tow		Location	Sampler	Time (UTC)		Tow duration, min	Vessel log		Distance towed, n.m.	Sampler depth, m		Bottom depth, m		Towing speed, knots	Comment
		Lon.	Lat.	Lon.	Lat.			Start	Stop		Start	Stop		Start	Stop	Start	Stop		
		Dec.	Dec.	Dec.	Dec.														
1	24.01.2015	-4.960	-34.484	-4.960	-34.485	Wüst	BT	20:14:00	20:19:00	5	98.0	98.5	0.50	1066	1060	1066	1060	3.0	Interrupted and damaged trawl
2	26.01.2015	-2.837	-33.054	-2.801	-33.083	Wüst	PT	20:11:08	21:05:18	54	494.7	497.4	2.69	460	750	778	800	3.0	
3	27.01.2015	-2.778	-33.037	-2.795	-32.992	Wüst	PT	15:43:08	16:37:51	55	584.8	587.6	2.90	450	570	608	662	3.2	
4	31.01.2015	8.377	-31.662	8.395	-31.636	Vema	PT	17:04:07	17:51:20	47	1383.8	1386.0	2.16	50	80	82	108	2.8	Ripped trawl
5	31.01.2015	8.377	-31.621	8.385	-31.616	Vema	BT	18:54:34	19:04:35	10	1390.4	1390.9	0.51	71	94	71	94	3.1	
6	03.02.2015	6.354	-26.134	6.294	-26.163	Valdivia	PT	00:51:36	02:03:02	71	1793.1	1796.8	3.78	150	195	339	271	3.2	
7	03.02.2015	6.341	-26.206	6.320	-26.217	Valdivia	PT	13:50:05	14:21:47	32	1822.7	1824.0	1.33	320	335	564	559	2.5	
8	03.02.2015	6.278	-26.214	6.335	-26.155	Valdivia	PT	19:03:58	20:31:15	87	1836.0	1840.9	4.92	50	205	235	230	3.4	
9	05.02.2015	6.081	-25.526	6.102	-25.538	Valdivia	BT	14:25:14	14:55:05	30	2031.3	2032.7	1.37	878	877	878	877	2.7	
10	05.02.2015	6.211	-25.615	6.192	-25.624	Valdivia	PT	18:45:36	19:09:33	24	2048.2	2049.4	1.18	440	460	476	707	3.0	
11	07.02.2015	6.450	-24.887	6.434	-24.902	Valdivia	PT	07:05:33	07:32:43	27	2185.2	2186.5	1.27	500	560	573	707	2.8	
12	07.02.2015	6.411	-24.817	6.424	-24.794	Valdivia	BT	12:40:26	13:12:19	32	2202.8	2204.3	1.52	887	886	887	886	2.9	
13	07.02.2015	6.456	-24.882	6.463	-24.888	Valdivia	PT	18:55:55	20:35:00	99	2225.4	2230.8	5.41	450	550	644	973	3.3	
14	08.02.2015	8.229	-23.175	8.249	-23.188	Ewing	BT	17:13:10	17:44:27	31	2390.9	2392.2	1.33	1014	1023	1014	1023	2.5	

Appendix 2. List of grab stations and the samples generated. Dr Fridtjof Nansen, Cruise 2015402, to seamounts in the SEAFO Convention Area (Jan-Feb 2015). Grabs that were empty on retrieval were not included in the list.

