SURVEYS OF FISH RESOURCES OF NAMIBIA

Cruise Report No 3/97

Survey of the Valdivia Bank
2 - 14 July 1997

Ministry of Fisheries & Resources
Swakopmund, Namibia

Institute of Marine Research
Bergen, Norway
SURVEYS OF THE FISH RESOURCES OF NAMIBIA

Cruise Report No 3/97, Part 1

Survey of the Valdivia Bank
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by

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CHAPTER 1 INTRODUCTION

1.1 Objectives

The Valdivia Bank consists of a complex series of peaks and troughs, with pinnacles of rock rising from more than 2000 m depth to within 23 m of the surface.

The area has characteristics which suggest that it has a good potential for offshore fisheries resources such as orange roughy, alfonsino, tuna, billfish and other migratory offshore species. It may also be an important nursery area for various species.

The main objectives are listed below:

1. As the bathymetry is based on a rather coarse data set, a detailed mapping of the seamounts was planned.

2. The hydrographic structure of the region, especially around the seamounts, was a central objective, with special reference to food production, (up- and downwelling, eddies and gyres).

3. The sampling of nutrients was planned in order to get a picture of the biological processes taken place in the investigation area.

4. Eggs and larvae were sampled to learn about the regions importance as a spawning and nursery area.

5. Trawling for fish on targets, based on the acoustic echosystem, was planned for identification of species.

1.2 Participation

The scientific staff from the National Marine Information Centre (NatMIRC), Swakopmund, Namibia were:

Alan KEMP, Gerhard OECHSLIN and Anja RISSER
The Scientific staff from the Institute of Marine Research (IMR) in Bergen, Norway were:

Oddgeir ALVHEIM, Martin DAHL, Tor GAMMELSRØD and Jarle KRISTIANSEN.

In addition, we had a guest investigator from Instituto Investigação Pesqueira (IIP), Angola Luanda:

Vianda L. L. FILIPE

1.3 Schedule

The RV ‘Dr. Fridtjof Nansen’ left Walvis Bay at 16h00 on July 2 1997 and steamed west towards the survey area. The first CTD stations was taken at 24°S, 7°E after about 40 hours steaming. On the way the meteorological and sea surface temperature were recorded, as well as the bottom depth. The acoustic integrator system was also activated.

After having completed the first CTD section the wind picked up to gale force, preventing us from station work for a period of about 24 hours.

The main survey area was in the area 23°S to 26°30’S, 4°30’E to 8°30E.

The vessel returned to Walvis Bay on July 14. A total of 2200 NM were steamed.

1.4 Survey effort

The course track with CTD stations, Bongo trawls and fish trawling stations are shown in Fig. 1. A total of 41 CTD stations, 24 Bongo hauls and 2 pelagic trawl hauls were worked.
Figure 1  Course tracks and stations.
2.1 Bathymetry

The 18 kHz echo sounder was recording the bottom continuously by setting the range according to depth. Depths were stored on file for every nautical mile (nm). In addition paper copies of the recordings are available for detailed studies of the bottom profile. Also the 38 kHz echosounder was running continuously. The depth range was usually 0-500 m, but sometimes set to 0-1000 or 0-1500 m. Both the 18 kHz and the 38 kHz were continuously logged to the Bergen Integrator System.

Ships positions were determined with the GPS navigation system.

The bathymetry data were transferred to UMS format using a program developed onboard earlier (Floen, 1997). The actual bottom values were printed on the map using the UMS program. In addition the isobaths were marked using the contour device in UMS. The final isobaths were then drawn by hand.

2.2 Hydrography

A Seabird 911+ CTD probe was used to obtain vertical profiles of temperature, salinity and oxygen. Real time plotting and logging was done using the Seabird Seasave software installed on a PC. The stations were organised in large scale sections to reveal the general hydrographic structure, and detailed studies near the seamounts, for station map, see Fig. 1. The profiles were taken down to a few meters above the bottom, but not deeper than 1500 m due to the capacity of the CTD cable.

Up to 11 Niskin bottles were triggered for water samples on each station for calibration samples of temperature and salinity, and for nutrient determination.

