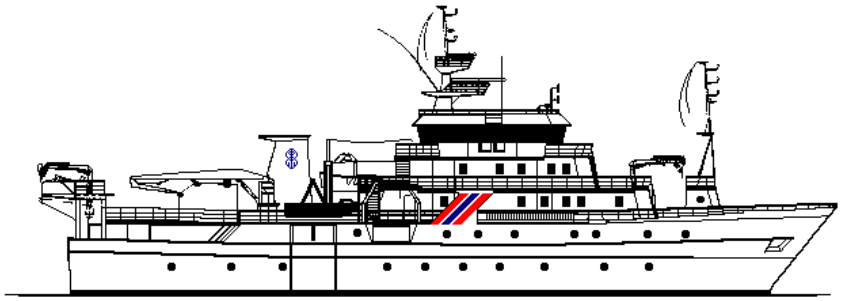

East Madagascar Current
Ecosystem Survey

ASCLME / FAO 2008 Cruise 1

23 August– 01 October 2008

Preliminary report

Institute of Marine Research (IMR)
Norway

CRUISE REPORTS "DR. FRIDTJOF NANSEN"

East Madagascar Current Ecosystem Survey

ASCLME / FAO 2008 Cruise 1

24 August– 01 October 2008

Preliminary report

by

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Institute of Marine Research
Bergen, 2008

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1. INTRODUCTION

This survey is the first survey of the GEF funded "Agulhas and Somali Current Large Marine Ecosystem" (ASCLME) project. The survey is conducted jointly with the Food and Agriculture Organisation of the United Nations (FAO) Nansen Programme.

It has been more than 25 years since the first visit of the previous "Dr. Fridtjof Nansen" in Madagascar. The former "Dr. Fridtjof Nansen", decommissioned in 1993, surveyed the fish resources and environmental conditions of the Malagasy waters in June 1983 covering the south and east coast only.

The main objective of fisheries surveys in the 1980s was to find new resources. Today, when most of the world's fish resources are located, and in many instances overexploited, the main focus is not on finding new resources, but to monitor the ecosystem and ensure that resource exploitation does not exceed the carrying capacity of the system. Hence an ecosystem approach - a holistic approach encompassing not only the targeted fishery species but the entire physical, chemical and biological environment - to the management of marine resources is advocated.

This new baseline will enable Madagascar and the other countries within the region to monitor subsequent changes in the resources and in the environment. This is especially important today as we are in a crucial period of global warming with likely heavy impact on the coastal areas over time. The new Nansen EAF (Ecosystem Approach to Fisheries) programme with the full backup from the FAO and other UN agencies such as UNEP and the IOC will assist the coastal states in the SW Indian Ocean in following up on this important task in the years to come.

1.1 Aims and Objectives

Following discussion between the ASCLME project, the Nansen Programme coordinator and FAO, the following aims and objectives were decided for the survey.

1.1.1 Aims

- To establish a baseline for the ecosystem off southern and eastern Madagascar.
- To establish for the very first time the physical, chemical and biological characteristics of the East Madagascar Current system as a whole, its bifurcation and with special regard to its influence on the ecosystem of the adjacent continental shelf. This current

system (including shelf) is one of the least known systems of the world ocean; physically, chemically and biologically (Lutjeharms, 2006). The cruise has been planned to establish a baseline for all three of these disciplines, albeit a once off. It is planned to deploy current meters for long-term monitoring at a later stage to overcome this shortcoming. The ecosystem baseline assessment is expected to be completed with a special survey on the demersal fauna, (fish and benthos) next year.

1.1.2 Objectives

- To carry out the first multi-disciplinary, quasi-synoptic cruise that encompasses the whole of the East Madagascar Current and the adjacent shelf.
- To establish the distribution of organisms on a number of trophic levels and how these are affected by the prevailing current system.
- To establish, as far as possible, the productivity, biodiversity and biomass of the pelagic ecosystem.
- To determine the nature of the South Equatorial Current as a driving force for the marine ecosystem east of Madagascar and its interaction with the northern branch of the East Madagascar Current.
- To determine the nature of the termination of the southern branch of the East Madagascar Current south of Madagascar.
- To undertake preliminary investigations of species diversity in the demersal fish fauna.
- To fulfil the data management agreement contained in Annex V.

1.1.3 Key questions

- What are the main components in the East Madagascar pelagic ecosystem, its distribution and abundance?
- How does the East Madagascar Current change along its full length?
- How does the East Madagascar Current affect the circulation on the adjacent shelf?
- What influence does the East Madagascar Current have on the distribution of organisms and thus on the local ecosystem?
- What are the cross-shelf characteristics of the current and its biota?
- What is the biodiversity of the pelagic ecosystem and the main species comprising the demersal fish community?

1.2 Participation

A total of 27 scientists and technicians participated in the three legs of the survey. The full list of the participants, their affiliations and the stages of the survey where they participated is given in Table 1.1 below:

Table 1.1 List of participants

Participants	Institution	Period
James Stapley	ASCLME, Britain	23.08-02.10
Aboudou Roger	CNRO, Madagascar	17.09-02.10
Jacques Philippe	CNRO, Madagascar	30.08-02.10
John Bemiasa	IHSM, Madagascar	30.08-16.09
Norosoa M G Bakary	CNRO, Madagascar	30.08-02.10
Irene Rasoamananto	IHSM, Madagascar	30.08-16.09
Roger	IHSM, Madagascar	30.08-16.09
Thomas Razafimanambina	IHSM, Madagascar	30.08-16.09
William Rakotoarinivo	IHSM, Madagascar	17.09-02.10
Einar Osland	IMR	17.09-02.10
Inger Marie Beck	IMR	17.09-02.10
Jan Frode Wilhelmsen	IMR	23.08-02.10
Jens-Otto Krakstad (Cruise Leader 1st leg)	IMR	23.08-16.09
Kåre Tveit	IMR	23.08-16.09
Magne Olsen	IMR	23.08-16.09
Sigbjørn Mehl (Cruise Leader 2nd leg)	IMR	17.09-02.10
Christian E Raheriniaina	Madagascar	17.09-02.10
Jarisoa Tsarahevitra	Madagascar	17.09-02.10
Roberto Komeno	Madagascar	17.09-02.10
Berthin Rakotonirina	Madagascar	17.09-02.10
Sean Fennessy	ORI, South Africa	23.08-30.08
Jessica Escobar-Porras	RU, Colombia	23.08-02.10
Raymond Roman (Local Chief Scientist)	UCT, South Africa	23.08-02.10
Arrie Klopper	UP, South Africa	23.08-30.08
Carel Oosthuizen	UP, South Africa	30.08-16.09
Bradley Flynn	UWC, South Africa	23.08-02.10

List of institution abbreviations:

ASCLME; Agulas and Somali Current Large Marine Ecosystems project

CNRO; Centre National de Recherches Océanographiques

IHSM; Institut Halieutique et des Sciences Marines

IMR; Institute of Marine Research, Norway

ORI; Oceanographic Research Institute, South Africa

RU; Rhodes University, South Africa

UCT; University of Cape Town

UWC; University of Western Cape

1.3 Narrative

The Vessel left Durban, South Africa just after midnight on 24 August. The weather was rough, with near gale force wind from the northeast and strong current. The weather improved gradually and was good by the time the first environmental station was reached late evening on 26 August. After finishing the first environmental transect on the coast of Madagascar at midday on 28 August, the survey continued with acoustic transects and fishing operations on the southern shelf until a pause in surveying was required due to a scheduled change of scientific personnel during the morning of 30 August; the vessel steamed to Taolanaro. After departing Taolanaro in the evening, the vessel steamed south west on the Madagascan shelf to resume the environmental transects. A short break was made on 15 September to bring a sick participant to Toamasina. Just after lunch on 16 September the vessel entered Toamasina again for an official reception and change of scientific personnel the next day. During late evening 18 September the vessel left Toamasina and the survey continued with the environmental transect at 18° S. In the following days the north-eastern coast was cover by acoustic transects out to about 1000 m bottom depth and environmental transects to about 100 nm from the coast. The northern point of Madagascar was reached in the evening 26 September and the surveyed continued with an environmental transect to the Farquhar Group, which was reached in the early morning of 28 September. The vessel then steamed towards Mauritius. The first environmental transect of the Mauritius survey was taken 1 October and the vessel docked in Port Louis late afternoon the same day.

Continuous acoustic recording and analysis were carried out along transects throughout the survey. Pelagic and demersal trawling was carried out to identify acoustic target species and to obtain information on fish abundance and species composition in the area. Environmental transects consisting of CTD-stations were taken to the bottom or to a maximum of 3000 m depth on predefined stations along selected hydrographical transects and water samples were collected with Niskin bottles at predefined depths on these. Zooplankton samples were taken from 500 m depth to the surface (100 m depth interval per net) with Hydrobios Multinet plankton sampler on the hydrographical stations. Bongo nets were taken to 200 m depth on three stations (far offshore, mid transect and shelf break) along each environmental transect (see Figures 1.1-1.3 for details).

1.4 Survey effort

For the purpose of acoustic abundance estimation the coast was divided into three areas; The South coast, south of 25° S, the Southeast coast between 25° S and 20° S and the East coast between 20° S and 13° S. These correspond roughly with known marine biogeographic regions of Madagascar (Spalding *et al*. 2007). Figures 1.1-1.3 show the cruise tracks with bottom trawls, pelagic trawls, hydrographic and plankton stations.

Table 1.2 summarises the survey effort in each region. Based on topographic characteristics and bio-diversity the coast was divided into three regions.

Table 1.2 Number of hydrographic (CTD), plankton (P), pelagic trawl (PT), bottom trawl (BT) stations and distance surveyed (NM) during the survey.

Region	CTD	P	PT	BT	Distance surveyed (NM)
South coast	43	37	7	6	2455
East coast 25°-20°	27	22	5	3	1205
East coast 20°-12°	34	24	5	2	1704
Transect Cap d'Ambre 12°-10°	11	8		1	230
Total	115	91	17	12	5595

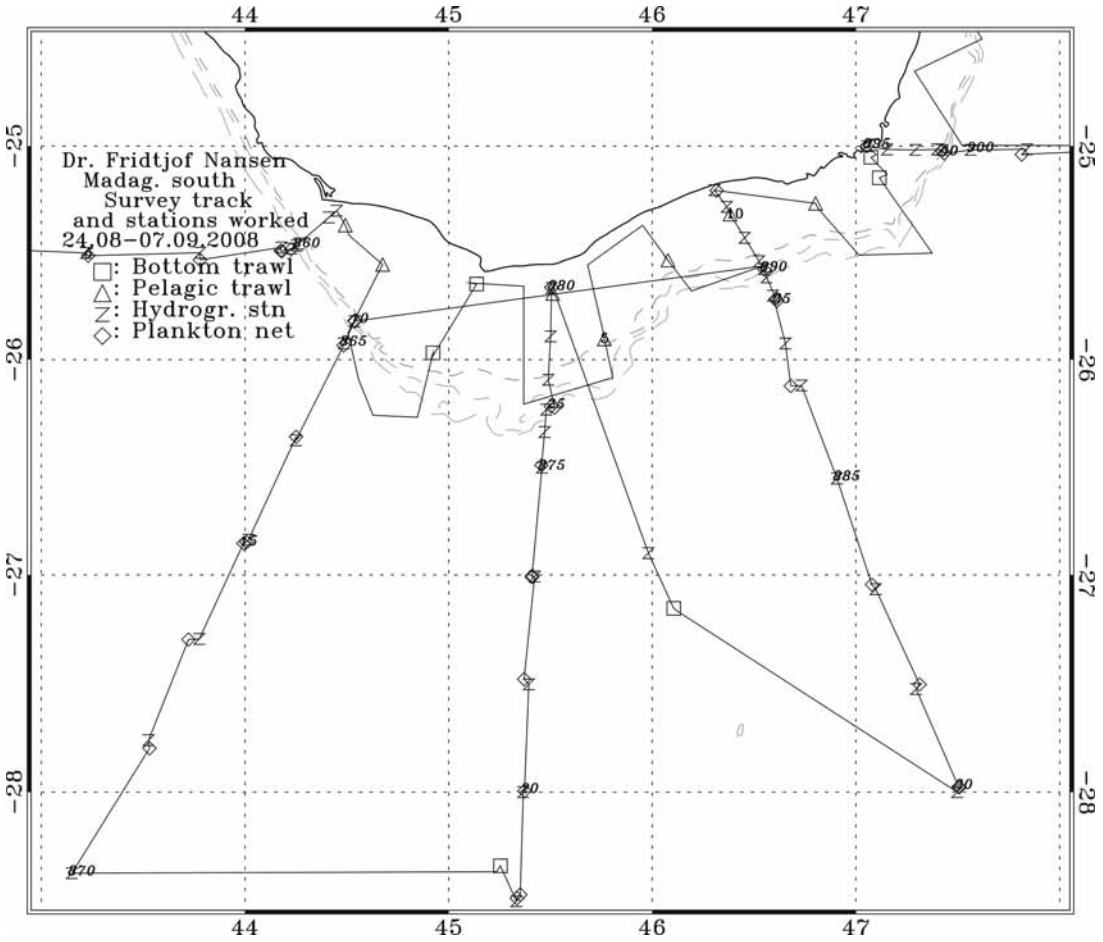


Figure 1.1. Southern region. Course tracks with bottom trawl, pelagic trawl, plankton and hydrographic stations. The 100, 500 and 1000 m depth contours are indicated.

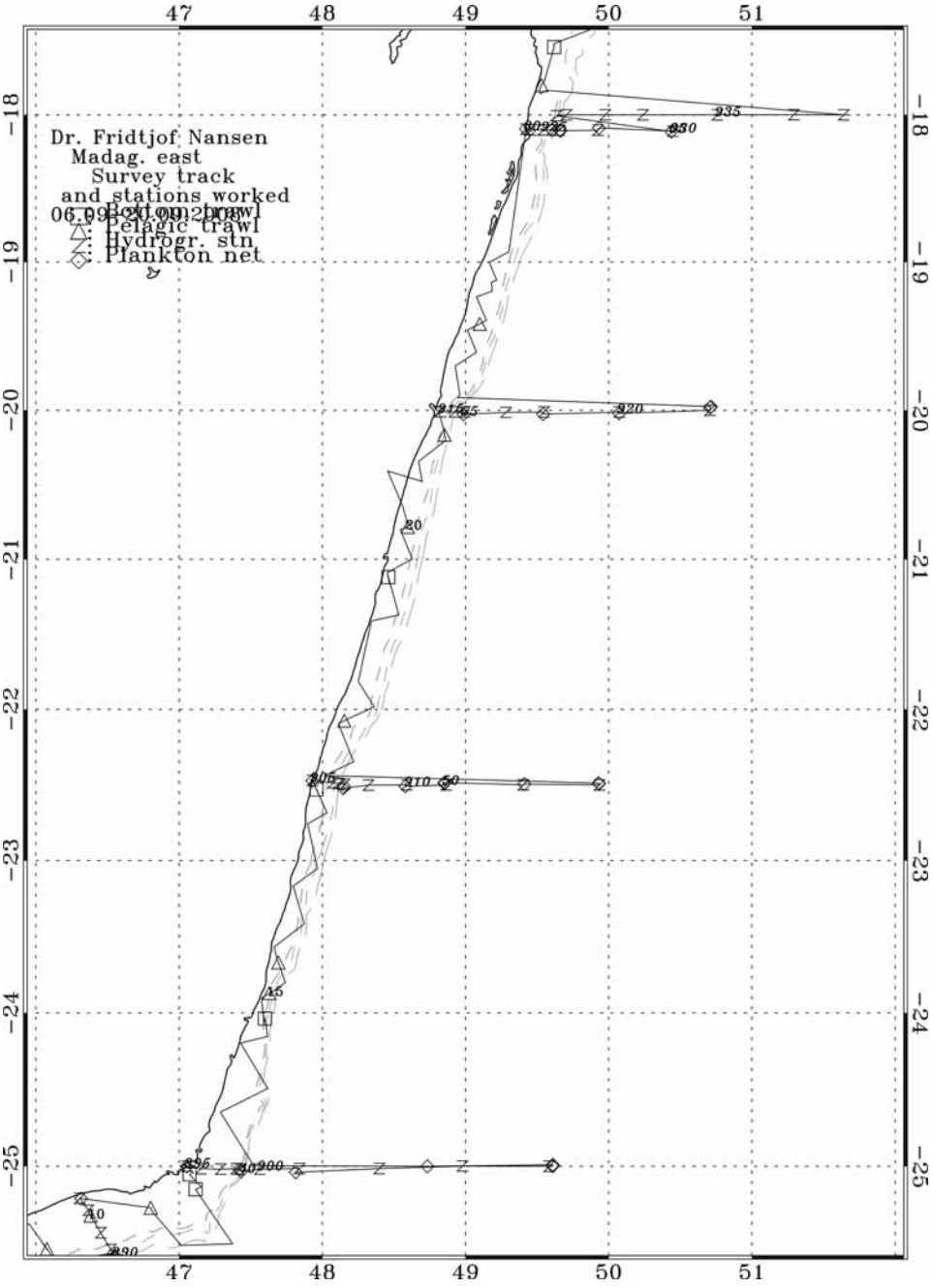


Figure 1.2. South-eastern coast. Course tracks with bottom trawl, pelagic trawl, plankton, and hydrographic stations. The 100, 500 and 1000 m depth contours are indicated.

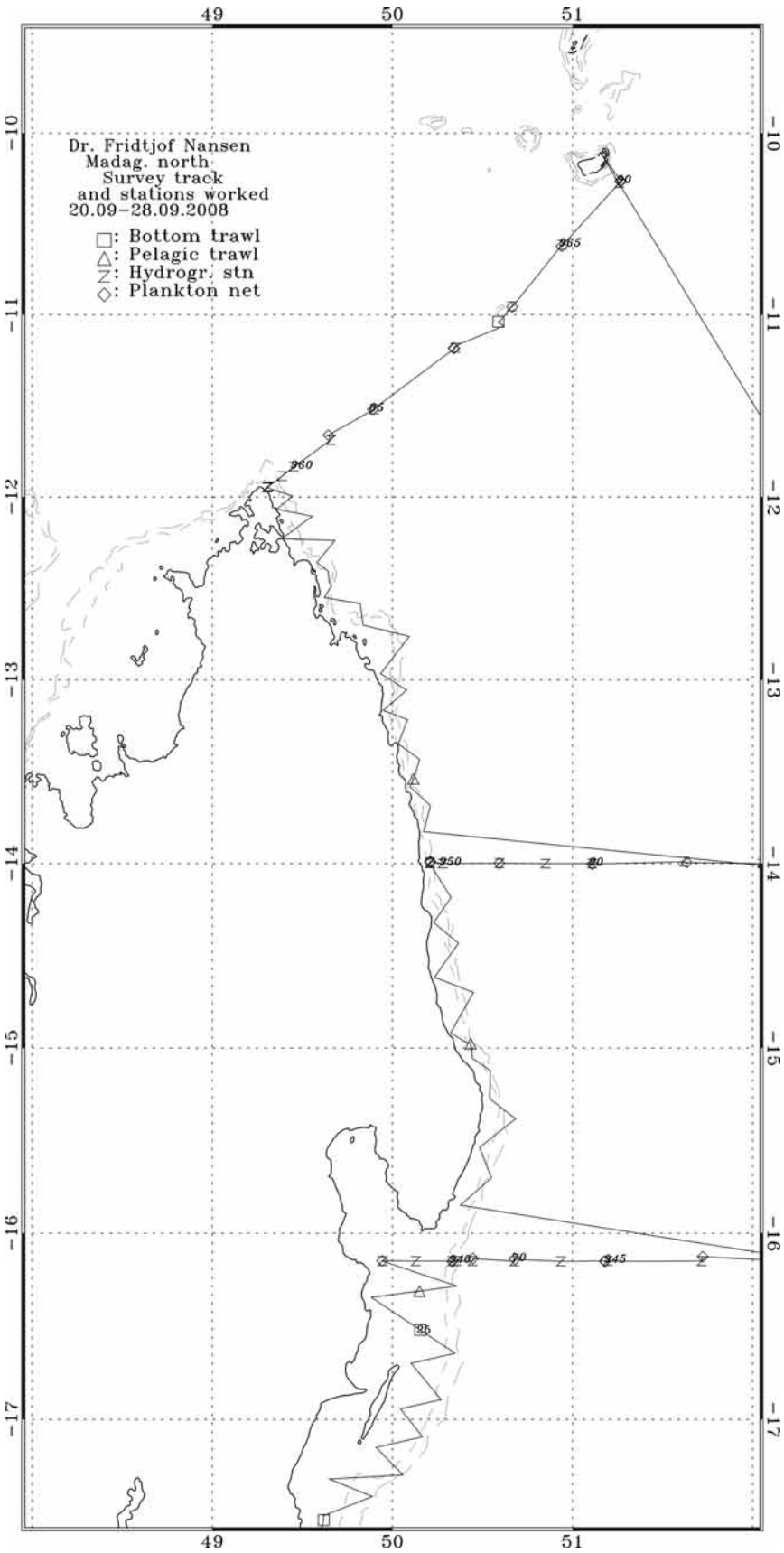


Figure 1.3. North-eastern coast and the Farquhar Group. Course tracks with bottom trawl, pelagic trawl, plankton, and hydrographic stations. The 100, 500 and 1000 m depth contours are indicated.

2. METHODS

2.1 Meteorological and hydrographical sampling

2.1.1 CTD profiles

A total of 115 CTD stations were conducted along selected hydrographical transects (Figures 1.1-1.3). A Seabird 911plus CTD plus 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 profiles along the Madagascar shelf and slope were usually taken down to a few metres above the bottom, whilst offshore, due to instrument restrictions, the maximum sampling depth was 3000 m. Water samples were normally taken at 12 standard depths; 3000, 2500, 1750, 1250, 1000, 800, 500, 300, 100, 85, 50, surface (4-5 m) for nutrient analysis as well sensor calibrations of oxygen and salinity. Nutrient samples were frozen onboard for analysis on land.

The oxygen sensor calibration showed a slope and offset of: what?

Salinity calibration with the Portsal salinometer showed a slope and offset of: what?

Also attached to the CTD was a Chelsea Mk III Aquatracka fluorometer. It measures chlorophyll a concentration in micrograms per litre with an uncertainty of 3%. Factory slope and offset were 0.921 and -0.02.

Fluorescence: Chl-a

Water samples were taken from up to 5 depths from Niskin bottles on the CTD rosette, dependant on other hydrographic sampling priorities. An ideal sampling regime was to have a sample from below fMax, one at fMax (maximum fluorescence noted during the CTD downcast), two between fMax and the surface, and one at the surface. Frequently, only 3 or 4 of these depths were available.

500 ml of water from each depth was filtered through a 2.5 cm diameter Whatman GF/F filter. This paper was then placed in a labelled plastic tube and 10 ml of 90% acetone was added; this sample was then stored in a refrigerator for approximately 24 hours. After this 24 hour extraction period, the samples were allowed to warm to room temperature in a dark place and the acetone solution was decanted into a borosilicate glass tube and its fluorescence measured on a Turner Designs Fluorometer, both before and after the addition of one drop of 10% HCl acid. A one minute period was allowed to elapse between the addition of the acid and the subsequent reading being taken. The sensitivity of the machine was adjusted to ensure a mid-scale reading. If the reading was off the scale at minimum sensitivity, the sample was diluted,

the dilution factor noted, and a reading taken. 90% acetone blanks at all sensitivities were taken at least once every time the machine was turned on, and the machine was left on for at least 30 min prior to taking any readings. All procedures were performed in subdued light.

As some uncertainty exists around the accuracy of the fluorometer, duplicate samples from fMax were taken once per transect, wrapped in tinfoil, labelled and deep frozen for later analysis on shore.

Fluorescence readings were converted with the following formula:

$$\text{Chlorophyll a } (mg.m^{-3}/\mu g.l^{-1}) = F_D * (T/T-1)*(R_B-R_A)*(v/V)$$

Where

v = volume of acetone used for extraction (10ml)
V = volume of seawater filtered (500ml)
R_B = fluorescence reading prior to adding acid
R_A = fluorescence reading after adding acid
Acid ratio $T = R_B/R_A$
T = 2.19
T/T-1 = 1.84

F_D was a calibration factor determined prior to the cruise, dependent on the sensitivity of the fluorometer:

1x sensitivity on Min and 3.16 settings: 25.792
1x sensitivity on 20 and 31.6 settings: 2.7948
100x sensitivity on Min and 3.16 settings: 0.2876
100x sensitivity on 10 and 31.6 settings: could not be determined.

2.1.2 Phytoplankton

At each CTD station, water samples from fMax (maximum fluorescence noted during the CTD downcast) and the surface were taken. An attempt was made to assess flagellate abundance using a Leitz phase contrast microscope by placing one drop of seawater on a slide and placing a coverslip over it and examining. If flagellates were found, an attempt to categorise them into taxa and an estimate of abundance was made (noting the dominant taxa), along with sketches. If no flagellates were apparent in the first drop, a second drop was examined in the same manner.

Those aboard the first leg had no familiarity with flagellate identification, and were unable to definitively identify flagellates.

500ml of water from each of fMax and the Surface Niskin bottles was placed in separate Ütermohl settling chambers with 10 ml of prepared formalin solution (equal volume of 40% formaldehyde solution to distilled water with 100 g/l hexamine added). After settling for 24 hours in a fume cupboard, the supernatant layer was drained by slowly separating the baseplate, and the settled plankton remaining in the well were transferred using a glass micropipette into a labelled 50ml dark amber plastic bottle and stored in a plastic bin.

When the Vaseline for sealing the chambers ran out, a slight modification of the method was employed; 500 ml of sample water was placed in a 600 ml jar with 10ml of formalin solution and stored in a bin for later settling.

The samples will be analysed on shore for species composition.

2.1.3 Bongos

A bongo net with 300 μm and 500 μm mesh nets was deployed when possible; given limited sampling time, it was not possible to conduct bongo tows on all lines, nor at all the stations on each line. Where possible, a minimal sampling regime was therefore attempted, with bongo tows being made at the shelf break, midway out along the CTD line and at the furthest station from shore.

The bongo was deployed to 200 m and retrieved. Flow meters were mounted inside the mouth of each net, and the meter readings before and after each tow, along with the time down, were recorded. Tows generally lasted 20-30 minutes.

The 500 μm sample was preserved in a 500 ml jar using 40 ml of 40% formaldehyde with the remainder of the bottle being sample and seawater. The jar was labelled and stored for later analysis.