Id	Grab Stn	Locat-ion	Main taxon	Species	Nos.	Weight, g	SEAFO label	Remarks	Lon. (dec.)	Lat. (dec.)	Depth, m
220	2A	Schmitt-Ott	Hydrozoa	Stylasteridae indet 1	1	1	40012	Sediment with fragments of Pterópodos shells.	13.48618	-38.7745	1176
82	3B	Wust	Decapoda	Decapoda indet	1	1	40015		-5.02777	-34.4649	1084
215	3B	Wust	Hexactinellida	Hexactinellida indet	1	1	40045		-5.02777	-34.4649	1084
245	4B	Wust	Polychaeta	Maldanidae indet	1	1	40285	4 tubes 1 indiv.	-5.03397	-34.4783	1083
256	5B	Wust	Scaphopoda	*Cadulus* sp	1	1	40405		-5.035	-34.4789	1080
39	5B	Wust	Bryozoa	Cyclostomata indet	1	1	40375		-5.035	-34.4789	1080
221	5B	Wust	Hydrozoa	Stylasteridae indet	19	1	40435	2 species	-5.035	-34.4789	1080
267	6B	Wust	Stylasteridae	*Crypthelia* sp	2	1	40374		-2.76992	-33.0698	704
257	6B	Wust	Scleractinia	*Enallopsammia rostrata*	3	7.3	40078		-2.76992	-33.0698	704
210	7A	Wust	Alcyonacea	*Lepidisis* sp	1	11	40108	Recorded as Gorgonacea	-2.76968	-33.0703	694
255	7B	Wust	Prosobranchia	*Capulus* sp	1	0	40138		-2.76933	-33.0662	630
37	7B	Wust	Bivalvia	Bivalvia	2	0	40168	Shells	-2.76933	-33.0662	630
40	7B	Wust	Bryozoa	*Idmidronea* cf *atlantica*	2	0	40228		-2.76933	-33.0662	630
258	8A	Wust	Scleractinia	*Enallopsammia rostrata*	3	0	40258	Old fragments of *E. rostrata* with Bryozoa, boring sponges, one actinian and one Bivalvia empty shell inside the calice. Globigerines sand, fragments os Stilasteridae, sclerites of *Lepidisis* and other Cyclostomata, one valve from Anomidae, fragments of Pteropods. spines of echinoids.	-2.76985	-33.0662	639
242	8C	Wust	Ophiuroidea	Ophiuroidea indet	1	1	40288		-2.76917	-33.0638	563
291	8C	Wust	Various	Various	1	400	40408	Scleractinians, Actinians, Bryozoa, Sipunculidae tubes, Porifera, Gasteropods shells, Polychaeta tubes, Pteropodos, Sipunculido, Stilasterido.	-2.76917	-33.0638	563
268	8C	Wust	Stylasteridae	*Crypthelia* sp	7	1	40468		-2.76917	-33.0638	563
269	8C	Wust	Stylasteridae	*Errina* sp	3	1	40498	*Errina* sp + demospongiae	-2.76917	-33.0638	563
216	14B	Valdiv.	Hexactinellida	Hexactinellida indet	1	1	40087		6.3945	-26.2098	622
48	14B	Valdiv.	Bryozoa	Bryozoa spp	6	1	40147		6.3945	-26.2098	622
251	14B	Valdiv.	Polychaeta	Polychaeta spp	3	2	40177		6.3945	-26.2098	622
233	14B	Valdiv.	Isopoda	Isopoda indet	1	1	40687		6.3945	-26.2098	622

259	14B	Valdiv.	Scleractinia	*Enallopsammia rostrata*	1	1	40117	+ epibionts	6.3945	-26.2098	622
34	15A	Valdiv.	Antipatharia	Antipatharia indet	1	1	40265		6.4506	-24.8876	570

Appendix 3. Preliminary list of fish taxa collected by means of bottom and pelagic trawl and included in the SEAFO collection, IZIKO South African Museum, Cape Town.

Phylum Chordata – Subphylum Vertebrata - Class Actinopterygii – Infraclass Teleostea			
Family	Species	Weight (kg)	Number
Nemichthydae	*Nemichthys curvirostris*	0.022	2
Serrivomeridae	*Serrivomer beanii*	0.11	2
Synaphobranchidae	*Diastobranchus capensis*	2.55	2
	Ilyophis blachei	1.15	11
	Simenchelys parasiticus	0.12	4
Alepocephalidae	*Alepocephalus productus*	6.47	9
	Talismania sp.	0.022	2
	Unid.	0.074	2
Platytroctidae	*Maulisia microlepis*	0.014	1
Bathysauridae	*Bathysaurus ferox*	9.08	17
Paralepididae	*Stemonosudis* sp.	0.003	1
Scopelarchidae	*Benthalbella infans*	0.036	3
	Benthalbella sp.	0.027	2
Exocoetidae	*Unid.*	0.001	1
Berycidae	*Beryx splendens*	24.72	20
Diretmidae	*Diretmoides parini*	1.29	3
Trachichthyidae	*Hoplostethus atlanticus*	3.43	15
	Hoplostethus cadenati	0.023	1
Bathygadidae	*Bathygadus favosus*	0.664	42
	Gadomus capensis	8.49	109
	Gnathophis capensis	1.47	20
Macrouridae	*Coelorinchus acanthiger*	4.18	39
	Coelorinchus karrerae	1.24	44
	Coelorinchus sp.	1.98	8
	Coelorinchus labiatus	2.55	12
	Coryphaenoides striaturus	1.8	8
	Lucigadus ori	0.22	13
	Nezumia brevibarbata	0.72	20
Macrouroididae	*Squalogadus modificatus*	31.26	141
Moridae	*Antimora rostrata*	2.14	12
	Halargyreus johnsonii	0.52	1
	Lepidion natalensis	0.32	1
Chaunacidae	*Chaunax pencillatus*	0.008	1