The samples were analysed for salinity using a Guildline Portasar salinometer, and the oxygen content was determined using the Winkler method. These results were used to calibrate the CTD values.
For oxygen we did not obtain a good calibration, because the narrow range of the oxygen values, and some problems with the Winkler method. We therefore used the calibration obtained just prior to the present cruise, which was obtained using 187 samples. A linear regression gave the following formula for correcting the oxygen values:

\[ O_2 = O_{2,\text{CTD}} \times 0.928 + 0.302 \]

The standard deviation of the oxygen calibration was 0.154.

For salinity 60 calibration samples were used. The average difference between laboratory and CTD values was -0.007 (CTD too low) with a standard deviation of 0.0094. Since the difference was less than the standard deviation, salinity values from the CTD were accepted without corrections.

**ADCP current measurements**

A ship borne Acoustic Doppler Current Profiler (ADCP) from RD Instruments was activated on every CTD station. The ADCP was set to ping every 8 seconds, the depth cell was chosen to 8 m and the number of cells to 50. As a routine the data was stored on files.

The ADCP data was transferred to the UMS format (Underway Mapping System, Zauner, 1993), by the ADCP2UMS program developed onboard earlier (Dahl, 1996). The data was analysed and presented using the PC software UMS supported by Sea Fisheries Research Institute, Cape Town, South Africa.

**Meteorological observations**

Wind (direction and speed), air temperature, global radiation and sea surface temperature (SST) (5 m depth) were logged automatically every nautical mile using an Aanderaa meteorological station.

The data were transferred to UMS format using a program developed onboard earlier (Floen, 1997). The data were presented using the UMS program package (Zauner 1993).

**2.3 Nutrient sampling**
Nutrient samples were taken at every CTD station for the following depths (in m): near surface (5), 30, 100, 250, 500, 750, 1 000, near bottom (but not deeper than 1500 m).

Samples were collected from the Niskin bottles into 15 ml Falcon tubes and immediately frozen. It was not deemed necessary to filter the samples as plankton concentrations in oceanic waters are generally low. The 286 samples that were taken will be analysed for silicate, phosphate, nitrate, nitrite and ammonia with the Bran & Luebbe TRAACS 800 Auto Analyser at the laboratory in Swakopmund.

2.4 Plankton sampling

Deck hose pump

An attempt was made to sample for fish eggs using the fire hose on the aft deck. This procedure has been successfully used in South Africa for the sampling of pilchard eggs. The fire hose is directed into a CalVET net and, at set times, a sample is taken. Unfortunately the fire hose on the Nansen is too strong (30 m³ per hour), and all samples collected were broken up, making it difficult to identify. This method was aborted after 4 stations.

Bongo sampling

The Bongo net was fitted with a 180 micron net and a 375 micron net. The 180 micron net was fitted with an uncalibrated flowmeter. Calibration of this flowmeter is to be done at NatMIRC after the cruise. A depressor was used as a weight for the Bongo. The SCANMAR was attached to the Bongo wire for depth determination. The SCANMAR was not very successful at the beginning, but all the problems were sorted out after a few days. This proved to be a very successful method of determining the sampling depth of the Bongo. All samples were preserved in approximately 5% Formalin, for further microscopic analysis.

It was decided to sample only on or near sea mounts. Bongos where done both at night and during the day to a maximum depth of around 450 m, or as close to the bottom as possible during shallower stations. Stations took up to 1 hour to complete.

2.5 Fish sampling
The bottom conditions were very rough in the whole investigated area and bottom trawling was not possible without risking a total damage with the light gear used on 'Dr. Fridtjof Nansen'. In addition fish recordings on the echo sounder were very small.
CHAPTER 3 RESULTS

3.1 Bottom topography

The results of the bottom tracking are shown in Fig. 2. For comparison the same area from the navigation map is shown in Fig. 3. On Fig. 3 the cruise track is also shown.

A comparison of Figs. 2 and 3 clearly show that show great discrepancies in the bottom contours. For example we crossed the positions, according to the navigational map (Fig.3), of five seamounts shallower than 238 m which were not found. The most shallow area (250 m) was found in the SE corner of our investigation area. For the purpose of the cruise we named this ‘Gunnars Hat’. Another important investigation area was a bank with minimum depth was found to be 583 m. We named this ‘Swakop Hill’ (see Fig. 2).

Fig. 2 Bathymetric chart based on the recordings obtained during the cruise

1 The name Gunnars Hat was chosen in memory of Gunnar Sætersdal who created the Nansen Programme. The name Swakop Hill was motivated from the fact that there are very few hills in Swakopmund, and we thought they deserved one.
The bottom profile of Gunnars Hat is shown in Fig.4. This profile was obtained when crossing the Hat from CTD station 711 towards SW (see Fig.1). The profile is very
characteristic with steep gradients leading up to a remarkably flat plateau at about 225 m depth.