The 300 μm sample, intended for stable isotope analysis, was size-fractioned through a 4 mm, 2 mm, 1mm and 500 μm sieve series. The 4mm sample was frozen so that large taxa could be identified and separately analysed. The other 3 size classes were individually washed from the respective sieve into a 300 μm sieve, concentrated, and then transferred without water into separate labelled sterile sample jars. The sample was pressed against the side of the jar, and then left in an oven at 50º C for 48 hours before being capped and stored. Labelling was restricted to the outside of the bottle only.

2.1.4 Thermosalinograph

The SBE 21 Seacat thermosalinograph was running routinely during the survey, obtaining samples of sea surface salinity and relative temperature and fluorescence (5 m depth) every 10

seconds. An attached in-line Turner Design SCUFA Fluorometer continuously measured Chlorophyll A levels [RFU] at 5 m below the sea surface while underway during the entire cruise.

2.1.5 Current speed and direction measurements (ADCP)

A vessel-mounted Acoustic Doppler Current Profiler (VMADCP) from RD Instruments was run continuously during the survey in broadband mode shallower than about 400 m and in narrow band mode in deeper waters. The frequency of the VMADCP is 150 kHz, and data were averaged and stored in 3 m or 4 m vertical bins. All data were stored on files for post survey processing.

2.1.6 Meteorological observations

Wind direction and speed, air temperature, air pressure, relative humidity, and sea surface temperature (5 m depth) were logged automatically every 1 min. on an WIMDA meteorological station.

2.2 Zooplankton sampling

Zooplankton samples (Figures 1.1-1.3) were collected with Hydrobios Multinet zooplankton sampler that takes up to five discrete samples at predefined depths while measuring the water flow through the net. The aim was to collect depth-stratified information on the abundance and distribution of zooplankton and to collect zooplankton for genetic analysis. The obliquely-hauled multi-net configuration was 5 nets, fitted with 180 um mesh. Nets were deployed using standard protocols and were retrieved at a rate of ~ 1.5 m per second. The ship's personnel deployed the net at each environmental station except when severe wind prevented deployment. The nets were triggered at 100 m intervals starting at a maximum depth of 500 m. No adjustments to the sampling protocols were made for day or night.
The samples collected were rinsed into the cod end and thoroughly washed into a sieve with a 100 micron mesh. The contents of the sieve were then washed into a sample jar using a water bottle filled with ambient seawater. Labels showing full station details, net number and fishing depth range were placed into the sample jars, which were topped up with 40 ml of 40% formalin. The lids of all sample jars were labelled with station details – including net and station number. The main types of zooplankton observed in each sample were identified and recorded in the log. Any medusa or other obstructions found in plankton samples were fixed and preserved separately (with full labels). Large specimens of other interesting taxa were removed, fixed and preserved separately, with full labels.

Jars were placed in the plastic fish box provided for 24 hours. At the end of each haul, after the samples had been processed, the cod ends were inspected for damage, repaired if necessary, and replaced on the nets. After 24 hours, the approximate volume of zooplankton in each sample was recorded and entered into the logbook. Thereafter, the samples were stored for further analysis on land.

Every 10th zooplankton haul were stored in sample jars filled with 96% ETOH. Samples were labelled and stored in the freezer. After 24 hours, the ETOH was replaced; and then again after a further 48 hours.

2.3 Biological fish sampling

The trawl catches were sampled for species composition by weight and number. The deck sampling procedure is described in more detail by Strømme (1992). Length measurements were taken for most target species on most stations. An Electronic Fish Meter (SCANTROL) coupled to a customised data acquisition system (Nansis) running on a Windows PC was used for length measurement. The total length of each fish was recorded to the nearest 1 cm, rounding down when this was between sizes. The carapace length for shrimp was measured to the nearest 0.1, again rounding down. Basic information recorded at each fishing station, i.e. trawl hauls, is presented in Annex I. Pooled length frequency distributions, raised to catch per hour, of selected species by area are shown in Annex II.

Three individuals of each species were sampled for DNA and Isotopes. These specimens were measured (total length), sexed (when possible) and a picture taken.

DNA: Muscle tissue was always taken from the right hand side of the fish, or from the ventral in the case of flatfish. This was done in order to keep left side in good condition for a reference picture (sample tag, ruler and colour chart). The tissue was removed from below the lateral line on the tail fin peduncle after cleaning away skin and scales. Where possible, muscle tissue was cut and placed into 1.5 ml Eppendorf tubes containing 95% ethanol and a unique number for identification e.g. ACEP 08-001. In most cases, specimens that were used for DNA sampling were also kept as vouchers by fixing them in 10% formalin. A label with the same identification number used for the DNA tube was attached to the specimens through the mouth and gills for future reference. Elasmobranch specimens that were still alive after the trawl were identified, weighed, measured (TL) and a fin clip taken for DNA analysis. Pictures of the specimen were also taken before returning it to the water.

Stable Isotope sampling: Muscle tissue was taken from behind the head, above the lateral line of the fish. The tissue sample was placed in a 1.5 ml Eppendorf tube, placed in a 50^{o} C oven and dried with the lid open at this temperature for 48 hours. Permanent markers were used to label the outside of the tube. When possible, 3 individuals of the same species from each trawl were sampled. Once dried, Eppendorf tubes were closed and stored in a “cryobox”. Full cryoboxes were wrapped in clingfilm for moisture protection and stored in a bin for subsequent analysis on shore.

For both DNA and stable isotope tissue samples, all equipment used was cleaned between individual sampling. The working surface used was also wiped clean and dried every time before a new individual was sampled in order to avoid contamination. Only one spreadsheet was used to record DNA, stable isotope sample and voucher specimen data.

Voucher specimens were kept for every species that DNA and isotopes samples were collected. All specimens were fixed in formalin until the end of the leg, then they were rinsed in freshwater and finally transferred to 80% Ethanol. They were store in plastic buckets and then put in wooden box protected from direct sunlight and wave action. Big specimens such as sharks were store in drums with 10% formalin solution until the end of the cruise. Specimens too fragile or small to remove tissue samples were kept frozen for further analysis. All specimens have a unique code number attached in the gills, and store by trawl number. Each Trawl bucket was label with date of collection, trawl station number, depth and ASCLME-LEG1.

All DNA tissue samples were store in plastic containers by trawl number. All trawl containers with DNA were put in a plastic bucket labelled ASCMLE-LEG1 and kept in the freezer. Name of the person that collected the samples were included in the bucket labels in case of questions arise at a later stage.

JELLYFISH medusae were also collected from the trawl and stored separately for genetic and morphological analysis. Medusae were separated after initial weighing of the catch. A small piece of tissue was removed from the oral arm and placed into a vial with 96% ETOH. The sample was given a unique letter/number combination and this, together with full station details were put on a label (in pencil) and placed in the tissue vial with the oral arm fragment. The vial was placed into the deep-freeze. After 24 hours, the ETOH was replaced for the first time and then again after 48 hours. The same sample details were entered onto another label (in pencil), which was attached to the actual specimen and placed into a large bucket containing 10% formalin/seawater mix by volume. Small, medium or damaged jellyfish were preserved in vials in 96% ETOH, in entirety, and treated as above. If specimens were of medium size, or too delicate to thread a label through, then the specimen was placed in a plastic bag (with a label) that had numerous holes punched in it to allow the 10% formalin solution to adequately preserve the specimen and placed into a bucket of formalin solution. A log was made of the sample details for each specimen collected.

2.4 Multibeam echo sounder for bottom mapping

The EM 710 multibeam echo sounder is a high to very high-resolution seabed mapping system. Acquisition depth is approximately 3 m below the transducers, and the maximum acquisition depth is in practice limited to 1500 m on *Dr. Fridtjof Nansen*. Across track coverage (swath width) is up to 5.5 times water depth and may be limited by the operator either in angle or in swath width without reducing the number of beams. The operating frequencies are between 70 to 100 kHz. There are 128 beams with dynamic focusing employed in the near field. The transmitting fan is divided into three sectors to maximize range capability and to suppress interference from multiples of strong bottom echoes. The sectors are transmitted sequentially within each ping, and use distinct frequencies or waveforms. The along track beam width is 1 degree. Ping rate is set (manually) according to depth. The receiving beam width is 2 degrees.

2.5 Biomass estimates

2.5.1 Acoustic abundance estimation

A SIMRAD ER 60 Echo sounder was used to survey the water column and the echograms were stored on files. The acoustic biomass estimates were based on the integration technique. The Large Scale Survey System (LSSS) from MAREC was used for integration and allocation of the integrated s_A-values (average area back scattering coefficient in m^2/NM^2) The splitting and allocation of the integrator outputs (s_A-values) was based on a combination of a visual scrutiny of the behaviour pattern as deduced from echo diagrams, LSSS analysis and the catch composition. The mean integrator value in each sampling unit (s_A-values) was divided between the following standard categories/groups of fish: Pel 1 (Clupeoid species), Pel 2 (Carangids, Scombrids, Leiognathids and associated pelagic like barracudas and hairtails), Dem (Demersal species), Meso (Meseopelagic species), Plank (Plankton).

The following target strength (TS) function was applied to convert s_A-values (mean integrator value for a given area) to number of fish by category:

$$TS = 20 \log L - 72\ dB \qquad (1)$$

or in the form

$$C_F = 1.26 \cdot 10^6 \cdot L^{-2} \qquad (2)$$

where L is the total length and C_F is the reciprocal back scattering strength, or the so-called fish conversion factor. Generally, in order to split and convert the allocated s_A-values (m^2/NM^2) to fish densities (number per length group per NM^2) the following formula was used

$$N_i = A \cdot s_A \cdot \frac{p_i}{\sum_{i=1}^{n} \frac{p_i}{C_{Fi}}} \qquad (3)$$

where: N_i = number of fish in length group i
A = area (NM^2) of fish concentration
s_A = mean integrator value (echo density) in area A (m^2/NM^2)
p_i = proportion of fish in length group i in samples from the area
C_{Fi} = fish conversion factor for length group i

$$N = \sum_{i=1}^{n} N_i \qquad (4)$$

Further, the traditional method is to sum the number per length group (N_i) to obtain the total number of fish:

The length distribution of a given species within an area is computed by simple addition of the length frequencies obtained in the pelagic trawl samples within the area. In the case of co-occurrence of target species, the s_A value is split in accordance with length distribution and catch rate in numbers in the trawl catches. Biomass per length group (B_i) is estimated by applying measured weights by length (W_i) when available or theoretical weights (calculated by using condition factors), multiplied with number of fish in the same length group (N_i). The total biomass in each area is obtained by summing the biomass of each length group:

$$B = \sum_{i=1}^{n} N_i \overline{W}_i \qquad (5)$$

The number and biomass per length group in each concentration are then added up to obtain totals for each region.

However, the combination of low s_A value recorded, few PEL1 and PEL2 in the bottom trawl catch and few pelagic trawls made the splitting by length groups unreliable. Therefore, a theoretic mean length of 23 cm was used to convert the s_A values by stratum (Equation 3) to number of fish. Equation 5 was used to convert the number of fish in the defined average length class (23 cm) to total estimated biomasses of PEL1 and PEL2.

A description of the fishing gears used, acoustic instruments and their standard settings is given in Annex III.

3. OCEANOGRAPHIC CONDITIONS

3.1 Background

Madagascar, the fourth largest island in the world, has a narrow shelf along its east coast that widen slightly along its south coast. The oceanic environment around the island is not well known but consists of the South Equatorial Current flowing eastward along a band 8° to 22°S (Woodberry et al., 1989; Hastenrath and Greishar, 1991). As the current encounters Madagascar it splits into a northward and southward East Madagascar Current. The southward branch is well developed from around 18°S and carries with it warm, highly saline, nutrient poor water (Ho et al., 2004). Quartly et al. (2006) showed the southern branch to be influenced by eddies ariving from the east that joins the current along its length. The current follows the east coast of the island to around 27°S, whereafter its flow appears variable and not well described due to limited hydrographic data. From drifter measurements the current has been shown to retroflect, flow westward to the Agulhas Current and into the Mozambique Channel (Tomczak and Godfrey, 2003). However this is still contentious as Quartley et al. (2006) have shown there is no persistent north flow into the Mozambique Channel or direct westward flow to the Agulhas Current. de Ruijter et al. (2002) showed the current to break up into cyclones and anti-cyclones that move westward to the Agulhas Current. The influence of the current on the shelf is either not known or not well understood. It has been suggested that at least in part it is responsible for the upwelling seen along the south east corner of the island (Lutjeharms and Machu, 2000). Webb (2007) indicated the upwelling observed along the Agulhas Current Sources Experiment II sections along the south east coast was probably due to a combination of favourable winds, a lee eddy and current influence.

The surface water of the East Madagascar Current consists of relatively fresh Tropical Surface Water (TSW) originating in the tropics (~0-100 m). This water mass is formed as a result of excess precipitation over evaporation (Read and Pollard, 1993). Below the TSW layer there is the highly saline, low oxygen, high nutrient Subtropical Surface Water layer (STSW) (~100-400 m). It is believed this water mass gets its high nutrient values from *in situ* bacterial breakdown of organic matter (Donohue and Toole, 2003). Around the thermocline depth, South Indian Central Water (SICW) with its characteristic oxygen maximum is the major water mass (~400-800 m). In this region SICW is recognised by its relatively linear Θ/S

relationship between approximately 9°C and 14°C (Gründlingh et al., 1991). Intermediate waters (800-1200) in this area consist of fresh Antarctic Intermediate Water (AAIW) of southern origin; saline, low oxygen Red Sea Intermediate Water (RSIW) with Red Sea and Persian Gulf influence and high silicate Indonesian throughflow Intermediate Water (IIW) originating in the east (You et al. 2003). The Deep waters around Madagascar are highly saline southward flowing North Indian Deep Water (NIDW) with its formation region in the Arabian Sea as well as Circumpolar Deep Water (CDW) of southern origin and nutrient poor North Atlantic Deep Water (NADW) flowing north.

3.2 Results

3.2.1 Flow patterns

Southern Madagascar

The flow at the southern part of Madagascar was dominated by the East Madagascar Current as well as cyclonic and anti-cyclonic eddies. The isolines of all the sections in this region indicate cyclonic circulation along the slope of Madagascar (figures 3.1-3.7). This circulation was due to the presence of two to three separate cyclones observed along the slope of the island. These deep reaching cyclones have pushed the East Madagascar Current away from the coast with current on average observed 100 km offshore. The distribution of Tropical Surface Water (TSW) associated with current indicates that the East Madagascar Current did not retroflect on this occasion at it western termination (figure 3.3). The eastward flow observed in the isolines further offshore was associated with a cyclonic eddy sitting just south of the current. Fresher TSW along line one (figure 3.1) indicates that some part of the East Madagascar Current water flow northwards into the Mozambique Channel. This surface water from the current does not appear to circulate around the eddy to the east of it and is assumed to flow westward towards the Mozambique coast. This is similar to what was observed along the WOCE I04 line and drifter tracks (Donohue and Toole, 2003; Tomczak and Godfrey, 2003). TSW observed along the south coast appear to be of the more saline Mozambique Channel variant lending support to the above concluded circulation patterns (figures 3.2, 3.5 and 3.7).

No upwelling was observed along the south coast and was confirmed by the low fluorescence values observed (figures 3.5 and 3.7) . The reason for this could be that upwelling is due to the current interaction with the Madagascar slope. Indications are that chorophyll-a dragged

along the inner edge of the current is not strongly associated with it and is easily dragged off by eddies that interact with the current (figure 3.4). Using chorophyll-a as a tracker of flow the East Madagascar Current as has been the case in many studies could thus be considered somewhat inconclusive. At the south eastern corner of the island there is some evidence of upwelling with offshore surface flow. Fluorescence indicate blooming taking place at and to the north of this position which would further lend weight to this interpretation (figure 3.9). The current was observed slightly offshore due to cyclonic motion in the south eastern part of the shelf.

South East Madagascar

At 22.5°S the current was found against slope with observed surface flow speeds exceeding 1 m/s (figure 3.10). The isolines indicate a undercurrent flowing north (at ~1200 m) below the southward flowing current. Offshore the isolines indicate weak southward flow with no eddy motions. At 20°S the isolines suggest a broader weaker southward flow along the slope. The northward undercurrent seen further south was also observed along this section. Further offshore the isolines indicate the presence of a cyclonic eddy. Surface flows are less than 1m/s which gives the indication that the southward branch of the East Madagascar is not fully formed at this latitude (figure 3.11).

North East Madagascar

The flow from 18°S northward was generally northward forming the northward branch of the East Madagascar Current (figures 3.12-3.16). From the isolines it is however evident that the northward flow appear somewhat less strong compared to that observed further south. ADCP observations indicate flow speed of about 0.75 m/s at some stations. At 18°S anti-cyclonic motion was observed along the coast with the surface water on the slope moving southward and with the northward flowing current sitting along the slope. Offshore of the current another anti-cyclone can be observed in the isolines. Indications from the isolines are that there is no deep counter current as observed further south (figures 3.12 and 3.13). At 16°S the isolines indicate northward flow along both the coast and slope. Similar to 18°S there appear to be a anti-cyclonic eddy situated just offshore of the current. Strong deep northward flow is observed in the isolines at around 200 km offshore at intermediate depths (figure 3.14). Flow pattern along 14°S appear to mirror that found along 16°S (figure 3.15). Isolines of the northern most line indicate north-westward flow along the coast and slope whilst offshore (~150 km) the flow is south eastward. North of the Hydra seamount the flow appear to be

anti-cyclonic. As is the case along all the other lines in this region no under counter current is evident in the isolines (figure 3.16). Relatively fresher cooler water along the coast for sections at 16°S and 14°S would suggest upwelling along the coast. This will however only be conclusively answered when after the nutrient and ADCP data have been carefully studied.

3.2.2 Water masses

South and South East Madagascar

Surface water masses

In the Mozambique Channel (line 1 and 2) surface waters consisted of Tropical Surface Waters (TSW) of coming from the north and from the east (figures 3.1 and 3.2). Surface from the east is slightly fresher and most likely came from the East Madagascar Current. The second more saline variant with Arabian Sea influence dominates the surface waters of the Mozambique Channel and can be seen along the coast of Madagascar (figure 3.2). Along the south coast (figures 3.3-3.8) the fresher Tropical Surface Water was observed only associated with the current. The tropical surface water in the Mozambique Channel can be seen along the coast inshore of the current. This distribution is due to the cyclonic motion observed inshore of the current. Surface waters along line 9 (figures 3.9 and 3.10) with its lower temperature, higher salinity indicate upwelling of Sub-tropical Surface (STSW) on the coast rather than circulation from the east. Higher fluorescence values seem to confirm this conclusion. Sub-tropical Surface Water was found subducted under the TSW in the current and to the south of it. It characteristic oxygen minimum can clearly be observed along the Madagascar slope (figures 3.1-3.8). South of the current however the more saline STSW is the major surface water mass with a considerably higher oxygen concentration. This would strongly suggest the eastward flow observed south of current is not due to the retroflection of the current. East of Madagascar the freshest TSW was found along section at 20°S along the slope where surface salinity values were as low as 34.90 psu (figure 3.11). Below the STSW layer Sub-Antarctic Mode Water (SAMW) or the Indian Ocean Central Water (SICW) layer can be clearly observed at around 500 m with its oxygen maximum and pycnostad (figures 3.1-3.10). This layer is however not evident along the section at 20°S.

Intermediate water masses

Along the coast Red Sea Intermediate (RSIW) and Indonesian Intermediate Throughflow Water (IIW) are the dominant water masses along the east coast of Madagascar. This can be

seen in the high salinities and low oxygen water found along the coast (800-1200 m). These water masses appear strongly associated with the East Madagascar Current, moving offshore as the current was pushed offshore in the south. On the south coast the fresher cooler Antarctic Intermediate Water (AAIW) was the dominant water mass and could also be seen offshore of the current. As would be expected the freshest AAIW was found to the south with the most saline RSIW found to the north. This water mass was also found to be the dominant water mass in the centre of the cyclonic eddy situated in the Mozambique Channel. For the section at 20°S the flow is somewhat different with a RSIW bolus found offshore and AAIW/IIW found along the coast (figures 3.1-3.11).

Deep water

The deep waters consisted of Circumpolar Deep Water (CDW) and North Indian Deep Water (NIDW). Along the slope NIDW with its lower oxygen values appear to be the dominant water mass whilst further offshore CDW with its higher oxygen values dominate. Northward transport of CWD long the slope as previously found appears inconclusive. We will have to wait for the result from the nutrients to shed light on this (figures 3.1-3.11).

North East Madagascar

Surface water masses

The freshest surface water was observed along section 18°S with salinities of 33.75 psu along the coast. River input needs to be considered here as there is no offshore equivalent for this value. TSW is still the major surface water mass and somewhat fresher than that found further south. STSW with its salinity maximum is now only observed subducted under the TSW layer with the lowest oxygen associated with water mass found in the extreme east of the lines. Along the northern most line the STSW layer is completely absent. The SAMW layer with its oxygen maximum can also be clearly observed along all the sections south of 14°S of the northern flowing East Madagascar Current. At 14°S and further north this layer is no longer evident (figures 3.12-3.16).

Intermediate water masses

Intermediate water flow appears to change over at around 14°S. South of this RSIW and IIW appear to be mostly confined to the slope with AAIW being the dominant water mass. At 14°S and further north the fresher IIW/AAIW appear to be the dominant intermediate water

mass with the low oxygen RSIW found offshore of the current. The highest salinity lowest oxygen RSIW was found along the northern most section (figures 3.12-3.16).

Deep waters

NIDW as was the case further south was found mostly along the slope whilst offshore CDW flowing northward was the dominant water mass. Clear distinctions between these two water masses can however only be made once the nutrient data become available (figures 3.12-3.16).