	Chaunax pictus	0.046	2
Linophrynidae	*Linophryne digitopogon*	0.003	1
	Linophryne sp.	0.021	3
Ogcocephalidae	*Malthopsis luteus*	0.001	1
Myctophidae	*Ceratoscopelus warmingii*	0.1	61
	Diaphus sp.	0.004	11
	Diaphus hudsoni	0.001	1
	Diaphus knappi	0.001	1
	Diaphus sp.	0.015	11
	Diogenichthys sp.	0.004	3
	Electrona risso	0.162	57
	Gymnoscopelus opisthopterus	0.005	3
	Gymnoscopelus sp.	0.004	1
	Hygophum hygomii	0.036	7
	Hygophum reinhardtii	0.01	2
	Lampadena dea	0.100	10
	Lampadena sp.	0.065	1
	Lampanyctus sp.	0.008	1
	Lampichthys sp.	0.013	2
	Metelectrona ventralis	0.264	55
	Myctophum obtusirastre	0.006	2
	Protomyctophum sp.	0.002	1
	Unid.	0.539	302
Neoscopelidae	*Neoscopelus macrolepidotus*	0.028	1
Halosauridae	*Aldrovandia affinis*	0.045	3
	Aldrovandia phalacra	0.12	5
	Unid.	0.002	1
Notacanthidae	*Notacanthus sexspinis*	0.47	8
Emmelichthyidae	*Emmelichthys nitidus*	2.28	23
Epigonidae	*Epigonus robustus*	0.39	63
Howellidae	*Howella sherborni*	0.039	3
Sparidae	*Unid.*	0.005	1
Trichiuridae	*Aphanopus* sp.	2.02	1
Sebastidae	*Helicolenus dactylopterus*	0.023	9
	Trachyscorpia eschmeyeri	2.6	5
Melamphaidae	*Melamphaes* sp.	0.011	3
	Poromitra crassiceps	0.003	1
	Poromitra megalops	0.004	1
	Scopeloberyx robustus	0.275	20

	Scopeloberyx sp.	0.004	1
	Scopelogadus mizolepis	0.009	1
	Unid.	0.001	1
Gonostomatidae	*Diplophos* sp.	0.025	2
	Diplophos taenia	0.061	2
	Gonostoma atlanticum	0.022	3
	Gonostoma elongatum	0.016	1
	Margrethia obtusirostra	0.004	7
	Margrethia valentinae	0.006	2
	Unid.	0.089	19
Phosichthyidae	*Ichthyococcus ovatus*	0.001	1
	Phosichthys argenteus	0.039	21
	Vinciguerria attenuata	0.004	12
	Vinciguerria nimbaria	0.001	2
	Vinciguerria sp.	0.001	1
Sternoptychidae	*Argyropelecus aculeatus*	0.062	11
	Argyropelecus gigas	0.081	21
	Argyropelecus hemigymnus	0.041	106
	Maurolicus muelleri	7.45	16381
	Sternoptyx diaphana	0.014	10
	Unid.	0.001	1
Stomiidae	*Astronesthes indicus*	0.34	1
	Bathophilus longipinnis	0.015	1
	Bathophilus nigerrimus	0.023	2
	Chauliodus sloani	0.142	7
	Eustomias sp.	0.007	1
	Leptostomias sp.	0.097	1
	Melanostomias sp.	0.159	1
	Photonectes braueri	0.041	1
	Stomias sp.	0.001	3
Oreosomatidae	*Allocyttus verrucosus*	1.59	20
	Oreosoma atlanticum	2.65	14
Class Chondrichthyes			
Family	Species	Weight (Kg)	Number
Scyliorhinidae	*Apristurus manis*	1.8	1
	Apristurus microps	2.5	2
Etmopteridae	*Etmopterus sculptus*	0.44	8
	Etmopterus bigelowi	0.033	1
	Etmopterus granulosus	50.44	64

	Etmopterus sculptus	1.62	15

Appendix 4. Preliminary list of invertebrate taxa collected by means of bottom and pelagic trawl, and Van Veen grab. This list does not include a considerable number of specimens that could not be identified on board but which are curated in the SEAFO Collection in the IZIKO South African Museum, Cape Town.