The Swakop Hill bottom profile is shown in Fig.5 obtained steaming from CTD station 720 (see Fig.1) towards west. Again a relative flat area was observed surrounded by steep hillsides.

3.2 Oceanography
CTD measurements

The large scale water mass structure is revealed in two vertical sections (Figs. 6 and 7), one an E-W section in the northern part of the investigation area, and one oblique section running from the SW corner to NE corner of the investigation area, for positions see Fig. 1. Note that the horizontal scale is different for the two sections. Both sections show that for the temperature as well as the salinity the structure was rather flat. The Antarctic Intermediate water is recognised as a salinity minimum (S<34.4) at about 700 m depth. The oxygen concentration was around 4 to 5 ml/l in most of the area.

The vertical profiles of two stations (Stns. 697 and 708) show that the upper 100 m was well mixed (Fig. 8). Below the mixed layer a salinity and oxygen maximum was observed. At some of the stations a small, but noticeable maximum was also seen in the temperature profile at the bottom of the mixed layer, an example was station 708, (Fig. 8b).

Due to the deep mixed layer, very little structure was found in the horizontal distribution of the parameters at the surface. These are therefore not shown. However, the horizontal distribution of temperature and salinity at 100 m, (Figs. 9 and 10) show structure reflecting variations in the mixed layer depth. Such structure seems to be most pronounced above the seamounts.

Detailed investigations were performed around the seamounts. Vertical sections crossing the Ewing Seamount, the Swakop Hill and Gunnars Hat are shown in Figs. 11, 12 and 11, respectively. Note that both vertical and horizontal scales are different for these three figures. The effect of the seamounts on the water structure is readily seen, especially at Gunnars Hat, which comes up to about 225 m depth. Here the isotherms and isohalines clearly show a dome structure. The isolines are tilted upwards towards the mountain, both deeper than the mountain top, and above the seamount (Fig. 13). At Gunnars Hat this structure is readily seen all the way to the surface by a salinity minimum (S<35.5) situated just above the seamount (Fig. 13).

Even at the other seamounts the influence of the seamounts are noticeable. At the Swakop Hill, which has a minimum depth of about 550 m, the dome structure is clearly seen all the way to the thermocline. At the Ewing Seamount, which only comes up to about 800 m depth, the influence of the bottom seems to be restricted to below 400 m depth, where an undulating shape of the isolines may be noticed.
Fig. 6 Vertical section in the northern part of the area, a) temperature b) salinity and c) oxygen

Fig. 7 Vertical section crossing the investigation area oblique a) temperature b) salinity and c) oxygen
Fig. 8 Profiles of temperature, salinity and oxygen at a) Station 697, b) Station 708

Also included in Figs 11-13 are the calculated geostrophic velocities, using the surface as a reference level. It may be noticed that above the seamounts there are strong horizontal shears in the velocity structure. This is particularly clear at Gunnars Hat. The current structure just above the Hat indicates a strong anticyclonic circulation, while the general circulation further out from the seamount is cyclonic, and still strong.
Fig. 8 Profiles of temperature, salinity and oxygen at a) Station 697, b) Station 708
Fig. 9 Horizontal distribution of temperature at 100m depth. Dotted lines indicate the 1000m isobath.
Fig. 10 Horizontal distribution of salinity at 100m depth. Dotted lines indicate the 1000m isobath.
Fig.11  Vertical section of a) temperature b) salinity and c) geostrophic velocity near Ewing Seamount

Fig.12  Vertical section of a) temperature b) salinity and c) geostrophic velocity near Swakop Hill
Fig. 13 Vertical section of a) temperature b) salinity and c) geostrophic velocity near Gunnar's Hat
ADCP current measurements

The results of the ADCP registrations are shown in Fig. 14a and b for the currents above the thermocline (at 18 m and 34 m depth) and in Fig. 14c at 122 m depth, which is below the thermocline. All the measurements obtained are shown. Because the great bottom depth almost all the current measurements were obtained using navigation, not bottom track as reference. The recently installed Seapath system, which measures and corrects for the ships own movements, was unfortunately not functioning.