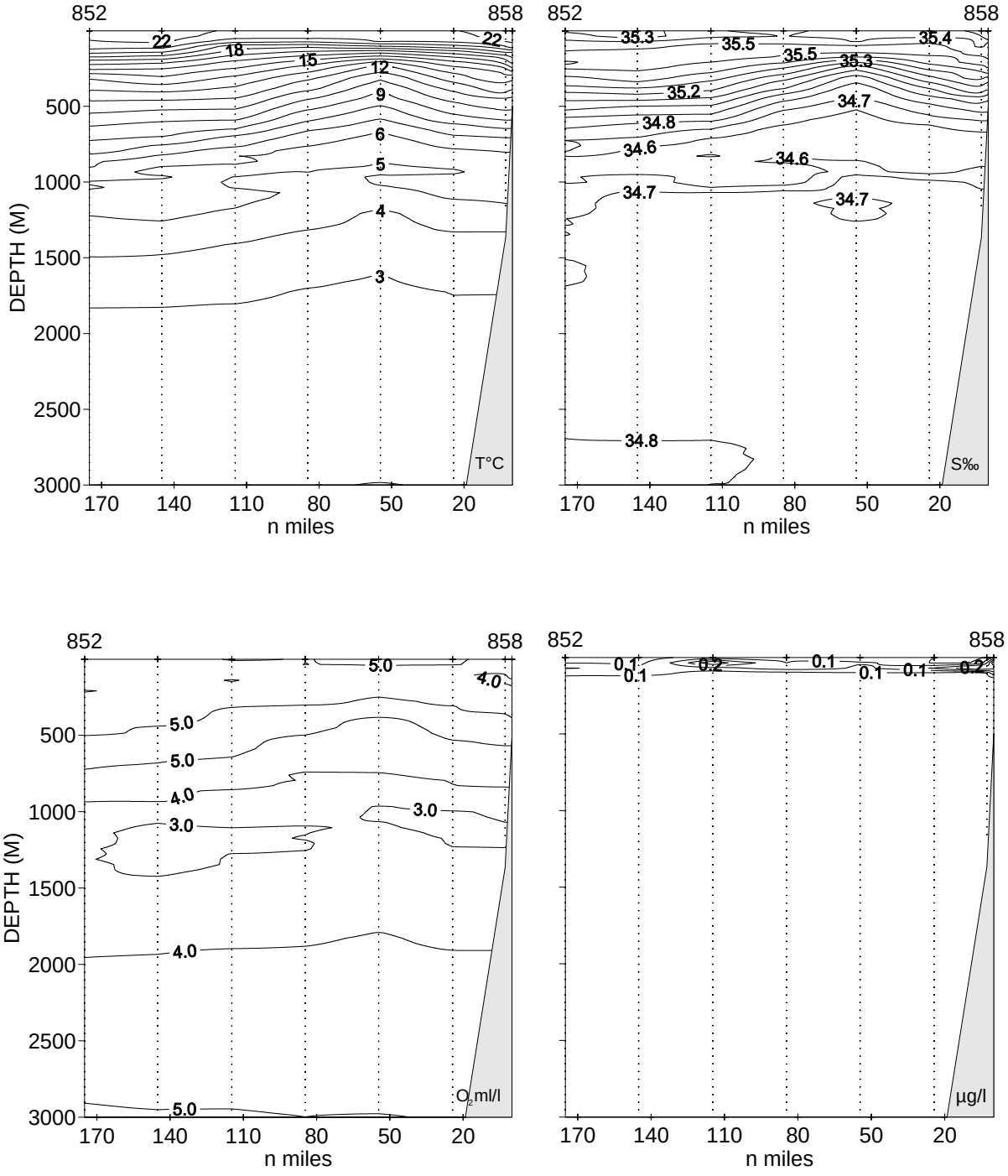


Fig. 3.1. Vertical sections of temperature, salinity, oxygen and fluorescence

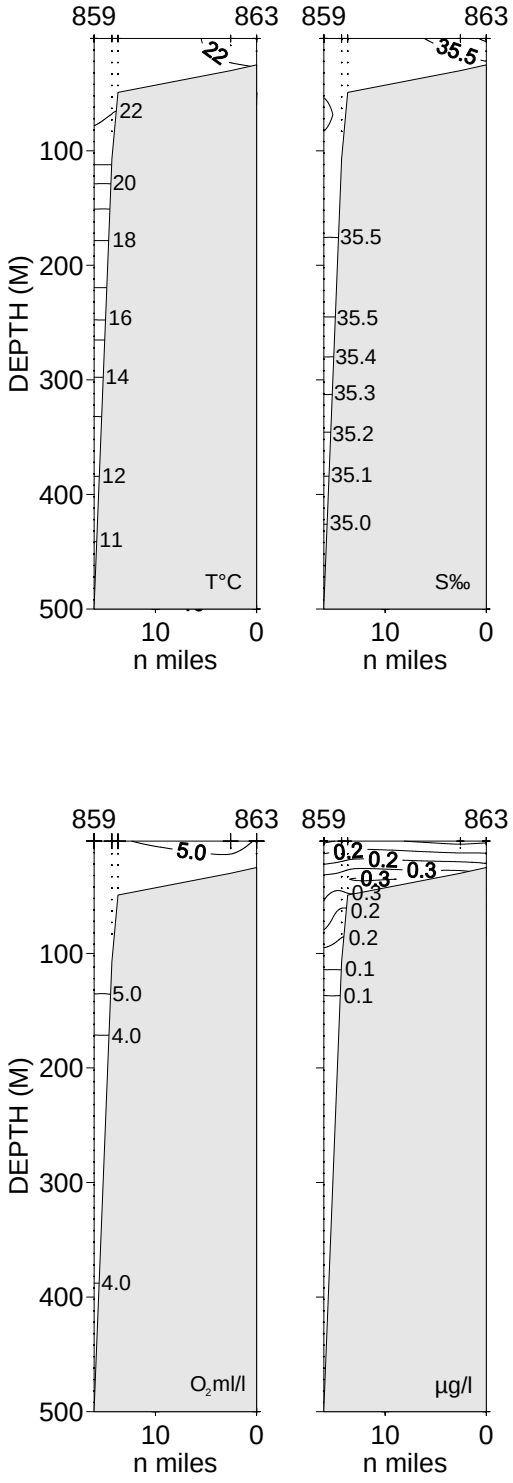


Fig. 3.2. Vertical sections of temperature, salinity, oxygen and fluorescence

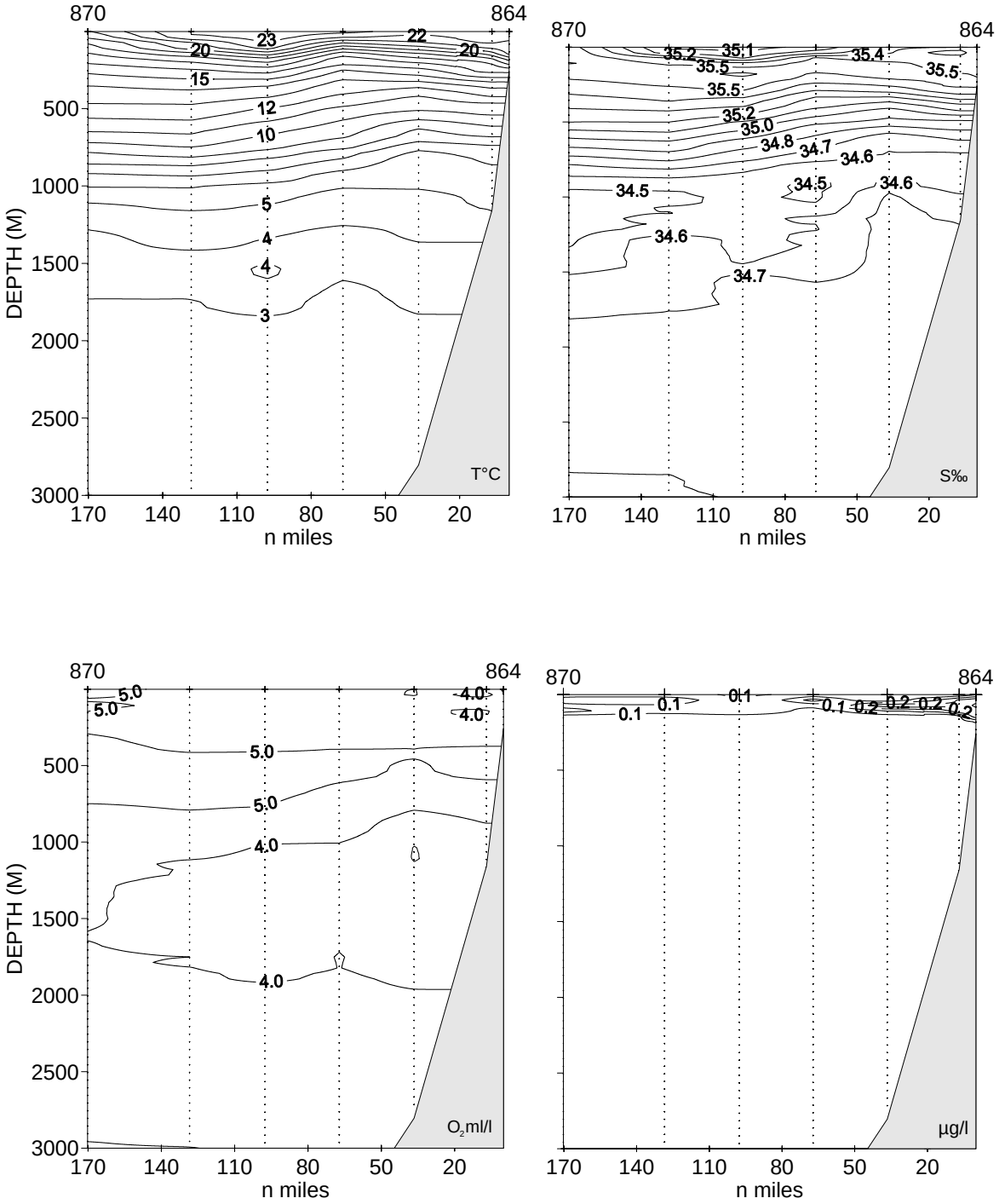


Fig. 3.3. Vertical sections of temperature, salinity, oxygen and fluorescence

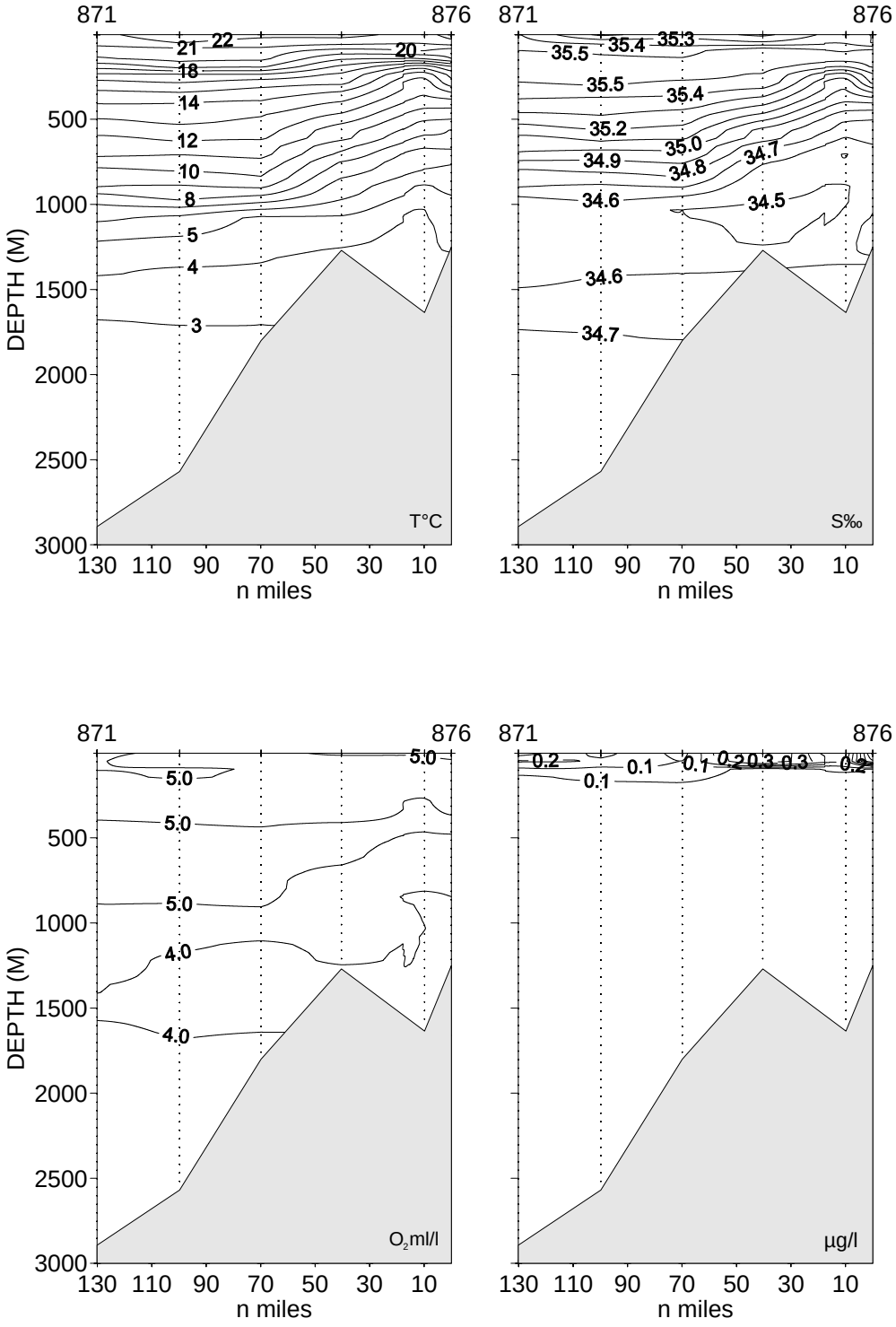


Fig. 3.4. Vertical sections of temperature, salinity, oxygen and fluorescence

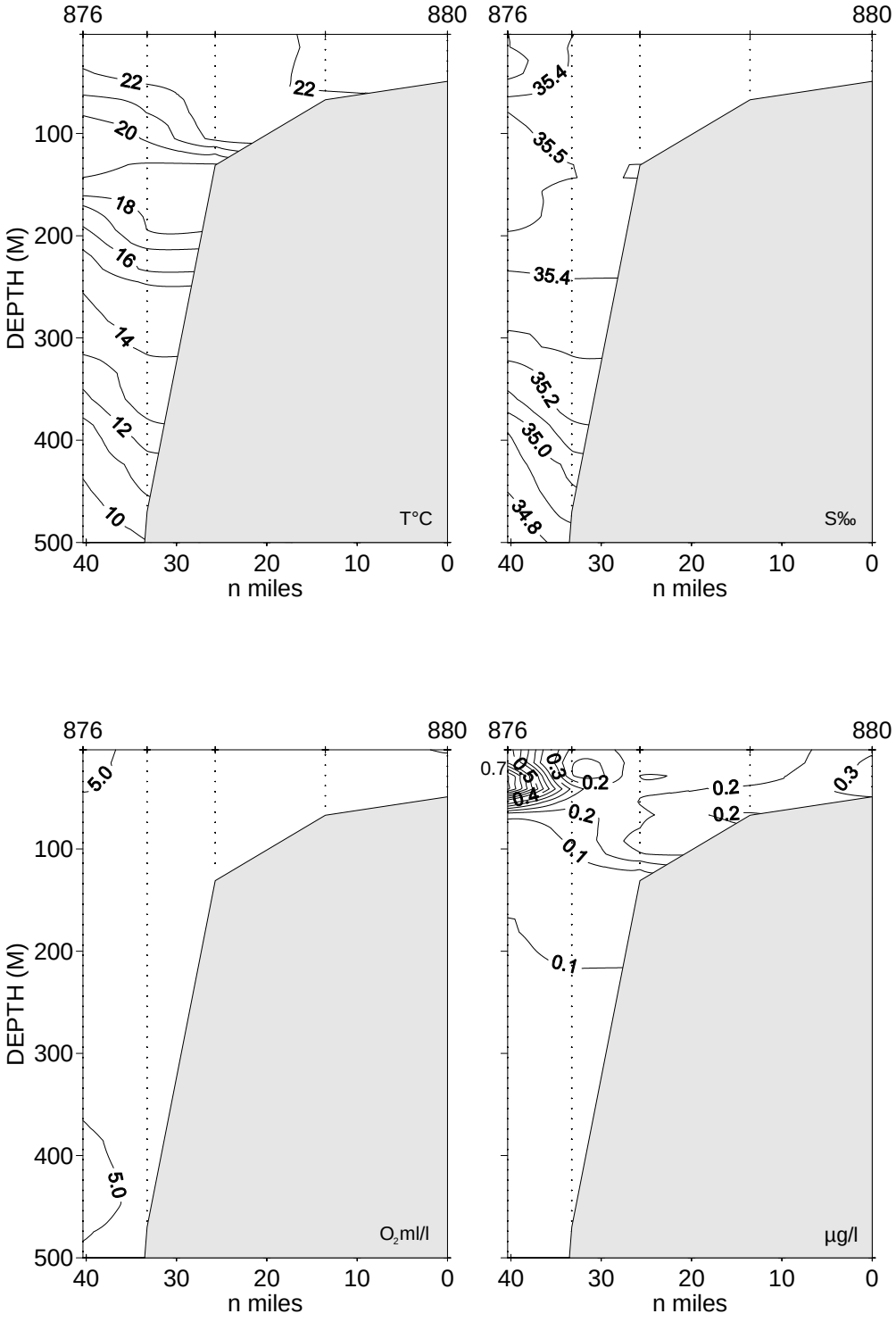


Fig. 3.5. Vertical sections of temperature, salinity, oxygen and fluorescence

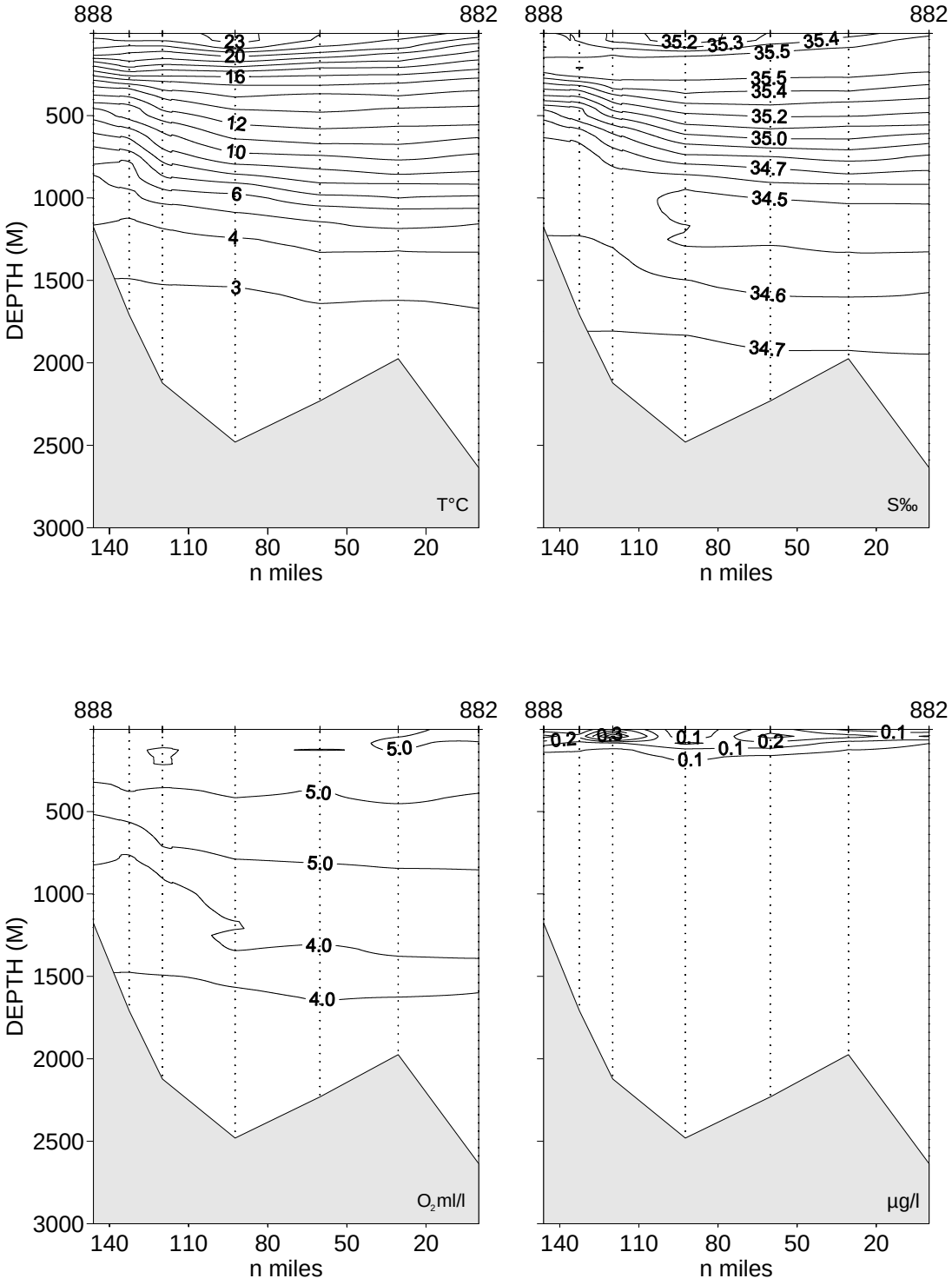


Fig. 3.6. Vertical sections of temperature, salinity, oxygen and fluorescence

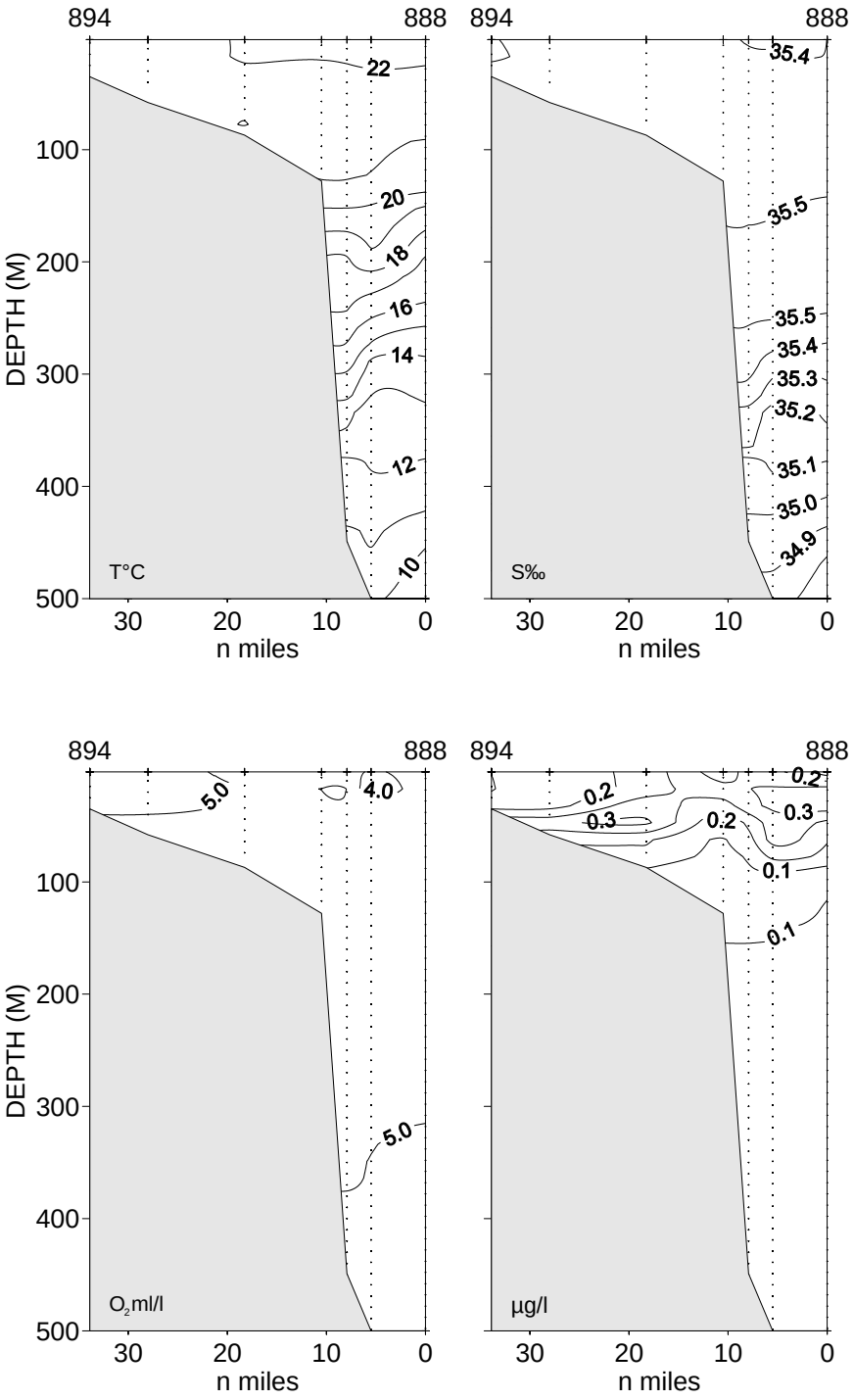


Fig. 3.7. Vertical sections of temperature, salinity, oxygen and fluorescence

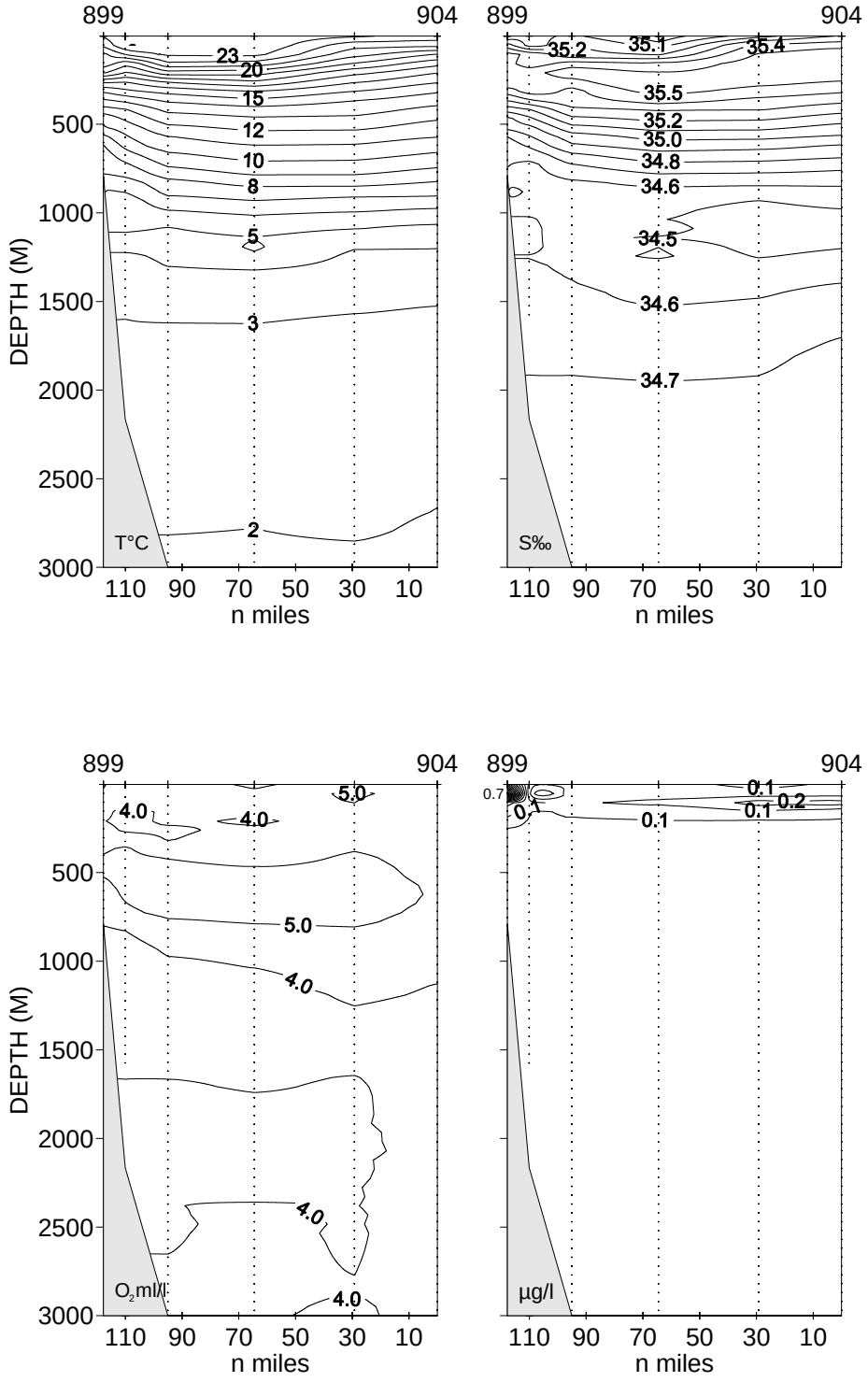


Fig. 3.8. Vertical sections of temperature, salinity, oxygen and fluorescence

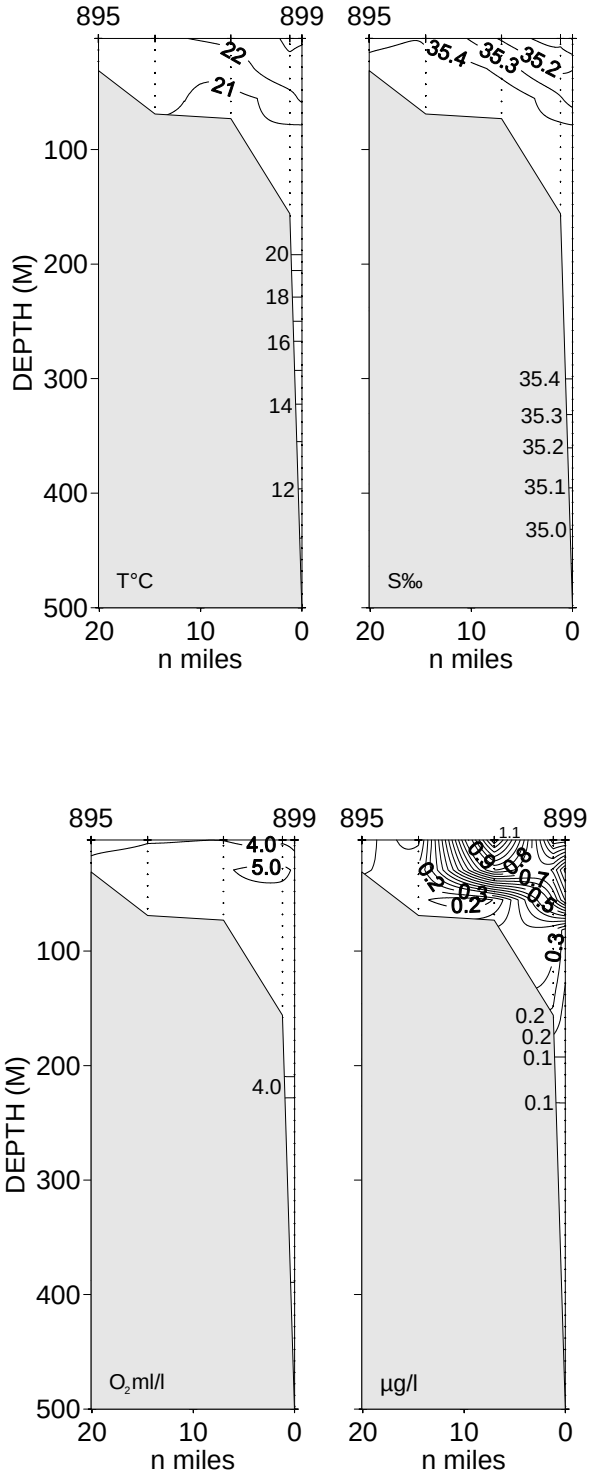


Fig. 3.9. Vertical sections of temperature, salinity, oxygen and fluorescence