Phylum Porifera – Order Demospongiae			
Family	Species	Weight (g)	Number
	Unid.	1	1

Phylum Cnidaria – Class Anthozoa – Order Actinaria			
Family	Species	Weight (g)	Number
Hormathidae	*Unid.*	1101	7
	Actinaria unid.	8	6
Order Alcyonacea			
Isididae	*Lepidisis* sp.	11	1
Gorgoniidae	*Leptogorgia viminalis*	22	2
Melithaeidae	*Melithaea rubra*	1	1
	Alcyonacea unid.	44	22
Order Scleractinia			
Dendrophylliidae	*Enallopsammia rostrata*	8	4
Order Zoantharia			
Epizoanthidae	*Epizoanthus paguriphilus*	7330	104
Order Antipatharia			
	Unid.	2	3
Order Corallimorpharia			
Corallimorphidae	*Corynactis* sp.		
Class Hydrozoa – Order Anthoathecata			
Stylasteridae	*Crypthelia* sp.	2	9
	Errina sp.	1	3
	Stylasteridae unid.	2	20
Eudendriidae	*Eudendrium* sp.	1	1
Oceaniidae	*Turritopsis dohrnii*	1	1
Order Leptothecata			
Campanulariidae	*Campanularia hincksii*	1	4
	Obelia geniculata	1	1
Lafoeidae	*Filellum* sp.	1	2
Plumulariidae	*Plumularia pulchella*	1	3
Sertulariidae	*Sertularella arbuscula*	1	1
Tiarannidae	*Stegopoma geniculata*	1	1
Order Siphonophorae			

Diphyidae	*Diphyies* sp.	1	1
	Diphyidae unid.	62	4
	Hydrozoa unid.	3	3
Class Scyphozoa – Order Coronatae			
Peryphillae	*Peryphylla periphylla*	1322	10
	Coronata sp.	360	13
	Scyphozoa unid.	3	1

Phylum Anellida - Class Polychaeta			
Family	Species	Weight (g)	Number
Euniciidae	*Unid.*	1	1
Maldanidae	*Unid.*	1	1
Serpulidae	*Unid.*	3	6
Spirorbidae	*Unid.*	1	1
Syllidae	*Unid.*	2	2
	Polychaeta Unid.	4	4

Phylum Mollusca – Class Bivalvia			
Family	Species	Weight (g)	Number
Pectinidae	*Delectopecten* sp.	1	1
	Bivalvia unid.	1	2
Class Gastropoda			
Capulidae	*Capulus* sp..	1	1
Cavoliniidae	*Cavolinia* sp.	1	5
	Cavolinia tridentata	1	3
Class Scaphopoda			
Gadilidae	*Cadulus* sp.	1	1
Class Cephalopoda		Weight (Kg)	
Opistoteuthidae	*Opisthoteuthis rossi*	2	1
Sepiolidae	*Rossia enigmatica*	0.014	8
	Stoloteuthis sp.	0.004	3
Spirulidae	*Spirula spirula*	0.001	1
Brachioteutidae	*Brachioteuthis picta*	0.002	1
Cranchiidae	*Cranchia scabra*	0.018	4
	Megalocranchia maxima	0.003	2
	Taonius pavo	0.069	2
Enoploteuthidae	*Abraliopsis gilchristi*	0.03	13
Histioteuthidae	*Histioteuthis bonnellii*	0.239	1
	Histioteuthis macrohista	0.333	3
	Histioteuthis reversa	0.177	1

Lycoteuthidae	*Lycoteuthis lorigera*	0.01	2
Ommastrephidae	*Illex* sp.	0.006	1
	Ornithoteuthis volatilis	0.015	5
	Todarodes angolensis	1.45	3
	Todaropsis eblanae	0.03	1
	Onychoteuthis banksi	0.001	1
	Onykia sp.	0.033	1