The immediate impression from Fig. 14 is a rather patchy picture. However, some structure emerges. At 18 m depth the prevailing currents seem to be between N and E. This layer is probably influenced by the wind, which was from SSW throughout the cruise (Fig. 15).

Deeper down the general impression is that there are not large differences in currents across the thermocline. Although patchy, the general picture is the same at these two levels. However, more analysis is needed to clearify this point.
Fig. 14a Results from the ADCP current measurements at 18m depth.
Fig. 14b Results from the ADCP current measurements at 34m depth.
Fig. 14c Results from the ADCP current measurements at 122m depth.
3.3 Nutrients

The samples will be analysed in Swakopmund in the end of July.

(Anja)
3.4 Plankton

It soon became evident that the samples contained a high number of fish larvae on the Valdivia Bank, the species of which will be determined at a later stage. The abundance of these larvae was greater during the night time stations than during the day. Orange roughy eggs were not observed, but this will have to be confirmed microscopically at a later stage. Both phytoplankton and zooplankton were abundant. Zooplankton comprising mainly Euphausids and small Copepods. Lobster larvae (Phyllosoma) was also present in many of the samples. The species of lobster is still unknown.

The presence of many different species of fish larvae throughout the survey area, both day and night, could suggest that the Valdivia Bank and the Ewing Seamount is an important nursery area for these specific species.

The samples will be analysed at a later stage (Alan)

3.5 Fish

The first pelagic haul were made on shoals in the south-western part of the investigated area. Only a large oilfish (*Ruvettus pretiosus*), a few alfonsinos (*Beryx splendens*) and some lanternfish were caught. The shoaling fish seemed to be fast swimmers avoiding the trawl.

The second haul was done near the bottom on Gunnars Hat during night-time on recordings of single fish. Only some few Cape bonnetmouth (*Emmelichthys nitidus*), alfonsinos, silver scabbardfish (*Lepidopus caudatus*), snoek (*Thyrsites atun*) and some lanternfish.

A Spanish trawler was operating on the southern part of Valdivia Bank. They reported catch of alfonsino and "blackfish", but no orange roughy.
CHAPTER 4 PRELIMINARY DISCUSSION

4.1 Do the seamounts exist?

During the survey we passed the position of five seamounts marked on the navigation map with depths ranging from 163 m to 23 m below the surface, see Fig. 3). None of these were found in the positions indicated. They may therefore be located elsewhere, or, they may not be existing at all. Often in earlier times the navigation was not so accurate as our GPS system. There is therefore still possible that the seamounts exist, but in different positions.

A comparison with our results (Fig. 2) and the navigation map (Fig. 3), showed large discrepancies. We also did a comparison with the GEBCO Digital Atlas (Meirion et al 1994). That comparison was much closer. Also in the GEBCO atlas the 5 seamounts are absent.

4.2 The Valdivia Bank as a nursery area?

The preliminary results from the Bongo hauls indicate that the region investigated may be an important nursery area for various species. The reason for this may be found in the hydrographic structure around the seamounts. As noticed in Chapter 3 the seamounts seem to influence the water masses around is and above it. At Gunnars Hat (Fig. 11), which was the most shallow area investigated, this structure was particularly clear. The cylonic gyre around the seamount may be due to a so called Taylor Column (Taylor, 1923). The ambient currents may flow around the Taylor Column, while the water within the Column will be trapped. Thus one of the conditions in ‘Bakuns Triad’ (Bakun, 1996) for survival of species at an early stage, namely retention, seems to be fulfilled.

The lifting of the thermocline above the mountain top may transport nutrient rich water into the photic zone. In addition the strong anticyclonic circulation around the seamounts, see Fig. 11 for a clear example on Gunnars Hat, will create strong friction layers near the bottom. In this layer, often called Ekman layer, the current is slowed down, and therefore the Coriolis force will be to small to balance the pressure force. A transport out from the seamount in the bottom layer will therefore take place. This will in turn set up a vertical circulation which may transport nutrient rich water in to the stagnant area. This is the second condition in ‘Bakuns triad’, the enrichment.
The rich catches of larvae, and maybe eggs in the Bongo hawls indicate that the Valdivia Bank is an important nursery area for various species. The fact that the hydrographic structure around the seamounts seem to fulfill two of the three conditions in ‘Bakuns triad’ for survival of species at an early life stage, namely retention and enrichment supprt this hyphothesis.

References