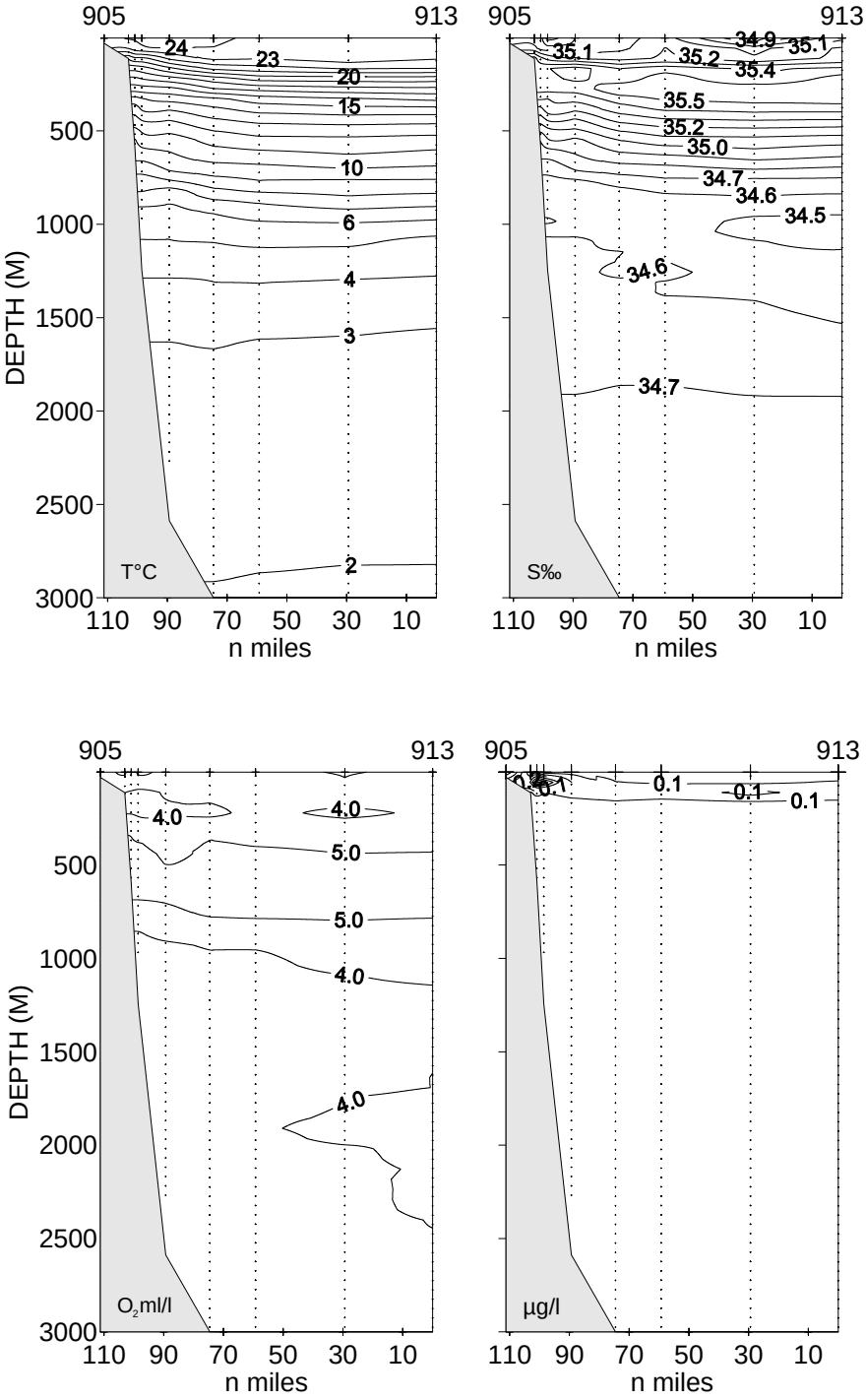


Fig. 3.10. Vertical sections of temperature, salinity, oxygen and fluorescence

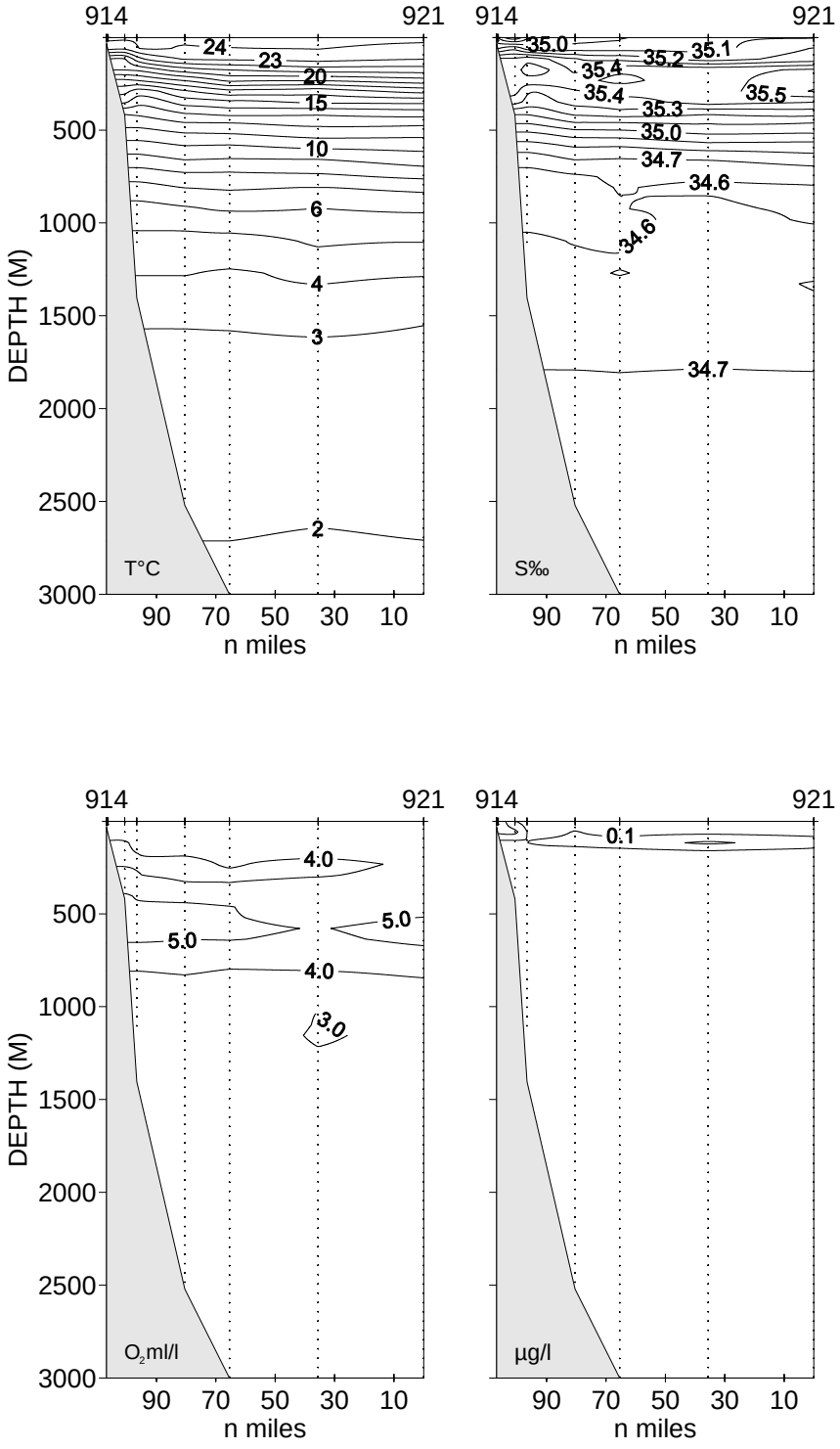


Fig. 3.11. Vertical sections of temperature, salinity, oxygen and fluorescence

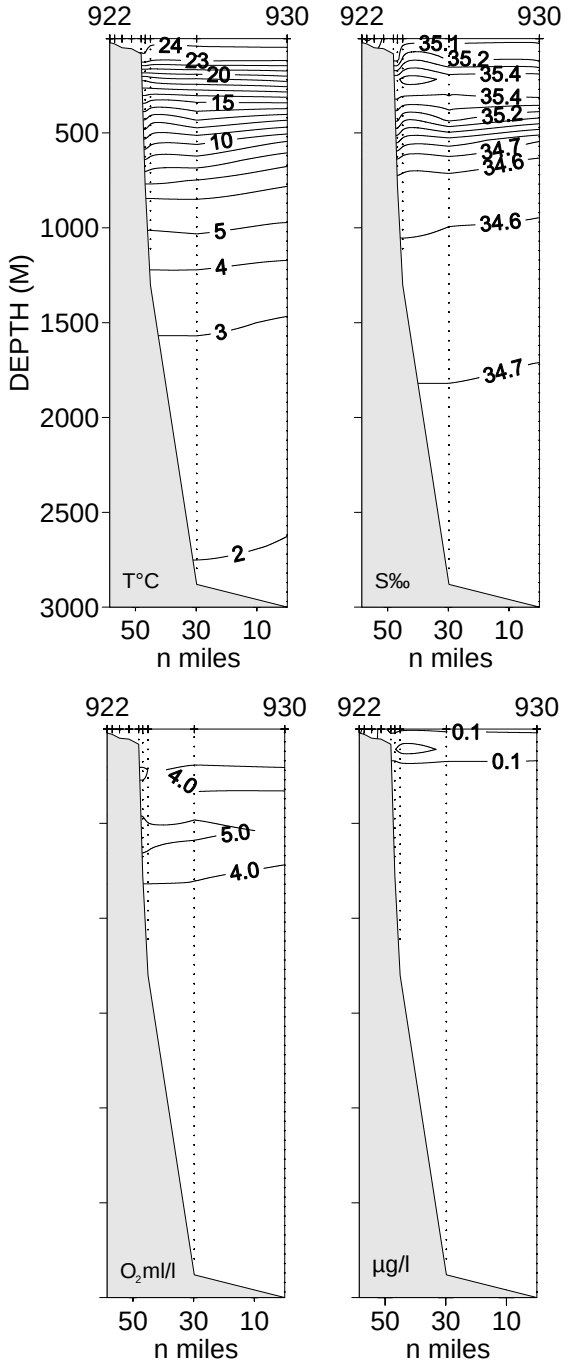


Fig. 3.12. Vertical sections of temperature, salinity, oxygen and fluorescence

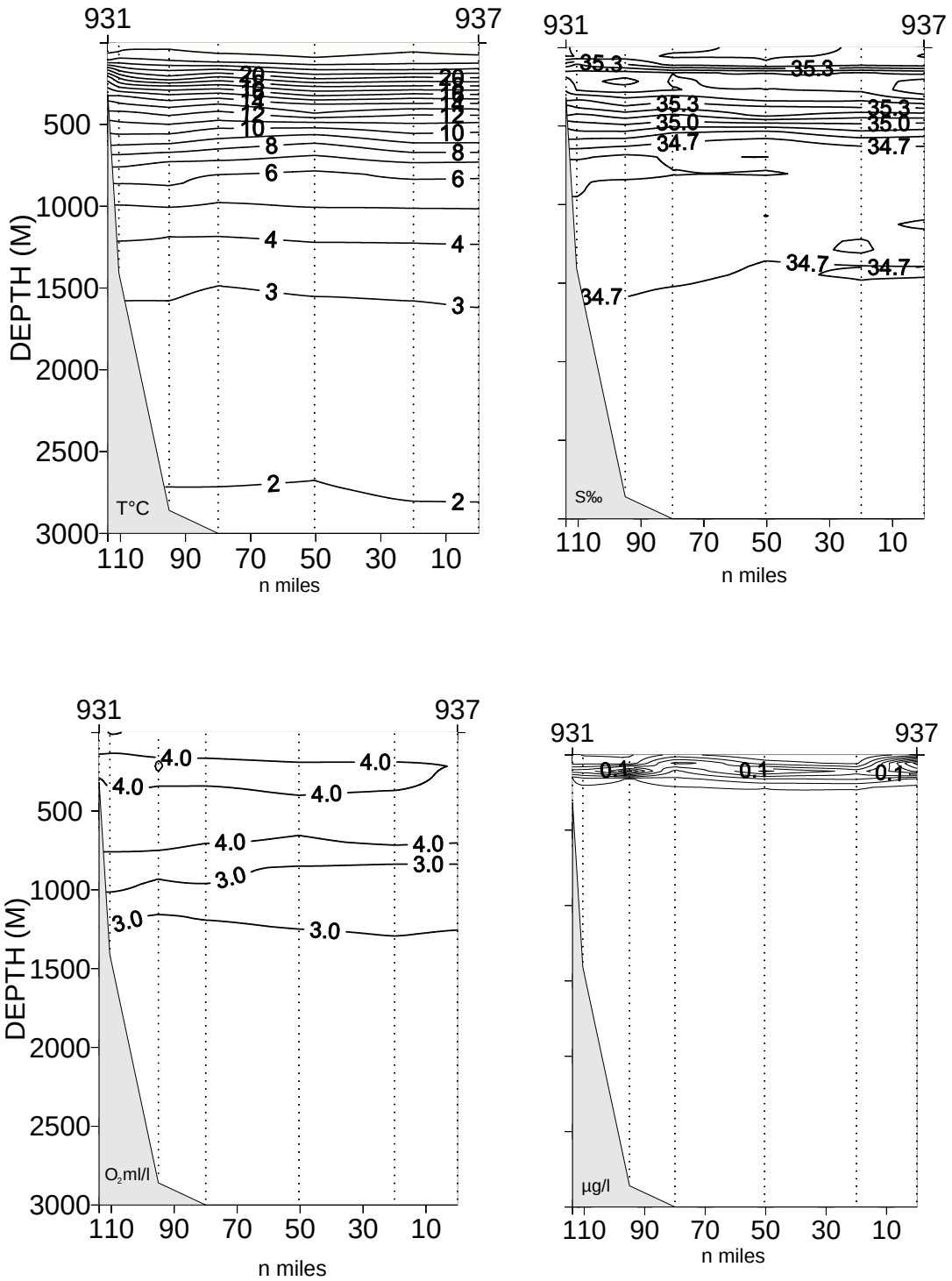


Fig. 3.13. Vertical sections of temperature, salinity, oxygen and fluorescence

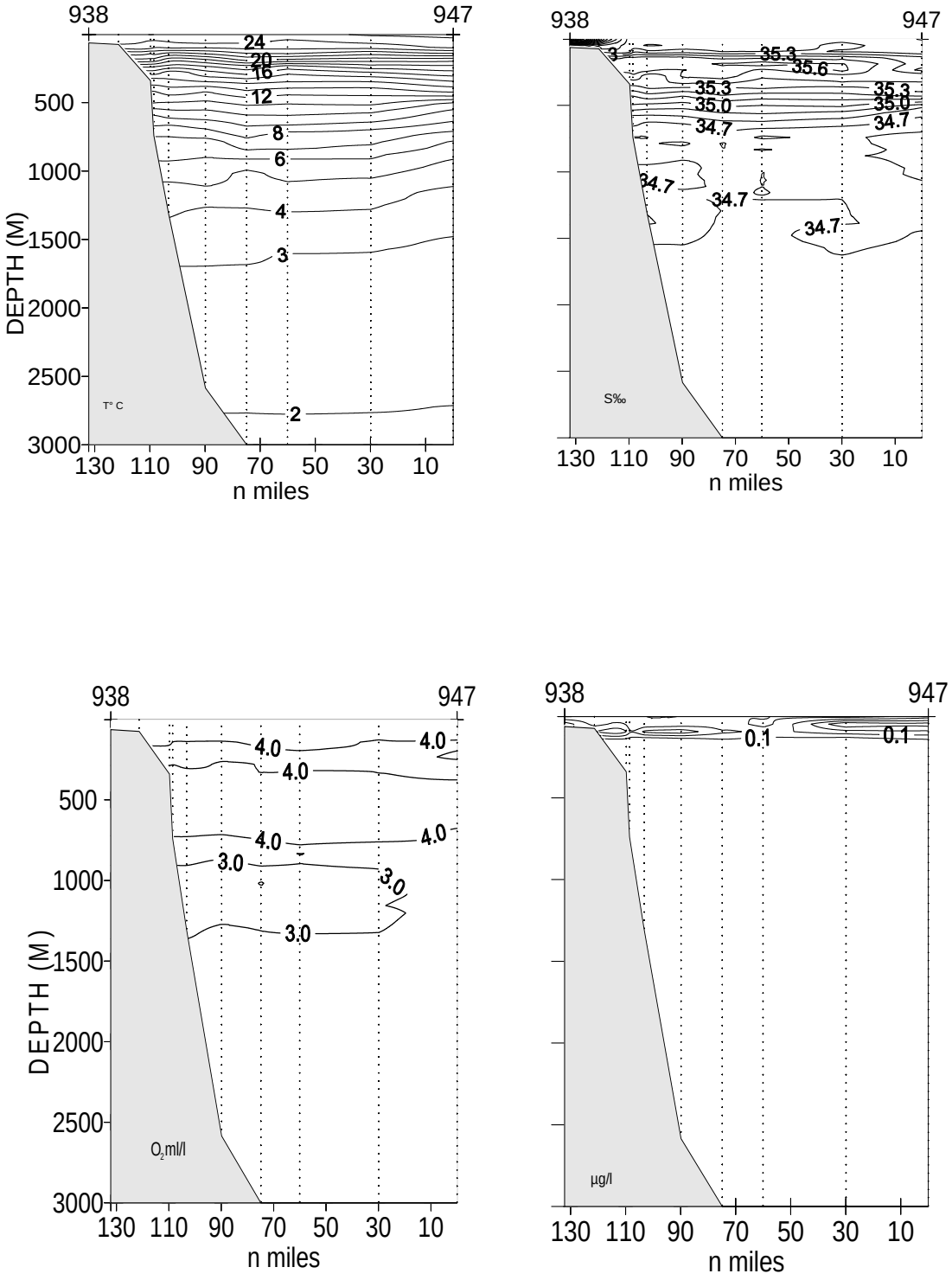


Fig. 3.14. Vertical sections of temperature, salinity, oxygen and fluorescence

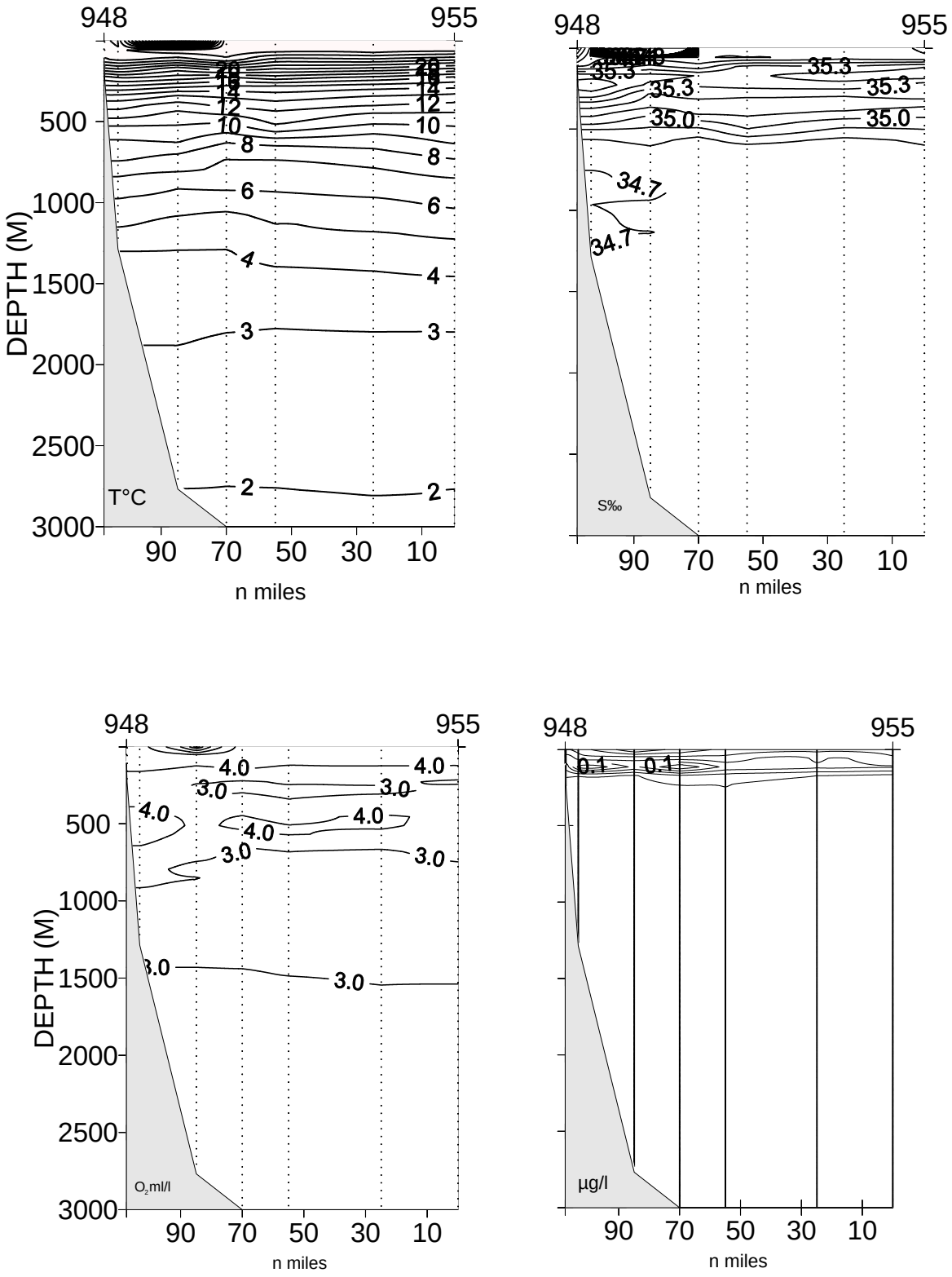


Fig. 3.15. Vertical sections of temperature, salinity, oxygen and fluorescence

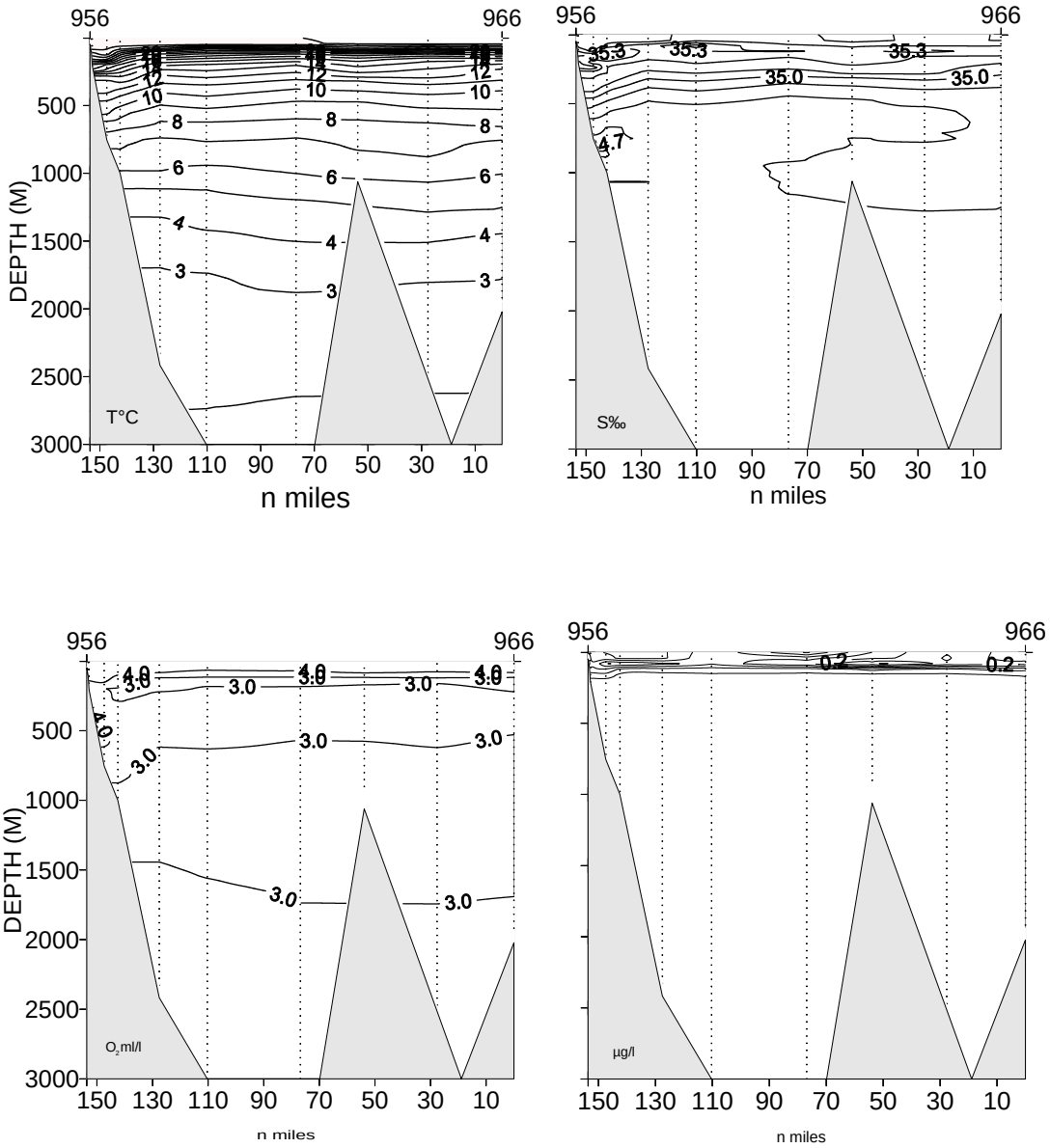


Fig. 3.16. Vertical sections of temperature, salinity, oxygen and fluorescence

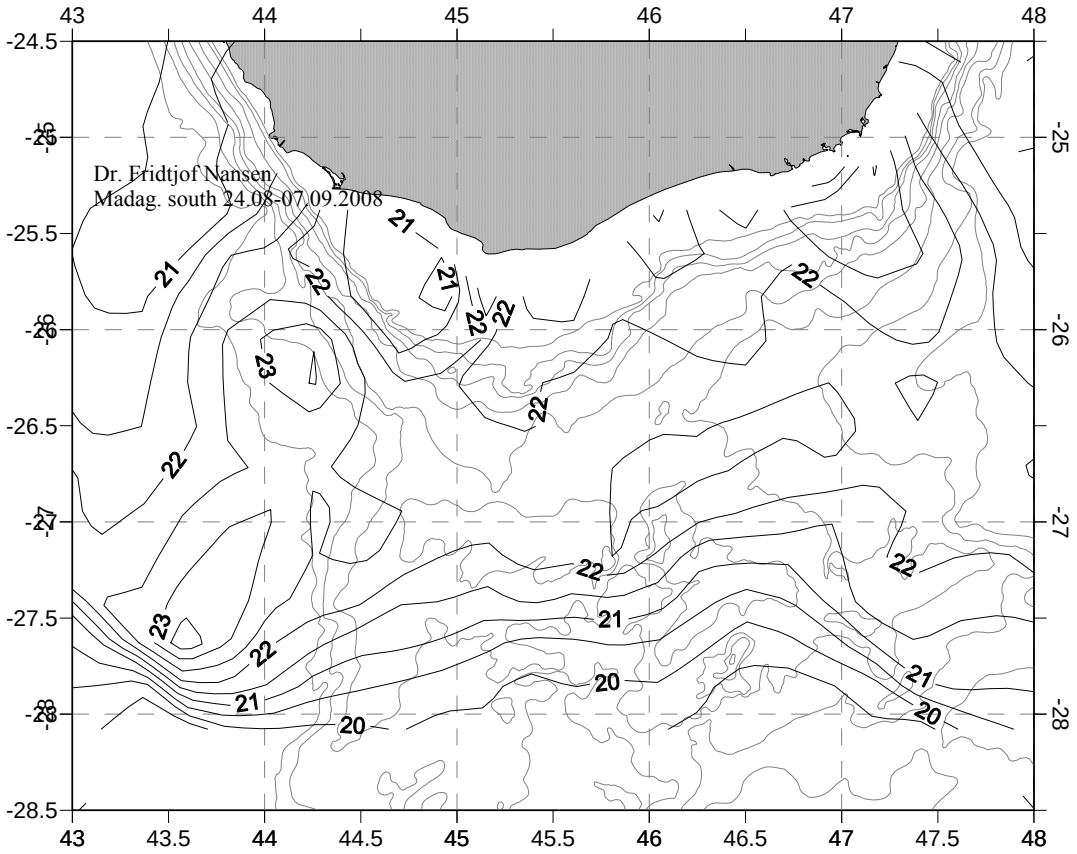


Figure 3.17 Horizontal distribution of sea temperature at 5 m on the Southern shelf of Madagascar based on data recorded underway.