Phylum Artropoda - Subphylum Crustacea – Class Malacostraca – Order Amphipoda			
Family	Species	Weight (g)	Number
Hyperiidae	*Hyperoche* sp.	1	1
Phronimidae	*Phronima sedentaria*	1	1
	Phronima sp.	81	77
Phrosinidae	*Phrosina semilunata.*	2	8
Platyscelidae	*Platyscelus ovoides.*	34	164
Stegocephalidae	*Unident.*	4	4
	Amphipoda Unident.	9	9
Order Decapoda			
Acanthephyridae	*Acanthephyra acanthitelsonis*	86	19
	Acanthephyra eximia	1513	82
	Acanthephyra kingsleyi	4	1
	Acanthephyra pelagica	22	5
	Acanthephyra quadrispinosa	25	15
	Acanthephyra sp.	12	5
	Notostomus auriculatus	34	5
Aristeidae	*Plesiopenaeus armatus*	18	1
	Plesiopenaeus edwarsianus	14	3
	Plesiopenaeus nitidus	1260	150
Benthesicymidae	*Benthonectes filipes*	29	4
	Gennadas sp.	55	49
Nematocarcinidae	*Nematocarcinus longirostris*	593	14
Oplophoridae	*Oplophorus spinosus*	84	67
	Oplophorus novazelandae	2	1
	Systellaspis cristata	1	1
	Systellaspis sp.	1	1
Pandalidae	*Heterocarpus grimaldii*	139	6
	Plesionika martia	10	2
	Pandalidae unid.	3	5

Parapaguridae	*Parapagurus pilosimanus*	NA	104
Pasiphaeidae	*Pasiphaeae carina*	4	1
	Pasiphaea pacifica	61	20
	Pasiphaea sp.	42	24
Penaeidae	*Funchalia woodwardi*	212	19
Polychelidae	*Polychelidae unid.*	205	25
Sergestidae	*Sergestes armatus*	4	6
	Sergestes corniculum	11	6
	Sergestes diajunctus	8	1
	Sergestes extenuatus	6	3
	Sergestes sp.	74	44
	Sergestes armatus	9	21
	Sergestes diapontius	3	8
	Sergestes sargassi	1	1
	Sergestes sp.	2	3
	Sergia grandis	26	9
	Sergia potens	12	8
	Sergia regalis	3	2
	Sergias cintillans	3	1
	Sergia regalis	3	1
	Decapoda unid.	11	7
Order Euphausiacea			
Euphausiidae	*Nematobrachion* sp.	1	2
	Stylocheiron abbreviatum	1	13
	Stylocheiron carinatum	1	1
	Stylocheiron elongatum	1	1
	Stylocheiron sp.	2	4
	Thysanopoda cornuta	16	35
	Thysanopoda monocantha	3	14
	Thysanopoda sp.	1	11
	Thysanopoda egregia	3	3
	Thysanopoda sp.	6	23
	Thysanopoda tricuspidata	1	1
	Euphausiidae unid.	15	89
Order Isopoda			
Janiridae	*Unid.*	1	2
	Isopoda unid.	1	13
Order Lophogastrida			
Gnatophausiidae	*Gnathophausia zoea*	5	5

Phylum Echinodermata – Order Asteroidea			
Family	Species	Weight (g)	Number
Luidiidae	*Luidia sagamina aciculata*	1	1
Order Crinoidea			
	Unid.	3	8
Order Echinoidea			
Clypeasteridae	*Clypeaster* sp.	8	4
Echinothuriidae	*Higrosoma petersii*	1430	11
Order Holoturoidea			
Mesothuriidae	*Zygothuria lactea*	420	3
	Zygothuria sp.	410	4
	Holoturoidea unid.	4450	10
Order Ophiuroidea			
	Unid.	2	2

Phylum Chordata–Subphylum Tunicata-Class Ascidiacea–Order Enetrogona			
Family	Species	Weight (g)	Number
Polyclinidae	*Unid.*	15	3
Class Thaliacea – Order Pyrosomatida			
Pyrosomatidae	*Pyrosoma atlanticum*	2911	389

Phylum Bryozoa			
Family	Species	Weight (g)	Number
Bugulidae	*Bicellariella ciliata*	1	2
Tubuliporidae	*Idmidronea atlantica*	1	13
	Bryozoa unid.		