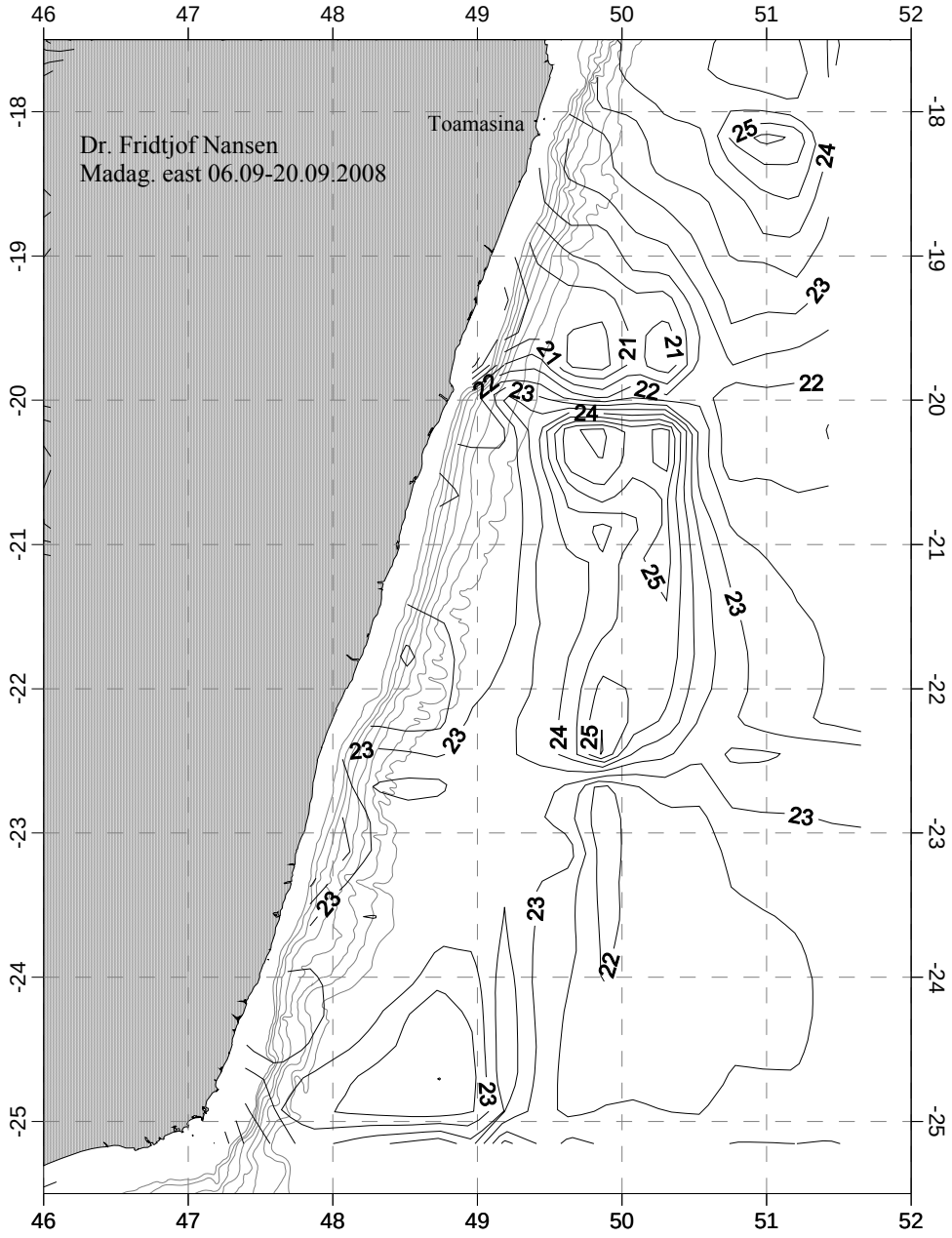


Figure 3.18 Horizontal distribution of sea temperature at 5 m on the south-eastern shelf of Madagascar based on data recorded underway.

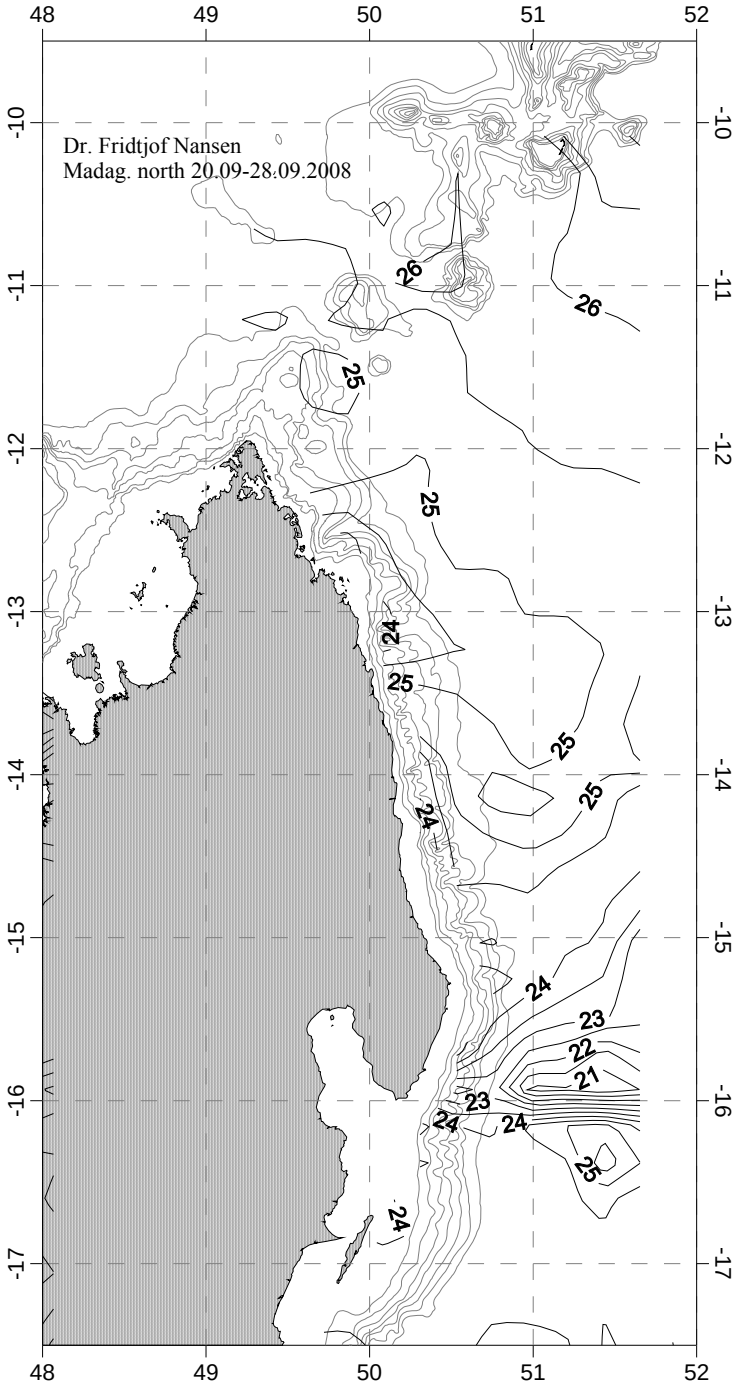


Figure 3.20 Horizontal distribution of sea temperature at 5 m on the north-eastern shelf of Madagascar based on data recorded underway

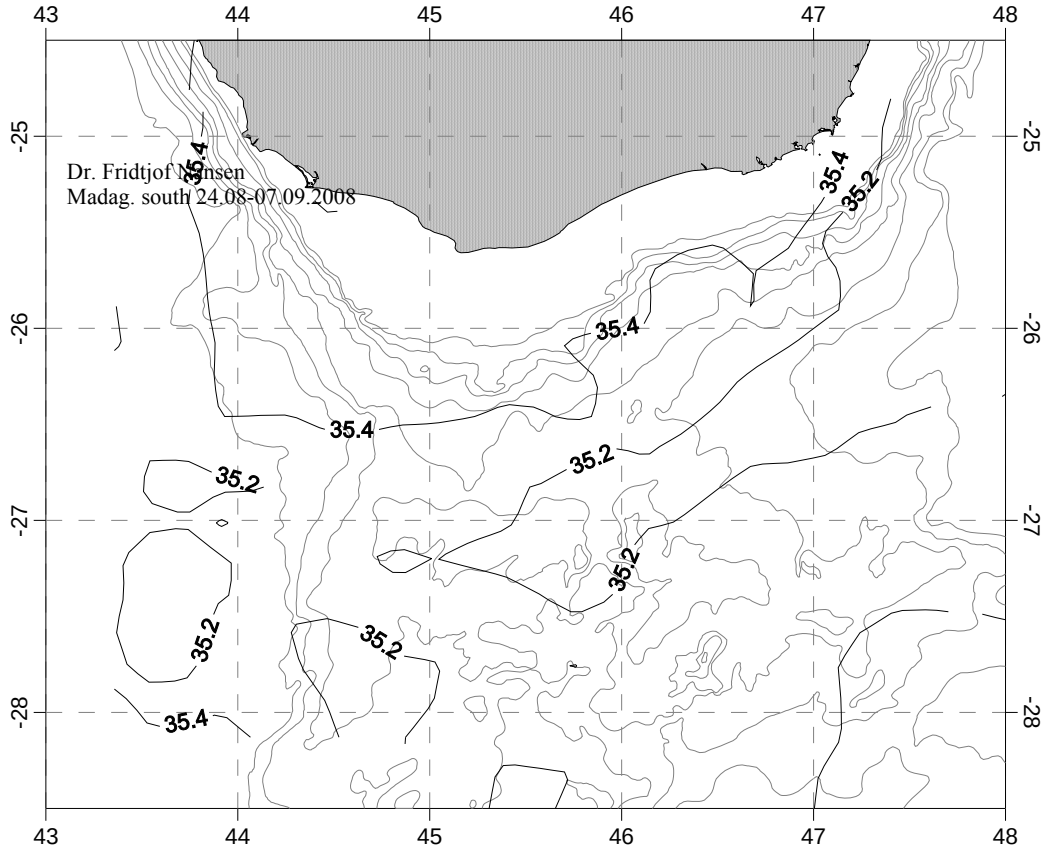


Figure 3.21 Horizontal distribution of salinity at 5 m on the Southern shelf of Madagascar based on data recorded underway.

Figure 3.21 Horizontal distribution of salinity at 5 m on the Southern shelf of Madagascar based on data recorded underway.

Figure 3.21 Horizontal distribution of salinity at 5 m on the Southern shelf of Madagascar based on data recorded underway

4. RESULTS OF THE ACOUSTIC SURVEY

The hydroacoustic survey covered the shelf and slope to about 1000 m bottom depth. Continuous acoustic recording and analysis was carried out throughout the survey. The southern shelf was covered with parallel transects about 20 nm apart, while the eastern shelf was covered with zigzag transects with 15-20 nm between turning points on the coast. This was done due to the narrowness of the shelf and to reduce the effect of the current and weather on working conditions. In addition to bottom trawling during daylight hours, pelagic trawling was carried out for pelagic species identification, either as random blind trawl hauls close to the surface with pelagic trawl equipped with large floats, or on registrations noted on the echo sounder equipment. Generally low acoustic densities where found over most of the shelf and only plankton and mesopelagic fish were found in the water column from the shelf break and further offshore. The dispersed fish distribution and high abundance of plankton made acoustic detection and separation very difficult. An additional factor that may have had an impact on acoustic estimation in the southern region may have been the high number of humpback whales in the area surveyed. It has previously been observed that pelagic fish hide close to the bottom in the vicinity of cetacean predators [ref?]. During this survey it was common to observe both horse mackerel and other carangid species very close to the bottom.

4.1 Acoustic abundance and distribution

Biomass estimation were carried out separately for three areas of the shelf, These were the South coast, south of 25°S, the Southeast coast between 25°S and 20°S and the East coast between 20°S and 13°S. Biomass estimates are given for each of these regions separately.

Acoustic biomass estimates were calculated for two species groups of pelagic fish. The first group consisted of clupeoids (Pel 1), and the second group consisted mainly of carangids, but included also leiognathids, scombrids and associated pelagic like barracudas and hairtails (Pel 2). As discussed in the methods section, the low observed acoustic densities of these groups in combination with unreliable species and length segregations made it necessary to use constant acoustic target strength and default length (23 cm). Using these settings, the estimates of biomass are presented in Table 4.1 a-b. There is considered to be a higher than normal degree of uncertainty to these estimates due to pelagic fishes being close to the bottom; much of the coastline had seafloor unsuitable for bottom trawling and therefore also made accurate species identification difficult.

The distribution area of the main groups of pelagic fish in the regions, Pelagic 1 (Clupeoids) and Pelagic 2 (mainly carangids) are depicted in Figures 4.1-4.3 using acoustic integrator values from the LSSS echo-integration system. The acoustic densities (m^2/NM^2) are illustrated by a scale normally used on acoustic surveys with “Dr. Fridtjof Nansen”. In the southern region the Pelagic 1 species were found in two small low density areas on the south

coast off Cape Ste-Marie and south of Tolanaro (Figure 4.1). The species in the distribution area was mainly *Engraulis japonicus*, but small quantities of the sardinellas (*Sardinella gibbosa* and *Etrumeus teres*) was also found in the south western part. A total biomass of 15,000 tons was estimated. Pooled length frequencies of the species can be found in Annex II.

The Pelagic 2 species were distributed in two low density areas on the southern shelf (Figure 4.2) and as continuous low density distribution on the eastern shelf north to 20° S (Figure 4.3). North of 20° S Pelagic 2 species were recorded in small area off Toamasina, in a larger continuous area from about 18° S to 16° S and in a very small area just south of Antserana, all of low density (Figure 4.24). The biomass estimated on the south coast was 46 000 tons, while approximately 11 000 and 12 000 tons were found on the east coast south of 20° S and north of 20° S, respectively. The most abundant Pelagic 2 species in the catches in the southern area were *Trachurus delagoa* and *Decapterus macrosoma*, while catches of pelagic fish were generally small on the east coast. The two carangids with highest catch rates were *D. macarellus* and *D. macrosoma*. Length frequencies of the species can be found in Annex II.

Table 4.1a Acoustic estimates of clupeoids (Pel 1).

Area	Biomass (t)
South coast	15 000
East coast to 20°S	-
East coast from 20°S	-

Table 4.1b Acoustic estimates of carangids, scombrids and associated pelagic (Pel 2).

Area	Biomass (t)
South coast	46 000
East coast to 20°S	11 000
East coast from 20°S	12 000

4.2 Offshore acoustic recordings

Generally no commercial pelagic fish were found offshore, although some low concentrations of mesopelagic fish were found on the shelf break and on the offshore seamounts. An initial bottom mapping of five offshore seamounts was done as part of the survey on the southern shelf of Madagascar. Many of these may be trawlable but the priority during this survey was pelagic surveying and oceanographic features so only two bottom trawls were performed on these. These trawls can be found in Annex 1 (Trawls 7 and 9). Bottom depth at these ranged from 1000 m depth to 200 m depth below surface.

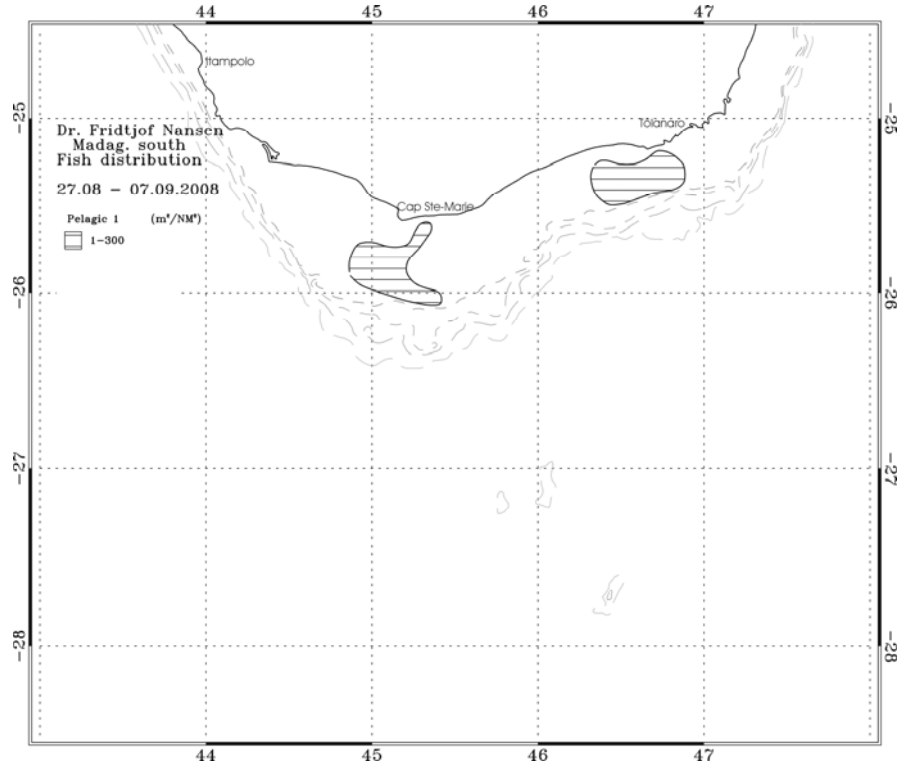


Figure 4.1 Distribution of Pel 1 (clupeoids) on the Southern shelf of Madagaskar.

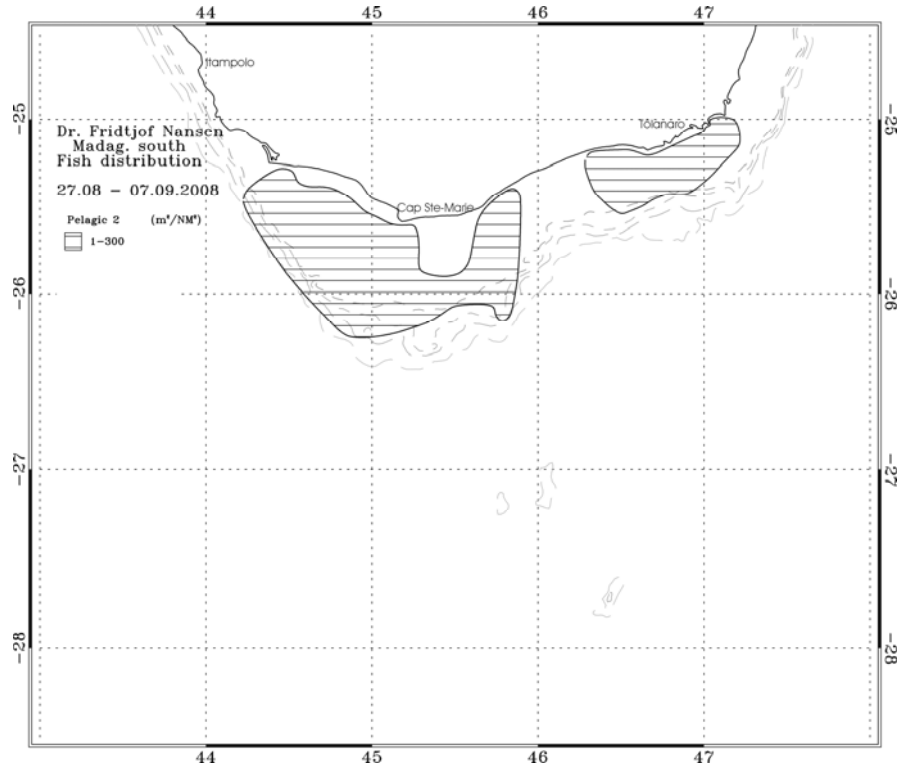


Figure 4.2 Distribution of Pel 2 (carangids and associated pelagic) on the southern shelf of Madagascar.

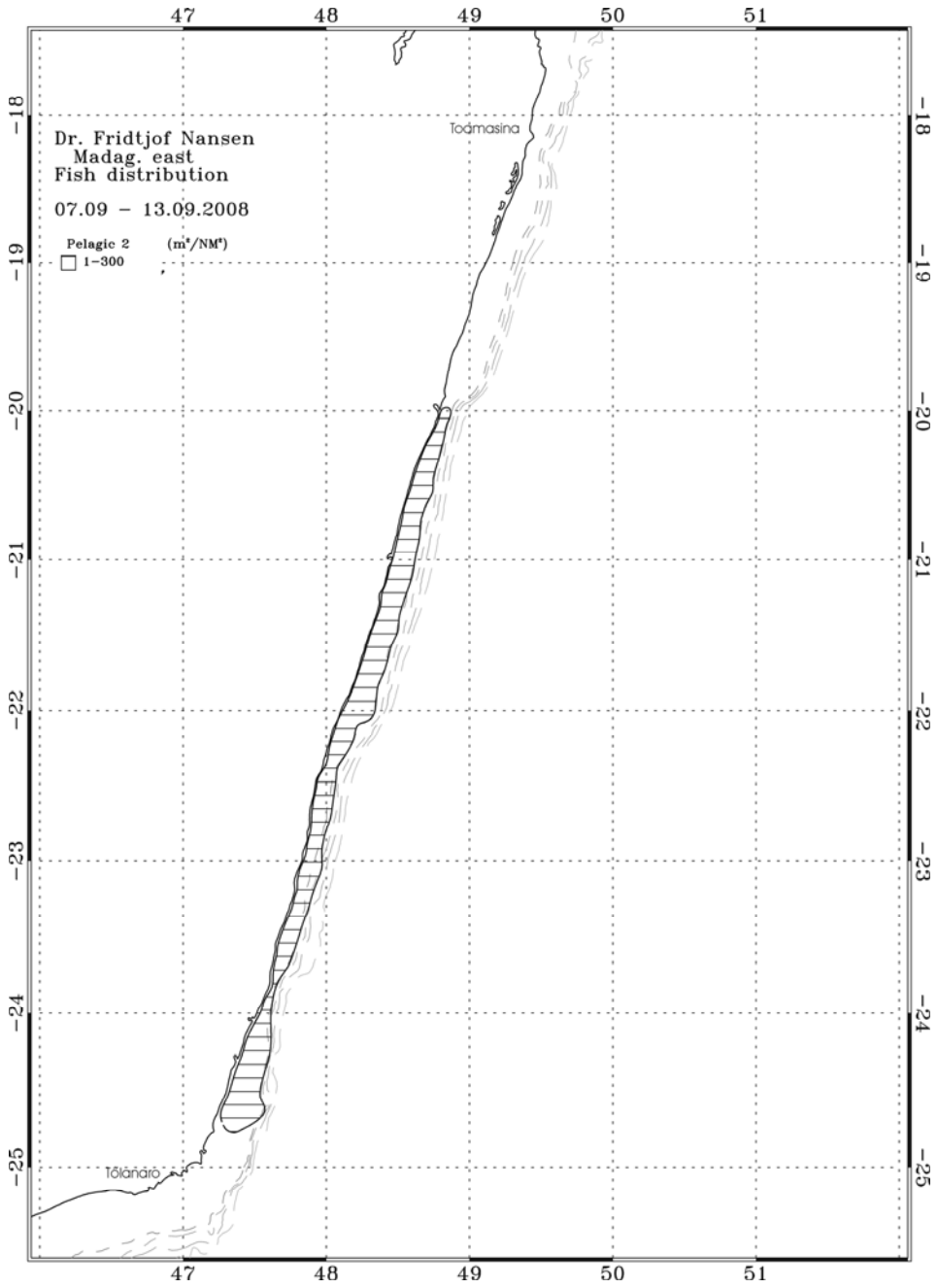


Figure 4.3 Distribution of Pel 2 (carangids and associated pelagic) on the south-eastern shelf of Madagascar.

Figure 4.4 Distribution of Pel 2 (carangids and associated pelagic) on the north-eastern shelf of Madagascar

4.3 Species diversity from trawl catches on the shelf

The south and east coast of Madagascar generally have large areas of ground unsuitable for bottom trawling. The outer shelf edge is a continuous reef with depths from 10 m to 70 m and is untrawlable, while the shelf has areas of variable hard and sandy substrate with patches of coral reef and beds of sponges in certain areas. The east coast also has several canyons cutting trough the shelf. The numbers of bottom trawls were limited due to difficult bottom and only give an indication of the most common species within the region. Future research on the demersal fauna of Madagascar should combine traditional demersal trawling with other types of sampling such as use of ROV, traps and long-line, scuba diving or other suitable methods.

The most commonly caught species on the south coast were the two carangid species *T. delagoa* and the *D. macrosoma*, but anchovy (*E. japonicus*) was also important in the catches (Table 4.2). *T. delagoa* had the highest all over catch rate, followed by *Carcharhinus brevipinna, Sphyraena helleri* and *D. macrosoma*. No species were noted as being very abundant on the south east coast to 20°S. Trawls in this region, particularly pelagic trawls, gave small catches. *Stegostoma fasciatum* had the highest all over catch rate, followed by *Lutjanus argentimaculatus*, while *D. macarellus* and *D. macrosoma* were the two most common carangids (

Table 4.3). On the north east coast from 20° S to 12° S only two bottom trawl hauls were made due to extremely bad bottom conditions. In addition five pelagic trawl hauls were taken, most of them as blind hauls. No species were noted as being abundant on this part of the east coast either. *Leiognathus elongatus* had the highest catch rate, followed by *Upenus moluccensis, D. macrosoma* and *E. japonicus*. Most of the species collected were mainly in juvenile or larvae stages, maybe suggesting the area being a nursery ground.

4.4 Catch composition on a sea mount

On the environmental transect between the northern point of Madagascar and the Farquhar Group a single bottom trawl haul (no. 29) was made on about 330 m depth 27 September. 21 fish species were collected and 4 groups of invertebrates. Sponges, corals, sea urchins and larvae of crustaceans were the most representative. DNA and isotopes of the 21 fish species was collected and voucher specimens of each species preserved. Length frequencies of the most abundant species were taken. The three most abundant species in the catch were *Beryx splendens* (XX amount), *Cholorphathalmus punctatus* (xx amount) and *Setarches verrucosus* (XX amount). Also here most the species collected were mainly in juvenile or larvae stages.

Table 4.2 Main species in all trawl catches on the south coast of Madagascar (all trawl catches included)

Row Labels	# trawls (Total 29)	Average (kg/h)	Total (kg/h)
Trachurus delagoa	10	145.1	1451.5
Decapterus macrosoma	8	117.8	942.3
Carcharhinus brevipinna	1	125.7	125.7
Sphyraena helleri	1	125.2	125.2
Ariomma indica	4	15.5	61.9
Lutjanus sanguineus	1	56.8	56.8
Engraulis japonicus	4	11.8	47.1
Epinephelus malabaricus	1	40.5	40.5
Caranx ignobilis	1	29.8	29.8
Mustelus manazo	3	9.8	29.4
JELLYFISH	2	14.3	28.6
Parupeneus rubescens	1	26.6	26.6
Siganus sutor	1	23.2	23.2
Terapon theraps	2	11.2	22.4
Loligo sp.	5	4.0	20.2

Table 4.3 Main species in all trawl catches on the south-eastern coast of Madagascar to 20° S (all trawl catches included)

Row Labels	# of trawls	Average (kg/h)	Total (kg/h)
Stegostoma fasciatum	2	50.94	101.88
Lutjanus argentimaculatus	1	41.8	41.8
Decapterus macarellus	1	34.73	34.73
Argyrosomus hololepidotus	1	29.11	29.11
Decapterus macrosoma	1	28.25	28.25
Argyrops filamentosus	3	2.02	6.06
Upeneus taeniopterus	1	5.72	5.72
Priacanthus hamrur	1	4.93	4.93
Sphyraena helleri	1	3.97	3.97

Table 4.4 Main species in all trawl catches on the north-eastern coast of Madagascar from 20° S to 12° S (all trawl catches included)

Row Labels	# of trawls	Average (kg/h)	Total (kg/h)
Leiognathus elongatus	1	180.91	180.91
Upeneus moluccensis	1	33.64	33.64
Decapterus macrosoma	1	11.04	11.04
Engraulis japonicus	1	10.01	10.01
SQUILLIDAE	1	6.39	6.39
Upeneus vittatus	1	3.56	3.56
Teixeirichthys jordani	2	2.99	5.98
Loligo sp.	5	2.78	13.9
Secutor insidiator *	1	2.48	2.48
Upenus pori	1	2.29	2.29

5. Other observations

5.1 Humpback whale observations

Frequent sightings of humpback whales, *Megaptera novaeangliae* were made during the first leg of the survey to Toamasina. However, as no whale observers were onboard no counting was carried out. This area is well known from literature to have a relatively high abundance of humpback whales this time of the year. Whales observed were generally distributed on the shelf to< 50 m depth and offshore in the vicinity of the shelf break. The humpbacks observed were commonly found in groups, of two to three. Distribution seemed continuous on the south coast and the east coast to 20° S but with decreasing numbers of observations as one moved northwards.

Very few seabirds were observed in the survey area.

6. Summary and conclusions

One previous survey has been conducted off the South and East coast of Madagascar with the former *Dr. Fridtjof Nansen*. That survey took place from the 16th to the 28th June 1983 (Sætre *et al.* 1983) with the main objective of covering the shelf < 200 m depth with a combined swept area and acoustic survey. The area covered is similar to what was covered during the present survey. The echo integration method at that time had a low level of accuracy compared with today's equipment. However, a rough estimate of 85 000 tons were estimated for the south and east coast north 17° S combined, which is about the same as the present estimate of 84 000 tons. Carangids were the most common pelagic fish groups in all three areas in both surveys.

Also in the 1983 survey *T. delagoa* and *D. macrosoma* were the most common pelagic species in the bottom trawl catches. Leiognathidae had the highest catch rates on the central part of the eastern coast in both surveys.

7. References

de Ruijter et al. 2002

Donohue and Toole, 2003

Gründlingh et al., 1991

Hastenrath and Greishar, 1991

Ho et al., 2004

Lutjeharms, 2006

Lutjeharms and Machu, 2000

Quartly et al. 2006

Spalding *et al*. 2007.

Strømme, T. 1992. NAN-SIS: Software for fishery survey data logging and analysis. User's manual. *FAO Computerized Information Series (Fisheries*). No. 4. Rome, FAO. 1992. 103.

Sætre, R., Strømsnes, T., Hansen, K., Abrahamsen, H., Schmidt, G. and Rakotondralambo, A. 1983. Fisheries resources survey Madacascar 16-28 June 1983. Cruise report r/V "Dr. Fridtjof Nansen". 16 pp.

Tomczak and Godfrey, 2003

Webb 2007

Woodberry et al., 1989

You et al. 2003

Annex I Records of fishing station

R/V "DR. FRIDTJOF NANSEN" SURVEY:2008405 STATION: 1
DATE :28.08.2008 GEAR TYPE: PT NO: 7 POSITION:Lat S 25°22.26
start stop duration Lon E 44°29.72
TIME :16:04:06 16:30:19 26.2 (min) Purpose : 1
LOG : 1705.72 1707.22 1.5 Region : 7500
FDEPTH: 5 5 Gear cond.: 0
BDEPTH: 33 36 Validity : 0
Towing dir: 0° Wire out : 101 m Speed : 3.2 kn
Sorted : 0 Total catch: 15.55 Catch/hour: 35.58

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
J E L L Y F I S H	17.36	7	48.80	
JELLYFISH	14.73	922	41.41	
Selar crumenophthalmus	2.52	34	7.07	
Ariomma indica	0.34	14	0.96	
Sardinella sp.	0.31	7	0.87	
Amblygaster sirm	0.10	2	0.28	
Decapterus russelli	0.08	2	0.21	
CAESIONIDAE	0.07	2	0.19	
Sphyraena sp.	0.05	11	0.13	
Parexocoetus mento	0.05	2	0.13	
Loligo sp.	0.02	5	0.06	
CARANGIDAE	0.01	11	0.04	
Stolephorus sp.	0.01	11	0.04	
Total	35.65		100.19	

R/V "DR. FRIDTJOF NANSEN" SURVEY:2008405 STATION: 2
DATE :28.08.2008 GEAR TYPE: PT NO: 1 POSITION:Lat S 25°33.34
start stop duration Lon E 44°40.54
TIME :20:29:48 21:00:50 31.0 (min) Purpose : 1
LOG : 1738.64 1740.76 2.1 Region : 7500
FDEPTH: 30 30 Gear cond.: 0
BDEPTH: 38 41 Validity : 0
Towing dir: 0° Wire out : 80 m Speed : 4.1 kn
Sorted : 0 Total catch: 563.90 Catch/hour: 1090.72

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Decapterus macrosoma	906.67	16191	83.13	1
Carcharhinus brevipinna	125.73	4	11.53	
Caranx ignobilis	29.79	2	2.73	
Carcharhinus limbatus	15.47	2	1.42	
Sardinella gibbosa	9.56	222	0.88	
Stolephorus indicus	0.81	77	0.07	
Etrumeus teres	0.56	10	0.05	
Penaeus canaliculatus	0.39	10	0.04	
Trachypenaeus curvirostris	0.32	77	0.03	
Bregmaceros mcclellandi	0.28	319	0.03	
Emmelichthys nitidus	0.27	77	0.02	
Apistus carinatus	0.26	19	0.02	
Trachurus delagoa	0.17	48	0.02	
Sphyraena acutipinnis	0.16	10	0.02	
Sphyraena sp.	0.15	10	0.01	
Gazza minuta	0.04	10	0.00	
Priacanthus hamrur	0.02	10	0.00	
Squilla sp.	0.01	10	0.00	
Stephanolepis sp.	0.00	10	0.00	
Lactoria sp.	0.00	10	0.00	
UNIDENTIFIED FISH	0.00	10	0.00	
UNIDENTIFIED FISH	0.00	10	0.00	
Total	1090.68		100.00	

R/V "DR. FRIDTJOF NANSEN" SURVEY:2008405 STATION: 3
DATE :29.08.2000 GEAR TYPE: BT NO: 21 POSITION:Lat S 25°58.10
start stop duration Lon E 44°55.40
TIME :05:25:58 05:59:07 33.0 (min) Purpose : 1
LOG : 1817.33 1819.10 1.8 Region : 7500
FDEPTH: 69 71 Gear cond.: 0
BDEPTH: 69 71 Validity : 0
Towing dir: 0° Wire out : 180 m Speed : 0.0 kn
Sorted : 68 Total catch: 68.42 Catch/hour: 124.40

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Lutjanus sanguineus	56.82	9	45.67	
Decapterus macrosoma	23.09	1282	18.56	2
Aprion virescens	19.45	2	15.64	
Epinephelus multinotatus	19.27	2	15.49	
Loligo sp.	3.55	196	2.85	
Selar crumenophthalmus	1.39	2	1.12	
MISCELLANEOUS	0.76	0	0.61	
Upeneus bensasi	0.04	2	0.03	
Chromis dasygensys	0.04	2	0.03	
Total	124.41		100.01	

R/V "DR. FRIDTJOF NANSEN" SURVEY:2008405 STATION: 4
DATE :29.08.2008 GEAR TYPE: BT NO: 21 POSITION:Lat S 25°38.83
start stop duration Lon E 45°8.22
TIME :09:27:40 09:57:17 29.6 (min) Purpose : 1
LOG : 1850.90 1852.72 1.8 Region : 7500
FDEPTH: 40 39 Gear cond.: 0
BDEPTH: 40 39 Validity : 0
Towing dir: 0° Wire out : 125 m Speed : 3.7 kn
Sorted : 0 Total catch: 92.78 Catch/hour: 187.95

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Epinephelus malabaricus	40.51	2	21.56	
Parupeneus rubescens	26.64	160	14.17	
Siganus sutor	23.19	241	12.34	
Cheimerius nufar	18.13	14	9.65	
Lethrinus crocineus	17.42	73	9.27	
Loligo sp.	15.29	952	8.14	
Parupeneus indicus	11.65	28	6.20	
Mustelus manazo	8.61	2	4.58	
Ostracion cubicus	5.37	4	2.86	
Pomacanthus imperator	3.95	2	2.10	
Diodon liturosus	3.54	2	1.89	
Sufflamen fraenatus	2.23	4	1.19	
Parupeneus heptacanthus	2.03	36	1.08	
Chaetodon blockburnii	1.82	77	0.97	
Priacanthus hamrur	1.42	14	0.75	
Scolopsis bimaculatus	1.32	10	0.70	
Bodianus perditio	1.11	2	0.59	
Pteragogus pelycus	0.87	55	0.46	
Parupeneus macronema	0.43	8	0.23	
Dascyllus trimaculatus	0.41	16	0.22	
CAESIONIDAE	0.37	14	0.20	
Decapterus macrosoma	0.31	14	0.17	
Parupeneus diagonalis	0.20	2	0.11	
Stephanolepis auratus	0.20	6	0.11	
Coris caudimacula	0.14	2	0.08	
Decapterus sp.	0.12	87	0.06	
Stolephorus sp.	0.10	63	0.05	
Stethojulis albovittata	0.10	4	0.05	
Apogon sp.	0.09	16	0.05	
Acanthurus sp.	0.09	2	0.05	
Halichoeres lapillus	0.07	2	0.04	
Coris sp.	0.07	2	0.04	
Zebrasoma gemmatum	0.05	2	0.02	
Labroides dimidiatus	0.03	6	0.02	
Ariomma indica	0.03	12	0.02	
Gazza sp.	0.02	2	0.01	
Oplegnathus robinsoni	0.00	2	0.00	
Total	187.95		100.00	

R/V "DR. FRIDTJOF NANSEN" SURVEY:2008405 STATION: 5
DATE :29.08.2008 GEAR TYPE: PT NO: 1 POSITION:Lat S 25°54.22
start stop duration Lon E 45°45.89
TIME :18:19:32 18:49:30 30.0 (min) Purpose : 1
LOG : 1937.28 1939.25 2.0 Region : 7500
FDEPTH: 77 68 Gear cond.: 0
BDEPTH: 90 79 Validity : 0
Towing dir: 0° Wire out : 200 m Speed : 3.9 kn
Sorted : 0 Total catch: 6.69 Catch/hour: 13.39

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Champsodon sp.	5.40	246	40.34	
Decapterus macrosoma	4.78	54	35.71	
Decapterus macrosoma	2.10	22	15.69	
C E P H A L O P O D A	0.40	32	2.99	
Trachurus delagoa	0.19	2	1.43	
Parupeneus heptacanthus	0.13	4	1.00	
BERYCIDAE	0.11	14	0.79	
Bregmaceros sp.	0.10	134	0.75	
UNIDENTIFIED FISH	0.04	4	0.33	
AMMODYTIDAE	0.04	6	0.27	
TETRAODONTIDAE	0.04	2	0.27	
UNIDENTIFIED FISH	0.02	4	0.12	
TETRAODONTIDAE	0.01	14	0.10	
Small crabs	0.01	6	0.04	
Dactyloptena orientalis	0.00	2	0.03	
Platycephalus sp.	0.00	4	0.03	
BOTHIDAE	0.00	2	0.03	
Chaetodon sp.	0.00	2	0.03	
BALISTIDAE	0.00	2	0.01	
UNIDENTIFIED FISH, juvenile	0.00	6	0.01	
Small squids unident.	0.00	2	0.01	
Total	13.39		100.00	

R/V "DR. FRIDTJOF NANSEN" SURVEY:2008405 STATION: 6
DATE :30.08.2008 GEAR TYPE: PT NO: 1 POSITION:Lat S 25°32.11
start stop duration Lon E 46°4.63
TIME :00:28:33 00:57:32 29.0 (min) Purpose : 1
LOG : 1990.78 1992.67 1.9 Region : 7500
FDEPTH: 35 35 Gear cond.: 0
BDEPTH: 72 66 Validity : 0
Towing dir: 0° Wire out : 105 m Speed : 3.9 kn
Sorted : 0 Total catch: 7.01 Catch/hour: 14.50

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Bregmaceros sp.	5.17	69334	35.68	
Decapterus macrosoma	4.49	66	30.97	
Champsodon capensis	4.18	857	28.83	
Decapterus maruadsi	0.20	2	1.38	
Sphyraena sp.	0.16	2	1.13	
Lagocephalus guntheri	0.14	2	1.00	
Engraulis sp.	0.07	6	0.49	
UNIDENTIFIED FISH	0.06	48	0.40	
Trachurus delagoa	0.01	8	0.04	
Fistularia commersonii	0.00	2	0.03	
TETRAODONTIDAE	0.00	2	0.01	
Chaetodon lunula	0.00	2	0.01	
POLYMIXIIDAE	0.00	2	0.01	
MISCELLANEOUS	0.00	12	0.01	
Total	14.50		100.00	

R/V "DR. FRIDTJOF NANSEN" SURVEY:2008405 STATION: 7
DATE :02.09.2008 GEAR TYPE: BT NO: 21 POSITION:Lat S 28°20.20
start stop duration Lon E 45°15.20
TIME :13:06:33 13:39:45 33.0 (min) Purpose : 1
LOG : 2570.58 2572.25 1.7 Region : 7500
FDEPTH: 759 739 Gear cond.: 0
BDEPTH: 759 739 Validity : 0
Towing dir: 0° Wire out : 650 m Speed : 3.0 kn
Sorted : 0 Total catch: 193.74 Catch/hour: 352.26

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Centrophorus sp.	186.82	11	53.03	
Beryx splendens	85.18	171	24.18	
PORIFERA (Sponges)	29.36	5	8.34	
Deania profundorum	26.09	13	7.41	
OMMASTREPHIDAE	8.49	5	2.41	
MACROURIDAE	6.73	109	1.91	
Etmopterus lucifer	4.22	27	1.20	
Plesiopenaeus edwardsianus	1.49	42	0.42	
Oreosoma atlanticum	0.82	7	0.23	
Yarella sp. *	0.37	11	0.11	
Malacocephalus sp.	0.35	2	0.10	
Invertebrate	0.33	4	0.09	
Neobythites sp.	0.32	4	0.09	
MYCTOPHIDAE	0.29	22	0.08	
Phosichthyidae sp.	0.29	7	0.08	
Chaunax sp.	0.19	2	0.05	
Caelorinchus sp.	0.18	4	0.05	
Chlorophthalmus sp.	0.17	4	0.05	
Heterocarpus laevigatus	0.14	4	0.04	
ECHINOMETRIDAE	0.12	2	0.03	
Plesionika martia	0.09	11	0.02	
Projasus parkeri	0.09	7	0.02	
Astronesthes sp.	0.05	2	0.02	
GERYONIDAE	0.04	4	0.01	
Argyropelecus aculeatus	0.03	5	0.01	
Chauliodus sloani	0.02	2	0.01	
ARISTEIDAE	0.01	4	0.00	
Total	352.26		100.00	

R/V "DR. FRIDTJOF NANSEN" SURVEY:2008405 STATION: 8
DATE :04.09.2008 GEAR TYPE: PT NO: 0 POSITION:Lat S 25°41.50
start stop duration Lon E 45°30.70
TIME :00:30:48 01:00:18 29.5 (min) Purpose : 1
LOG : 2773.09 2774.55 1.5 Region : 7500
FDEPTH: 15 15 Gear cond.: 0
BDEPTH: 54 55 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.0 kn
Sorted : 0 Total catch: 19.26 Catch/hour: 39.17

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Engraulis japonicus	35.69	5711	91.13	4
Scomber japonicus	2.07	179	5.30	3
Trachurus delagoa	0.73	16	1.87	
Etrumeus teres	0.47	14	1.19	
Loligo sp.	0.10	33	0.26	
BERYCIDAE	0.04	6	0.09	
Choridactylus natalensis	0.03	2	0.08	
Champsodon sp.	0.02	2	0.05	
PORTUNIDAE	0.01	2	0.02	
Xenolepidichthys sp.	0.00	2	0.01	
Chaetodon sp.	0.00	2	0.01	
Total	39.17		100.00	

R/V "DR. FRIDTJOF NANSEN" SURVEY:2008405 STATION: 9
DATE :04.09.2008 GEAR TYPE: BT NO: 21 POSITION:Lat S 27°9.27
start stop duration Lon E 46°6.34
TIME :16:07:25 16:37:09 29.7 (min) Purpose : 1
LOG : 2915.62 2917.10 1.5 Region : 7500
FDEPTH: 548 585 Gear cond.: 0
BDEPTH: 548 585 Validity : 0
Towing dir: 0° Wire out : 1300 m Speed : 3.0 kn
Sorted : 63 Total catch: 274.20 Catch/hour: 553.38

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Chlorophthalmus sp.	408.27	5925	73.78	
Polymixia sp.	37.74	145	6.82	
Beryx splendens	33.10	186	5.98	5
Centrophorus granulosus	28.78	16	5.20	
Squalus mitsukurii	14.89	12	2.69	
Setarches guentheri	10.49	16	1.90	
Pentaceros capensis	10.07	121	1.82	
Pyramodon punctatus	3.77	24	0.68	
Centrophorus sp.	3.29	2	0.59	
Caelorinchus sp.	1.05	8	0.19	
Deania quadrispinosum	0.73	2	0.13	
Acropoma japonicum	0.40	8	0.07	
MYCTOPHIDAE	0.35	97	0.06	
PENAEIDAE	0.24	8	0.04	
ECHINOMETRIDAE	0.22	8	0.04	
Malthopsis tiarella	0.16	8	0.03	
Astropecten sp.	0.11	8	0.02	
BEMBRIDAE *	0.09	8	0.02	
ARISTEIDAE	0.08	8	0.01	
Plesionika martia	0.05	24	0.01	
Total	553.91		100.10	

R/V "DR. FRIDTJOF NANSEN" SURVEY:2008405 STATION: 10
DATE :06.09.2008 GEAR TYPE: PT NO: 4 POSITION:Lat S 25°19.19
start stop duration Lon E 46°22.90
TIME :17:00:14 17:29:26 29.2 (min) Purpose : 1
LOG : 3223.64 3225.12 1.6 Region : 7500
FDEPTH: 10 10 Gear cond.: 0
BDEPTH: 67 57 Validity : 0
Towing dir: 0° Wire out : 78 m Speed : 3.0 kn
Sorted : 0 Total catch: 0.25 Catch/hour: 0.51

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
APOGONIDAE	0.01	8	0.00	
BOTHIDAE	0.01	4	0.00	
Selar crumenophthalmus	0.14	2	0.00	
Trachurus delagoa	0.00	2	0.00	
DIODONTIDAE	0.00	6	0.00	
Engraulis japonicus	0.19	84	0.00	6
GRAMMICOLEPIDIDAE	0.00	2	0.00	
POMACENTRIDAE, juvenile	0.00	2	0.00	
Priacanthus sp.	0.00	2	0.00	
Sphyraena sp.	0.02	14	0.00	
Loligo sp.	0.12	582	0.00	
Octopus sp., juvenile	0.01	2	0.00	
UNIDENTIFIED FISH	0.00	8	0.00	
UNIDENTIFIED FISH	0.00	8	0.00	

R/V "DR. FRIDTJOF NANSEN" SURVEY:2008405 STATION: 11
DATE :06.09.2008 GEAR TYPE: PT NO: 4 POSITION:Lat S 25°16.15
start stop duration Lon E 46°48.09
TIME :23:21:31 23:51:30 30.0 (min) Purpose : 1
LOG : 3260.84 3262.46 1.6 Region : 7500
FDEPTH: 20 20 Gear cond.: 0
BDEPTH: 73 78 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.2 kn
Sorted : 31 Total catch: 86.00 Catch/hour: 172.11

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus delagoa	164.51	2654	95.58	7
Engraulis japonicus	3.54	642	2.06	8
Scomber japonicus	1.56	24	0.91	
Decapterus macrosoma	0.77	90	0.45	
Champsodon sp.	0.72	594	0.42	
Trachurus delagoa	0.54	450	0.31	9
Argonauta sp.	0.28	6	0.16	
Bregmaceros sp.	0.02	30	0.01	
Sphyraena sp.	0.02	12	0.01	
BOTHIDAE	0.01	12	0.01	
UNIDENTIFIED FISH	0.01	24	0.01	
SCYLLARIDAE	0.01	6	0.00	
PALINURIDAE	0.01	18	0.00	
Leptocephalus	0.00	6	0.00	
SERRANIDAE	0.00	6	0.00	
UNIDENTIFIED FISH	0.00	6	0.00	
Total	172.01		99.94	

R/V "DR. FRIDTJOF NANSEN" SURVEY:2008405 STATION: 12
DATE :07.09.2008 GEAR TYPE: BT NO: 21 POSITION:Lat S 25°8.95
start stop duration Lon E 47°6.92
TIME :07:27:20 07:59:47 32.5 (min) Purpose : 1
LOG : 3330.45 3332.73 2.3 Region : 7500
FDEPTH: 81 81 Gear cond.: 0
BDEPTH: 81 81 Validity : 0
Towing dir: 0° Wire out : 212 m Speed : 4.2 kn
Sorted : 0 Total catch: 77.73 Catch/hour: 143.72

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus delagoa	104.93	1679	73.01	10
Mustelus manazo	18.86	6	13.12	
Ariomma indica	8.51	68	5.92	
Selar crumenophthalmus	3.88	33	2.70	11
Priacanthus hamrur	1.94	17	1.35	
Upeneus moluccensis	1.65	39	1.14	
Saurida undosquamis	1.15	7	0.80	
Sphyraena acutipinnis	0.71	6	0.49	
Pagellus bellottii natalensis	0.68	7	0.48	
Upeneus sp.	0.56	13	0.39	
Upeneus bensasi	0.23	7	0.16	
Terapon theraps	0.13	2	0.09	
Trachurus delagoa, juvenile	0.08	63	0.06	
Lagocephalus guntheri	0.08	2	0.06	
Champsodon sp.	0.07	18	0.05	
Trachinocephalus myops	0.07	2	0.05	
Synodus indicus	0.07	4	0.05	
Upeneus taeniopterus	0.04	4	0.03	
Bothus sp.	0.03	2	0.02	
Decapterus macrosoma, juvenile	0.03	9	0.02	
Callionymus cf persicus	0.02	2	0.02	
Synodus hoshinonis	0.01	2	0.01	
Total	143.72		100.00	

R/V "DR. FRIDTJOF NANSEN" SURVEY:2008405 STATION: 13
DATE :07.09.2008 GEAR TYPE: BT NO: 21 POSITION:Lat S 25°3.16
start stop duration Lon E 47°4.41
TIME :09:33:47 10:03:43 30.0 (min) Purpose : 1
LOG : 3343.92 3345.51 1.6 Region : 7500
FDEPTH: 64 69 Gear cond.: 0
BDEPTH: 64 69 Validity : 0
Towing dir: 0° Wire out : 170 m Speed : 3.2 kn
Sorted : 93 Total catch: 725.72 Catch/hour: 1453.86

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus delagoa	1180.33	20534	81.19	12
Sphyraena helleri	125.17	1827	8.61	15
Ariomma indica	52.99	553	3.64	13
Terapon theraps	22.28	246	1.53	14
Saurida undosquamis	13.82	260	0.95	
JELLYFISH	13.82	2	0.95	
Priacanthus hamrur	11.52	122	0.79	
Rhinobatos annulatus	7.93	4	0.55	
Engraulis japonicus	7.67	2610	0.53	16
Selar crumenophthalmus	5.37	30	0.37	
Ariodes dussumieri	4.91	2	0.34	
Mustelus manazo	1.90	2	0.13	
Upeneus moluccensis	1.54	30	0.11	
Upeneus sp.	1.08	16	0.07	
Apogon quadrifasciatus	1.08	108	0.07	
Penaeus semisulcatus	0.70	16	0.05	
Gazza minuta	0.48	30	0.03	
Polydactylus sextarius	0.46	16	0.03	
Nemipterus sp.	0.36	16	0.02	
Apistus carinatus	0.28	16	0.02	
Cynoglossus sp.	0.16	16	0.01	
Total	1453.86		100.00	

R/V "DR. FRIDTJOF NANSEN" SURVEY:2008405 STATION: 14
DATE :09.09.2008 GEAR TYPE: BT NO: 21 POSITION:Lat S 24°2.24
start stop duration Lon E 47°35.91
TIME :14:33:48 15:03:15 29.5 (min) Purpose : 1
LOG : 3704.92 3706.47 1.6 Region : 7500
FDEPTH: 70 70 Gear cond.: 0
BDEPTH: 70 70 Validity : 0
Towing dir: 0° Wire out : 180 m Speed : 3.1 kn
Sorted : 0 Total catch: 46.81 Catch/hour: 95.33

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Stegostoma fasciatum	41.55	2	43.58	
Decapterus macarellus	34.73	88	36.43	17
Priacanthus hamrur	4.93	65	5.17	
Sphyraena helleri	3.97	10	4.17	18
Argyrops filamentosus	3.81	18	4.00	
Parupeneus sp.	2.22	96	2.33	
Epinephelus rivulatus	1.77	6	1.86	
Nemipterus sp.	1.59	10	1.67	
Loligo sp.	0.24	22	0.26	
Chaetodon marleyi	0.18	2	0.19	
Chaetodon dolosus	0.16	4	0.17	
Cyprinocirrhites polyactis	0.14	2	0.15	
Halichoeres sp.	0.02	2	0.02	
BOTHIDAE	0.01	2	0.01	
Antigonia hulleyi	0.01	2	0.01	
Total	95.33		100.00	

R/V "DR. FRIDTJOF NANSEN" SURVEY:2008405 STATION: 15
DATE :09.09.2008 GEAR TYPE: PT NO: 4 POSITION:Lat S 23°52.26
start stop duration Lon E 47°37.76
TIME :17:11:23 17:44:43 33.3 (min) Purpose : 1
LOG : 3720.90 3722.06 1.1 Region : 7500
FDEPTH: 5 5 Gear cond.: 0
BDEPTH: 67 51 Validity : 0
Towing dir: 0° Wire out : 80 m Speed : 2.1 kn
Sorted : 0 Total catch: 0.38 Catch/hour: 0.69

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
ANGUILLIFORMES	0.00	4	0.00	
BALISTIDAE	0.00	2	0.00	
C R U S T A C E A N S	0.01	4	0.00	
Hygophum sp.	0.36	153	0.00	
Lactoria fornasini	0.00	2	0.00	
Loligo sp.	0.31	27	0.00	
Unidentified fish	0.00	2	0.00	
ANGUILLIFORMES, juvenile	0.00	2	0.00	

R/V "DR. FRIDTJOF NANSEN" SURVEY:2008405 STATION: 16
DATE :09.09.2008 GEAR TYPE: PT NO: 4 POSITION:Lat S 23°40.22
start stop duration Lon E 47°41.63
TIME :19:50:22 20:20:26 30.0 (min) Purpose : 1
LOG : 3737.00 3738.25 1.3 Region : 7500
FDEPTH: 0 0 Gear cond.: 0
BDEPTH: 62 61 Validity : 0
Towing dir: 0° Wire out : 70 m Speed : 2.7 kn
Sorted : 0 Total catch: 0.76 Catch/hour: 1.51

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Hygophum sp.	1.30	650	85.82	
Loligo sp.	0.18	26	11.88	
MYCTOPHIDAE	0.02	10	1.32	
C R U S T A C E A N S	0.01	26	0.77	
Ammodytes sp.	0.00	2	0.13	
Fistularia commersonii	0.00	2	0.08	
Total	1.51		100.00	

R/V "DR. FRIDTJOF NANSEN" SURVEY:2008405 STATION: 17
DATE :10.09.2008 GEAR TYPE: BT NO: 21 POSITION:Lat S 22°31.81
start stop duration Lon E 47°57.60
TIME :06:30:08 06:58:41 28.6 (min) Purpose : 1
LOG : 3828.77 3830.37 1.6 Region : 7500
FDEPTH: 60 63 Gear cond.: 0
BDEPTH: 60 63 Validity : 0
Towing dir: 0° Wire out : 160 m Speed : 3.4 kn
Sorted : 0 Total catch: 42.81 Catch/hour: 89.97

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Lutjanus argentimaculatus	41.80	8	46.46	
Argyrosomus hololepidotus	29.11	4	32.35	
Upeneus taeniopterus	5.72	261	6.35	
Pomacanthus striatus	3.15	2	3.50	
APOGONIDAE	2.08	2081	2.31	
Argyrops filamentosus	1.89	4	2.10	
Nemipterus japonicus	1.83	13	2.03	
MISCELLANEOUS	1.83	0	2.03	
Apogon apogonides	1.30	82	1.45	
Upeneus moluccensis	0.88	15	0.98	
PORIFERA (Sponges)	0.21	4	0.23	
Chaetodon dolosus	0.15	4	0.16	
Astropecten sp.	0.02	2	0.02	
Total	89.97		100.00	

R/V "DR. FRIDTJOF NANSEN" SURVEY:2008405 STATION: 18
DATE :12.09.2008 GEAR TYPE: PT NO: 1 POSITION:Lat S 22°4.48
start stop duration Lon E 48°9.18
TIME :01:10:08 01:41:53 31.8 (min) Purpose : 1
LOG : 4114.06 4115.64 1.6 Region : 7500
FDEPTH: 10 10 Gear cond.: 0
BDEPTH: 48 55 Validity : 0
Towing dir: 0° Wire out : 120 m Speed : 3.0 kn
Sorted : 0 Total catch: 16.26 Catch/hour: 30.73

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Decapterus macrosoma	28.25	446	91.93	19
Etrumeus teres	2.46	23	7.99	20
Apogon sp.	0.01	2	0.02	
Chaetodon sp.	0.01	6	0.02	
C R U S T A C E A N S	0.00	9	0.01	
Leptocephalus	0.00	2	0.01	
Xenolepidichthys dagleishi	0.00	2	0.01	
TETRAODONTIDAE	0.00	4	0.00	
Tetraodon sp., juvenile	0.00	2	0.00	
Total	30.73		99.99	

R/V "DR. FRIDTJOF NANSEN" SURVEY:2008405 STATION: 19
DATE :12.09.2008 GEAR TYPE: BT NO: 22 POSITION:Lat S 21°7.16
start stop duration Lon E 48°27.68
TIME :11:48:10 12:18:25 30.2 (min) Purpose : 1
LOG : 4201.93 4203.52 1.6 Region : 7500
FDEPTH: 43 47 Gear cond.: 0
BDEPTH: 43 47 Validity : 0
Towing dir: 0° Wire out : 110 m Speed : 3.2 kn
Sorted : 0 Total catch: 33.26 Catch/hour: 65.99

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Stegostoma fasciatum *	60.32	2	91.40	
Apogon sp.	1.77	220	2.68	
Dascyllus trimaculatus	1.29	117	1.95	
Echeneis naucrates	0.69	4	1.05	
Cyprinocirrhites polyactis	0.36	32	0.54	
Argyrops filamentosus	0.36	2	0.54	
Leiognathus equulus	0.26	36	0.39	
MULLIDAE	0.14	22	0.21	
Lutjanus sebae	0.14	2	0.21	
Chaetodon dolosus	0.14	10	0.21	
Anthias cooperi	0.12	14	0.18	
SEPIIDAE	0.10	4	0.15	
Plotosus lineatus	0.08	12	0.12	
Heniochus sp.	0.08	10	0.12	
Loligo sp.	0.06	6	0.09	
Teixeirichthys jordani	0.04	4	0.06	
Oxycirrhites typus	0.02	2	0.03	
Chaetodon blockburnii	0.02	2	0.03	
Labroides dimidiatus	0.02	4	0.03	
MURAENIDAE	0.00	2	0.00	
Total	65.99		100.00	

R/V "DR. FRIDTJOF NANSEN" SURVEY:2008405 STATION: 20
DATE :12.09.2008 GEAR TYPE: PT NO: 4 POSITION:Lat S 20°46.93
start stop duration Lon E 48°35.85
TIME :16:16:54 16:44:42 27.8 (min) Purpose : 1
LOG : 4235.28 4236.39 1.1 Region : 7500
FDEPTH: 0 0 Gear cond.: 0
BDEPTH: 302 226 Validity : 0
Towing dir: 0° Wire out : 110 m Speed : 2.4 kn
Sorted : 0 Total catch: 0.02 Catch/hour: 0.05

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
TETRAODONTIDAE	0.00	2	0.00	
Hygophum sp.	0.05	15	0.00	

R/V "DR. FRIDTJOF NANSEN" SURVEY:2008405 STATION: 21
DATE :12.09.2008 GEAR TYPE: PT NO: 4 POSITION:Lat S 20°9.85
start stop duration Lon E 48°51.18
TIME :22:25:07 22:55:14 30.1 (min) Purpose : 1
LOG : 4282.37 4283.54 1.2 Region : 7500
FDEPTH: 20 20 Gear cond.: 0
BDEPTH: 836 520 Validity : 0
Towing dir: 0° Wire out : 110 m Speed : 2.3 kn
Sorted : 0 Total catch: 0.05 Catch/hour: 0.09

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
LOLIGINIDAE	0.09	4	0.00	

R/V "DR. FRIDTJOF NANSEN" SURVEY:2008405 STATION: 22
DATE :15.09.2008 GEAR TYPE: PT NO: 4 POSITION:Lat S 19°25.08
start stop duration Lon E 49°5.94
TIME :00:30:22 01:00:37 30.3 (min) Purpose : 1
LOG : 4588.80 4590.56 1.8 Region : 7500
FDEPTH: 10 10 Gear cond.: 0
BDEPTH: 61 518 Validity : 0
Towing dir: 0° Wire out : 110 m Speed : 3.5 kn
Sorted : 0 Total catch: 0.09 Catch/hour: 0.18

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Leptocephalus	0.00	2	0.00	
Oratosquilla sp.	0.04	258	0.00	
Loligo sp.	0.07	8	0.00	
Euphausiacea	0.00	36	0.00	
Lestrolepis intermedia	0.02	2	0.00	
BERYCIDAE	0.01	2	0.00	
MYCTOPHIDAE	0.04	16	0.00	
BOTHIDAE	0.00	10	0.00	

R/V "DR. FRIDTJOF NANSEN" SURVEY:2008405 STATION: 23
DATE :20.09.2008 GEAR TYPE: PT NO: 4 POSITION:Lat S 17°47.80
start stop duration Lon E 49°31.84
TIME :04:20:00 04:50:41 30.7 (min) Purpose : 1
LOG : 5107.52 5109.37 1.9 Region : 7500
FDEPTH: 0 0 Gear cond.: 0
BDEPTH: 44 51 Validity : 0
Towing dir: 0° Wire out : 110 m Speed : 3.6 kn
Sorted : 0 Total catch: 0.13 Catch/hour: 0.26

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
BOTHIDAE	0.00	16	0.00	
CLUPEIDAE	0.01	18	0.00	
C R U S T A C E A N S	0.03	278	0.00	
ENGRAULIDIDAE, juvenile	0.19	764	0.00	
Stolephorus sp.	0.00	2	0.00	
Fistularia sp., juvenile	0.00	2	0.00	
LEIOGNATHIDAE, juvenile	0.01	31	0.00	
NEMIPTERIDAE, juvenile	0.00	8	0.00	
Lagocephalus sp., juvenile	0.02	49	0.00	

R/V "DR. FRIDTJOF NANSEN" SURVEY:2008405 STATION: 24
DATE :20.09.2008 GEAR TYPE: BT NO: 22 POSITION:Lat S 17°32.29
start stop duration Lon E 49°37.13
TIME :12:15:00 12:45:02 30.0 (min) Purpose : 1
LOG : 5159.36 5160.74 1.4 Region : 7500
FDEPTH: 52 51 Gear cond.: 0
BDEPTH: 52 51 Validity : 0
Towing dir: 0° Wire out : 130 m Speed : 2.8 kn
Sorted : 0 Total catch: 13.74 Catch/hour: 27.45

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Loligo sp.	11.49	629	41.85	
Teixeirichthys jordani	4.56	250	16.59	
Upeneus vittatus	3.56	194	12.95	
Secutor insidiator *	2.48	412	9.02	
Upenus pori	2.29	154	8.35	
Parupeneus heptacanthus	1.90	10	6.91	
Sepia sp.	0.76	4	2.77	
Nemipterus zysron	0.27	2	1.00	
Teixeirichthys jordani	0.12	2	0.45	
Synodus hoshinomis	0.03	2	0.10	
Total	27.45		100.00	

R/V "DR. FRIDTJOF NANSEN" SURVEY:2008405 STATION: 25
DATE :21.09.2008 GEAR TYPE: BT NO: 22 POSITION:Lat S 16°31.20
start stop duration Lon E 50°9.24
TIME :04:39:36 05:02:42 23.1 (min) Purpose : 1
LOG : 5315.55 5316.75 1.2 Region : 7500
FDEPTH: 72 70 Gear cond.: 0
BDEPTH: 72 70 Validity : 0
Towing dir: 0° Wire out : 180 m Speed : 3.1 kn
Sorted : 0 Total catch: 89.33 Catch/hour: 232.03

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Leiognathus elongatus	180.91	60304	77.97	21
Upeneus moluccensis	33.64	7312	14.50	23
Decapterus macrosoma	11.04	3247	4.76	22
Sepia sp.	2.83	3	1.22	
Teixeirichthys jordani	1.30	8	0.56	
Symphysanodon sp.	1.19	78	0.51	24
Loligo sp.	0.75	55	0.32	
Saurida undosquamis	0.31	5	0.13	
Canthigaster sp.	0.03	3	0.01	
Pseudorhombus sp.	0.01	3	0.01	
Lagocephalus sp.	0.01	3	0.00	
Nemiterus sp.	0.00	3	0.00	
Total	232.03		100.00	

R/V "DR. FRIDTJOF NANSEN" SURVEY:2008405 STATION: 26
DATE :21.09.2008 GEAR TYPE: PT NO: 1 POSITION:Lat S 16°18.65
start stop duration Lon E 50°9.03
TIME :09:18:05 09:48:11 30.1 (min) Purpose : 1
LOG : 5355.17 5357.22 2.0 Region : 7500
FDEPTH: 30 25 Gear cond.: 0
BDEPTH: 80 78 Validity : 0
Towing dir: 0° Wire out : 80 m Speed : 4.1 kn
Sorted : 0 Total catch: 5.02 Catch/hour: 10.01

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Engraulis japonicus	8.41	46983	84.06	26
Engraulis japonicus	1.59	1196	15.94	25
Leiognathus sp.	0.03	159	0.27	
C R U S T A C E A N S	0.02	0	0.20	
Loligo sp.	0.01	24	0.12	
TETRAODONTIDAE	0.01	0	0.12	
Decapterus sp.	0.01	12	0.07	
Leptocephalus	0.00	4	0.04	
Gempylus sp.	0.00	18	0.04	
Trachurus delagoa	0.00	2	0.02	
Monacanthus sp.	0.00	8	0.02	
Sphyraena sp.	0.00	2	0.02	
BOTHIDAE	0.00	2	0.02	
BOTHIDAE	0.00	10	0.02	
Uranoscopus sp.	0.00	2	0.02	
GRAMMICOLEPIDIDAE	0.00	4	0.02	
Total	10.11		101.00	

R/V "DR. FRIDTJOF NANSEN" SURVEY:2008405 STATION: 27
DATE :23.09.2008 GEAR TYPE: PT NO: 4 POSITION:Lat S 14°58.57
start stop duration Lon E 50°26.06
TIME :14:40:35 15:14:19 33.8 (min) Purpose : 1
LOG : 5731.51 5733.52 2.0 Region : 7500
FDEPTH: 5 5 Gear cond.: 0
BDEPTH: 896 397 Validity : 0
Towing dir: 0° Wire out : 110 m Speed : 3.6 kn
Sorted : 0 Total catch: 2.84 Catch/hour: 5.05

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
LEIOGNATHIDAE	2.13	5628	42.27	27
Loligo sp.	1.60	2052	31.70	
MYCTOPHIDAE	0.44	372	8.81	29
Lestrolepis intermedia	0.40	276	7.96	28
MURAENIDAE	0.23	183	4.55	
Brama orcini	0.07	4	1.42	
C R U S T A C E A N S	0.07	213	1.33	
Lagocephalus sp.	0.04	16	0.70	
L O B S T E R S	0.04	146	0.70	
Unidentified fish	0.01	16	0.16	
Xenodermichthys sp	0.01	7	0.15	
Unidentified fish	0.00	21	0.06	
MONACANTHIDAE	0.00	4	0.04	
OSTRACIIDAE	0.00	5	0.04	
Uranoscopus sp.	0.00	2	0.04	
Labridae sp.	0.00	2	0.03	
FISTULARIIDAE	0.00	2	0.02	
UNIDE03	0.00	4	0.01	
BOTHIDAE	0.00	4	0.01	
, juvenile	0.00	4	0.01	
Total	5.05		100.02	

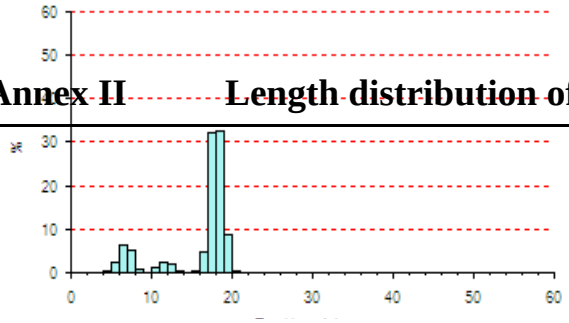
R/V "DR. FRIDTJOF NANSEN" SURVEY:2008405 STATION: 28
DATE :25.09.2008 GEAR TYPE: PT NO: 4 POSITION:Lat S 13°32.31
start stop duration Lon E 50°7.03
TIME :16:47:18 17:18:10 30.9 (min) Purpose : 1
LOG : 6072.14 6073.88 1.7 Region : 7500
FDEPTH: 0 0 Gear cond.: 0
BDEPTH: 196 717 Validity : 0
Towing dir: 0° Wire out : 109 m Speed : 3.4 kn
Sorted : 0 Total catch: 6.06 Catch/hour: 11.78

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
SQUILLIDAE	6.39	190	54.26	
MYCTOPHIDAE	3.01	754	25.56	30
J E L L Y F I S H	0.87	132	7.42	
MURAENIDAE	0.84	340	7.09	
Cypselurus sp.	0.23	2	1.95	
Sardinella sp.	0.17	4	1.48	
J E L L Y F I S H	0.10	62	0.82	
Lutjanus sp.	0.06	78	0.48	32
C R U S T A C E A N S	0.05	243	0.41	
UNIDENTIFIED FISH	0.03	4	0.28	
Paralichthodes sp.	0.02	21	0.18	31
Lactoria sp.	0.01	14	0.05	
Priacanthus sp.	0.00	2	0.02	
Total	11.79		100.02	

R/V "DR. FRIDTJOF NANSEN" SURVEY:2008405 STATION: 29
DATE :27.09.2008 GEAR TYPE: BT NO: 22 POSITION:Lat S 11°2.32
start stop duration Lon E 50°35.29
TIME :14:13:25 14:23:36 10.2 (min) Purpose : 1
LOG : 6401.33 6401.81 0.5 Region : 7500
FDEPTH: 339 331 Gear cond.: 0
BDEPTH: 339 331 Validity : 0
Towing dir: 0° Wire out : 840 m Speed : 2.8 kn
Sorted : 0 Total catch: 85.14 Catch/hour: 502.32

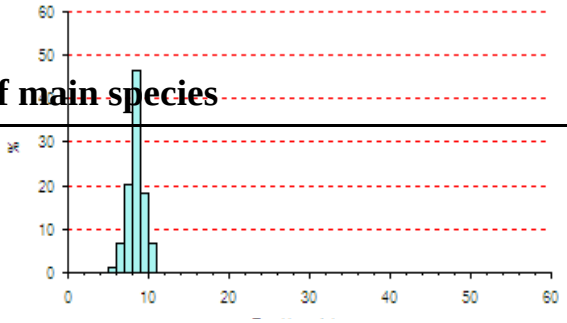
SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Scorpaenodes sp.	245.72	1145	48.92	33
Zenopsis conchifer	71.68	77	14.27	35
Antigonia sp.	64.90	702	12.92	34
Xenolepidichthys dagleishi	24.78	100	4.93	37
Chlorophthalmus sp.	16.70	861	3.32	38
Beryx splendens	15.93	130	3.17	36
UNIDENTIFIED FISH	12.51	236	2.49	
Unidentified fish	11.50	124	2.29	
Gephyroberyx darwini	5.90	6	1.17	
MYCTOPHIDAE	5.84	71	1.16	
Squalus megalops	4.90	18	0.97	
Sea cucumbers	4.02	383	0.80	
Unidentified fish	3.72	35	0.74	
UNIDE02	2.54	637	0.51	39
Lepidopus caudatus	2.06	6	0.41	
ECHINOMETRIDAE	1.95	6	0.39	
Allocyttus verrucosus	1.89	94	0.38	
UNIDE03	1.83	6	0.36	
Ophichthus sp.	0.94	18	0.19	
C R U S T A C E A N S	0.94	118	0.19	
Not found	**0.67**	**18**	**0.13**	
Satyrichthys investigatoris	0.53	24	0.11	
Coral - Alcyonaria?	0.29	6	0.06	
Sepia sp.	0.19	6	0.04	
E C H I N O D E R M A T A	0.16	6	0.03	
LESTIDIOPS JAYAKARI	0.16	24	0.03	
UNIDENTIFIED FISH	0.06	6	0.01	
PORIFERA (Sponges)	0.01	6	0.00	
Total	502.33		100.00	

Annex II Length distribution of main species



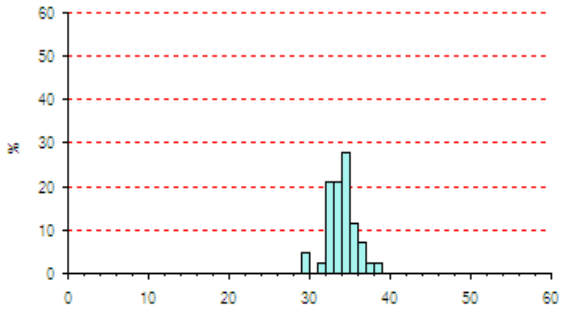
Decapterus macrosoma Madagascar

Mean length = 15.98 N = 953



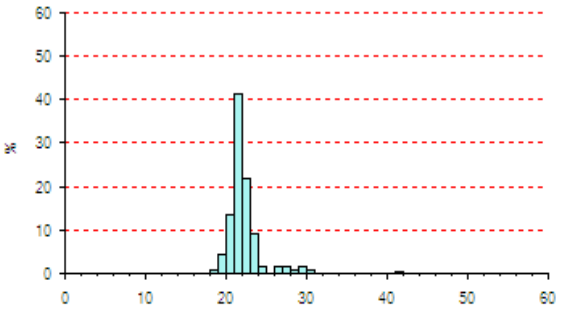
Scomber japonicus Madagascar

Mean length = 8.44 N = 88



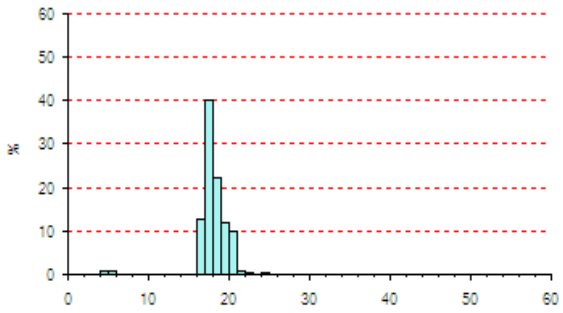
Decapterus macarellus Madagascar

Mean length = 33.99 N = 43



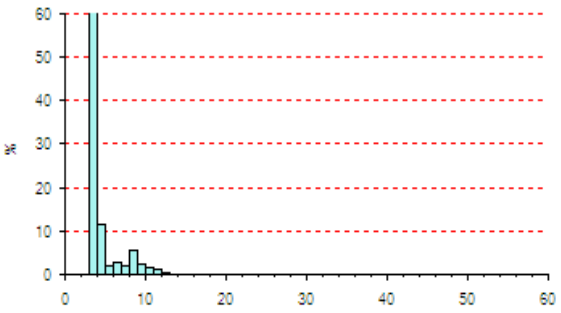
Sphyraena helleri Madagascar

Mean length = 22.29 N = 123



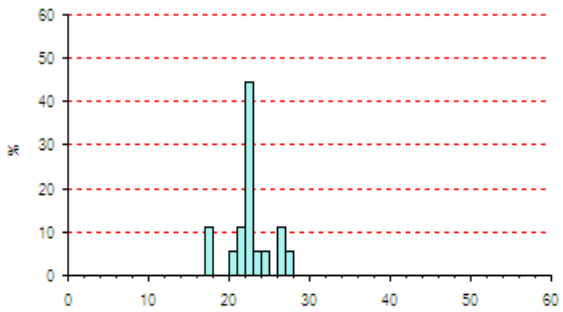
Trachurus delagoa Madagascar

Mean length = 17.98 N = 375



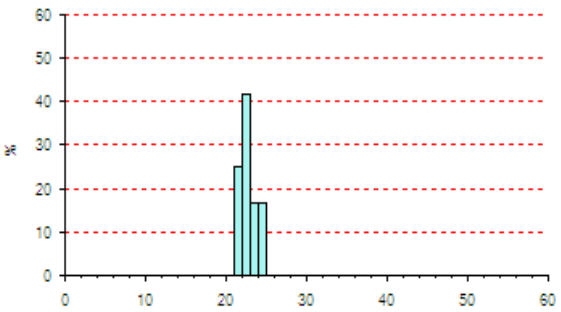
Engraulis japonicus Madagascar

Mean length = 4.45 N = 606



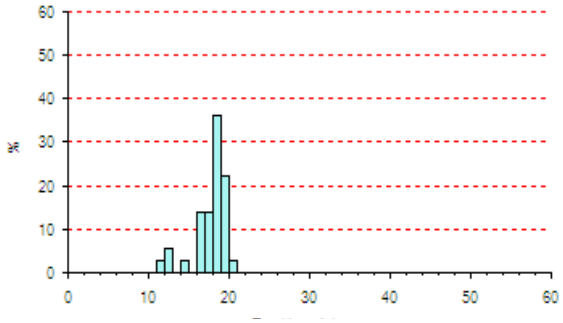
Selar crumenophthalmus Madagascar

Mean length = 22.61 N = 18



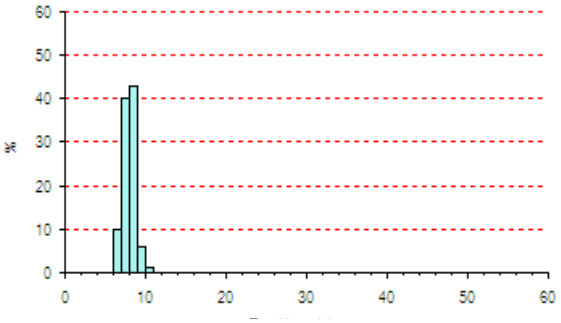
Etrumeus teres Madagascar

Mean length = 22.75 N = 12



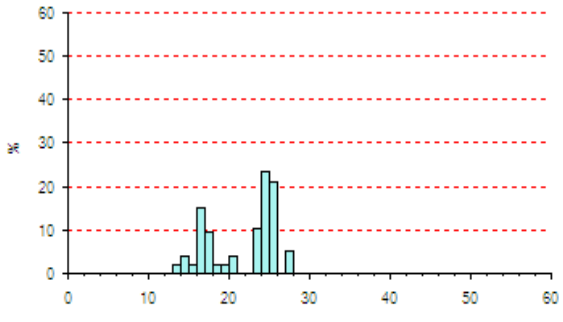
Ariomma indica Madagascar

Mean length = 17.72 N = 36



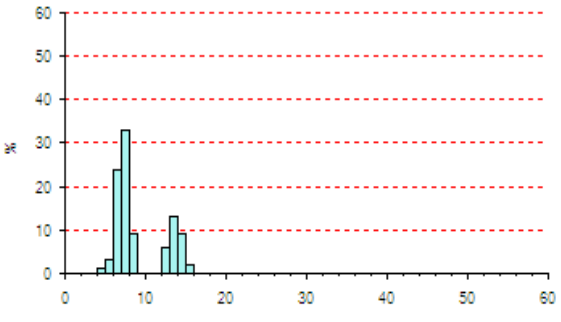
Upeneus moluccensis Madagascar

Mean length = 7.98 N = 100



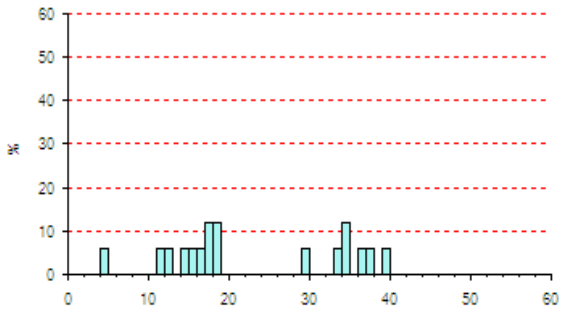
Beryx splendens Madagascar

Mean length = 21.75 N = 44



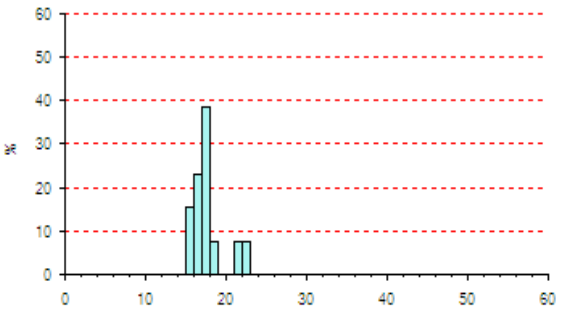
Lestrolepis intermedia Madagascar

Mean length = 9.13 N = 100



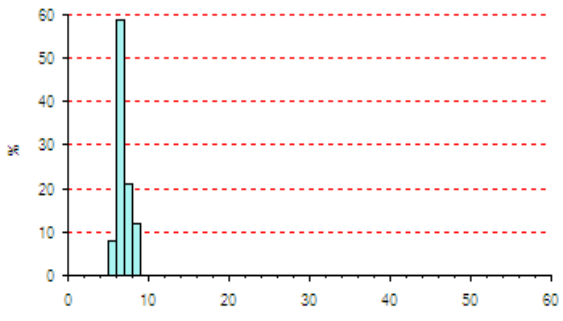
Xenolepidichthys dagleishi Madagascar

Mean length = 23.09 N = 17



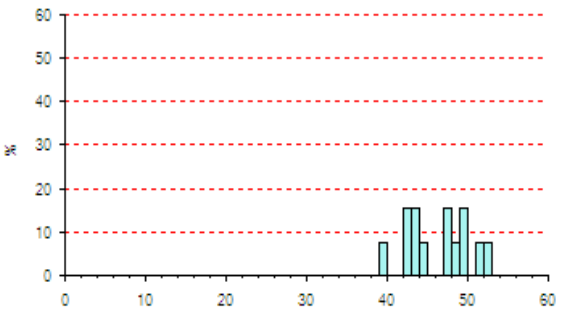
Terapon theraps Madagascar

Mean length = 17.73 N = 13



Leiognathus elongatus Madagascar

Mean length = 6.87 N = 100



Zenopsis conchifer Madagascar

Mean length = 46.35 N = 13

Annex III Instruments and fishing gear used

Echo sounder

The SIMRAD ER60/38 kHz scientific sounder was used during the survey for fish abundance estimation. The lowering keel was not submerged during the survey. The LSSS Integrator system was used to scrutinise the acoustic records. System calibration experiment using a standard copper sphere was performed 23.06.2008. The settings of 38 kHz echo sounder were as follows:

Transceiver-1 menu (38 kHz lowering keel)

Transducer depth	5.50 m
Absorbtion coeff.	6.7 dB/km
Pulse length	1.024ms
Bandwidth	2.43 kHz
Max power	2000 Watt
2-way beam angle	-20.6 dB
Transducer gain	25.82 dB
Angle sensitivity	21.9
3 dB beamwidth	6.95º alongship
	6.99º athwardship
Alongship offset	0.11º
Athwardship offset	0.04º

Display menu

Echogram	1 (38 kHz)
Bottom range	15 m
Bottom range start	10 m

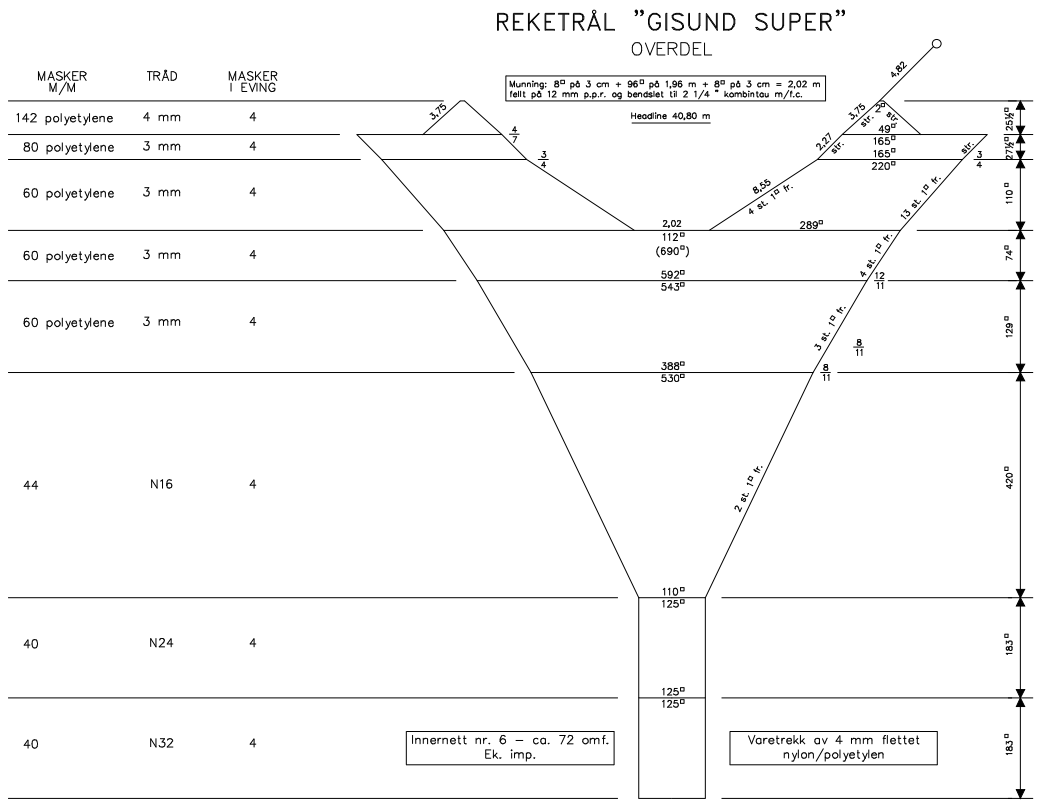
Fishing gear

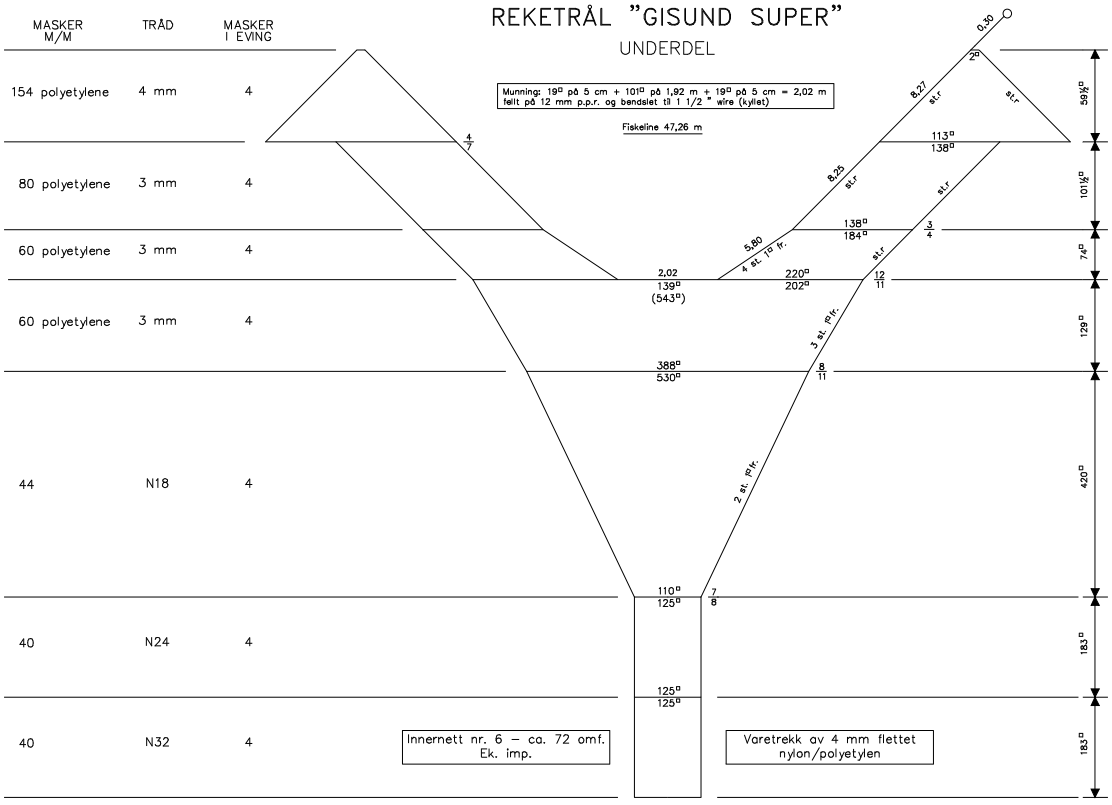
The vessel has both small and medium sized "Åkrahamn" pelagic trawls and a "Gisund super bottom trawl".

The bottom trawl has a headline of 31 m, footrope 47 m and 20 mm mesh size in the cod end with an inner net of 10 mm mesh size (Figure A1). The estimated opening is 6 m (observed 5.7) and distance between wings during towing about 18 m. The sweeps are 40 m long. The trawl is equipped with a 12" rubber bobbins gear. The doors are of 'Thyborøn' combi type, 7.81 m^2, 1670 kg, their distance while trawling about 45 - 55 m on average, depending on the depth (least distance at low depths). This distance can be kept constant (about 50 m) at all depths by the use of a 9.5 m strap between the wires at 130 m distance from the doors, normally applied at depths greater than 80 m.

The SCANMAR system was used on all trawl hauls. This equipment consists of sensors, a hydrophone, a receiver, a display unit and a battery charger. Communication between sensors and ship is based on acoustic transmission. The doors are fitted with sensors to provide information on their distance and the trawl with a trawl eye that provides information on the trawl opening, the distance of the footrope to the bottom, bottom contact and fish entering the trawl.

The figure below presents the design of the bottom trawl used.





Design of the trawl used.

Annex IV Samples collected and storage location

Refer to sampling methods (pg 15)

	Species	DNA (#)	Isotopes (#)
1	*Acanthurus sp.*	1	0
2	*Allocyttus verrucosus*	3	3
3	*Amblygaster sirm*	1	1
4	*Ammodytoides sp.*	3	0
5	*Antegonia hulleyi*	1	0
6	*Anthias cooperi*	3	3
7	*Antigonia nulleyi*	3	3
8	*Apistus carinatus*	3	3
9	*Apogon apogonides*	3	3
10	*Apogon quadrifasciatus*	3	3
11	*Apogon sp.*	7	7
12	*Apogonidae*	5	0
13	*Aprion visceres*	1	1
14	*Argyops filamentosus*	4	4
15	*Argyropelecus aculecitus*	3	3
16	*Argyrosomus hololepidotus*	2	2
17	*Ariomma indica*	4	4
18	*Ariomma indicus*	3	3
19	*Astronesthes*	1	0
20	*Bambridae*	1	0
21	*Berycidae sp.*	4	4
22	*Beryx sp.*	6	6
23	*Beryx spenders*	6	6
24	*Bodianus perdito*	1	1
25	*Bothidae*	7	0
26	*Bothus sp.*	1	0
27	*Bregnacerus sp.*	6	3
28	*Caelorinchus sp.*	2	2
29	*Caesio sp.*	4	4
30	*Callionymus persieus*	1	0
31	*Canthigaster sp.*	1	0
32	*Carangidae*	3	0
33	*Caranx ignoblis*	1	1
34	*Carcharhinus brevipinna*	2	0
35	*Carcharhinus limbatus?*	1	0
36	*Centrobranchus sp.*	1	1
37	*Centrophorus granulosus*	8	0
38	*Centrophorus lusitanicus*	6	0
39	*Centrophorus sp.*	1	0

40	*Chaetodon blackburnii*	4	4
41	*Chaetodon dolosus*	5	4
42	*Chaetodon marleyi*	1	1
43	*Chaetodon sp. 3*	1	0
44	*Chaetodon sp.1*	1	0
45	*Chaetodon sp.2*	1	0
46	*Champsodon sp.*	7	6
47	*Champsodon capensis*	3	3
48	*Chauliodus sloani*	1	0
49	*Chaunax sp*	1	0
50	*Cheimerius nufar*	3	3
51	*Chlorophthalmus*	2	2
52	*Cholorphathalmus punctatus*	2	2
53	*Chromis dasygenys*	1	1
54	*Clupeidae*	2	0
55	*Coelorinchus*	1	1
56	*Coris caudimacula*	1	0
57	*Coris sp.*	1	0
58	*Cynoglossus*	1	0
59	*Cyprinocirrhites polyactis*	4	4
60	*Cypselurus naresii*	1	1
61	*Cyrophlaeonides sp*	3	3
62	*Cyttopsis rosea*	1	1
63	*Dactyloptena orientalis*	1	0
64	*Dascyllus trimaculatus*	6	6
65	*Deania profundorum*	3	3
66	*Deania quadrispinosus*	1	0
67	*Decapterus sp.*	3	3
68	*Decapterus macarellus*	3	3
69	*Decapterus macrosoma*	10	10
70	*Decapterus muruadsi*	3	3
71	*Decapterus russelli*	4	4
72	*Dinematichthys*	3	3
73	*Diodontidae*	1	0
74	*Diodon liturosus*	1	1
75	*Eel larva*	2	0
76	*Emmelichthys nitidus*	3	3
77	*Engraulis sp.*	7	7
78	*Engraulis japonicus*	2	0
79	*Epigonus robustus*	3	3
80	*Epinephelus malabaricus*	1	1
81	*Epinephelus multinotatus*	1	1
82	*Epinephelus rivulatus*	3	3
83	*Equalites elongatus*	3	3
84	*Etmopterus lucifer*	3	3
85	*Etrumeus teres*	7	7
86	*Fistularia commersonii*	1	0
87	*Fistularidae*	1	0
88	*Gazza sp.*	3	2
89	*Gazza minuta*	1	1
90	*Gempylidae*	1	0
91	*Gephyroberyx darwini*	1	1

92	*Gonostoma sp.*	1	0
93	*Gramma orcini*	2	2
94	*Grammicolepididae*	3	0
95	*Gymnothorax johnsoni?*	1	0
96	*Gymnothorax sp.2*	1	0
97	*Halichoeres lapillus*	3	3
98	*Halichoeres sp.*	1	0
99	*Heniochus dipherentes*	3	3
100	*Hygophum sp.*	3	3
101	*Labridae*	1	0
102	*Labroides dimidiatus*	3	3
103	*Lactoria fornasini*	2	0
104	*Laeops sp.*	1	0
105	*Lagocephalidae*	2	0
106	*Lagocephalus guentheri*	2	0
107	*Lagocephalus sp.*	1	0
108	*Leiognathidae*	5	3
109	*Leiognathus elongatus*	3	3
110	*Lepidopus caudatus*	1	1
111	*Lestidiops jayakari*	3	3
112	*Lestrolepis intermedia*	2	2
113	*Lethrinus crocineus*	3	3
114	*Lutjanidae*	1	0
115	*Lutjanus argentimaculatus*	4	4
116	*Lutjanus sanguineous*	5	5
117	*Macrouridae sp.*	3	3
118	*Malacocephalus sp.*	1	1
119	*Malthopsis mitrigera*	0	0
120	*Malthopsis tiarella*	1	0
121	*Monacanthidae*	3	3
122	*Morey*	1	0
123	*Morey1*	1	0
124	*Mullidae*	3	3
125	*Mustelus manazo*	1	0
126	*Mustelus sp.*	4	0
127	*Myctophidae*	3	3
128	*Nemipteridae*	3	0
129	*Nemipterus japonicus*	3	3
130	*Nemipterus sp.*	4	4
131	*Nemipterus zystron*	1	1
132	*Neobythites*	2	2
133	*Ophichthus unicolor*	2	3
134	*Oplegnathus robinsomi*	1	0
135	*Oreosoma atlanticum*	3	3
136	*Ostraciidae*	2	0
137	*Ostracion cubicus*	2	2
138	*Oxycirrhites typus*	1	1
139	*Pagellus bellotti natalensis*	3	3
140	*Paracallionymus cf. costatus*	3	0
141	*Paralichthyidae*	3	3
142	*Parapeneus diagonalis*	1	1
143	*Parapercis xanthozona*	3	3

144	*Parexocoetus mento*	1	1
145	*Parupeneus heptacanthus*	6	6
146	*Parupeneus indicus*	3	3
147	*Parupeneus macronemus*	3	3
148	*Parupeneus rubescens*	3	3
149	*Parupeneus sp.*	3	3
150	*Pentaceros capensis*	3	3
151	*Phosichthys*	3	3
152	*Plotosus lineatus*	3	3
153	*Polimixia sp.*	3	3
154	*Polydactylus sextarius*	1	1
155	*Pomacanthus imperator*	1	1
156	*Pomacanthus striatus*	1	1
157	*Priacanthidae hamrur*	1	1
158	*Priacanthus hambur*	8	7
159	*Priacanthus sp.*	5	5
160	*Psettina sp. (Bothidae)*	1	0
161	*Pseudanthias*	1	0
162	*Pseudohombus sp.*	1	1
163	*Pteragogus*	3	3
164	*Puffer 1*	1	0
165	*puffer 2*	1	0
166	*Pyramodon punctatus*	2	2
167	*Rhinobatus ocellatus*	2	0
168	*Sardinella sp.*	6	6
169	*Sardinella gibbosun*	1	1
170	*Satyrichthys investigatoris*	3	0
171	*Saurida undosquamis*	8	8
172	*Scalopis bimaculatus*	3	3
173	*Scomber*	3	3
174	*Scomber japonicus*	3	3
175	*Selar crumenophthalmus*	5	4
176	*Setarches guentheri*	6	6
177	*Siganus sutor*	3	3
178	*Sphyraena sp.*	7	7
179	*Sphyraena africana?*	4	4
180	*Sphyraena helleri*	3	3
181	*Squalus megalops*	3	3
182	*Squalus mitsukurii*	6	0
183	*Stegostoma fasciatum*	2	0
184	*Stephanolepus auratus*	3	3
185	*Stethojulis albovittata*	2	0
186	*Stolephoros sp.*	4	0
187	*Stolephorus indicus*	1	1
188	*Sufflamen fraenatus*	2	2
189	*Symphodon sp.*	3	3
190	*Synodus hoshinonis*	2	2
191	*Synodus indicus*	2	2
192	*Teiseirichthys jordani*	5	5
193	*Terapon theraps*	1	1
194	*Tetradontidae*	1	0
195	*Therapon sp.*	1	1

196	*Trachinocephalus myops*	1	1
197	*Trachurus*	3	0
198	*Trachurus cephalus myops*	1	0
199	*Trachurus delagoa*	9	10
200	*Upeneus bensasi*	4	4
201	*Upeneus guttatus*	3	3
202	*Upeneus moluccensis*	9	9
203	*Upeneus pori*	3	3
204	*Upeneus sp.*	1	1
205	*Upeneus taeniopterus*	3	3
206	*Upeneus trontis*	2	2
207	*Uramoscopus archionema*	1	0
208	*Uramoscopus sp.*	1	0
209	*Xenolepidichthys dalgleishi*	3	3
210	*Yarrella sp.*	3	3
211	*Zebrasoma gemmatum*	1	0
212	*Zenion sp*	3	3
213	*Zenopsis conchifer*	4	4

Annex V Data management agreement

Data Management Agreement for the FAO/ASCLME Cruises

The intention of this Data Management Agreement is to clarify and protect the interests of all scientists and countries. This Agreement is appended to the ToRs for all scientists that are working on the Nansen as part of the 2008 ASCLME Cruise Schedule.

Introduction

Participating countries in the ASCLME Project, and their designated representatives, have the mandate to develop a comprehensive document on principles and guidelines for ASCLME data and information management so that it facilitates the effective collection, use and dissemination of information in support of TDA/SAP development in the short term and the ecosystem approach in the long term. National Data and Information coordinators in particular, have a responsibility for developing mechanisms for reliable long-term storage and use of information collected under the ASCLME Project.

This Agreement is intended to govern the collection, storage and access to data on the ASCLME 2008 Cruises as an interim measure prior to agreement of a more detailed MoU on data access and management which is currently under development as part of the overall ASCLME Programme (particularly as a joint MoU between the ASCLME and SWIOFP projects and their respective countries). In this context, data collected will be shared freely between the ASCLME and the SWIOFP Project with due note being taken of SWIOFP's own MoU with each of its countries regarding Transboundary Marine Scientific Research in Support of the South West Indian Ocean Fisheries Project (SWIOFP). Nothing in this current agreement should jeopardise the ability of SWIOFP scientists on joint research cruises from abiding by their terms of agreement as specified in this SWIOFP MoU.

Bearing in mind that access to new data, associated metadata, information collection **activities and resulting products funded by the FAO/ASCLME Project** shall be free and unrestricted;

The primary owner of data sets shall be the UNDP GEF ASCLME Project, the FAO and the member-countries of the ASCLME Project, and the primary contact points and archive locations for ASCLME-generated data shall be at nationally appointed data centres as well as through the ASCLME Project Coordination Unit and the FAO.

The first right to publish findings from new data, associated metadata, information collection activities and resulting products funded by the ASCLME Project resides with the principal investigator

and her/his associated team (in the case of a scientific investigation), the participating country and the ASCLME Project and FAO.

These guidelines for intellectual property assume that adequate opportunity has been given to regional scientists to collaborate on research projects (data collection, processing and paper-writing), particularly from countries in whose territorial waters the research cruises have taken place.

Interim data management guidelines with specific reference to 2008 ASCLME/EAF-Nansen cruises

Detailed documentation will be made of all measurements and samples collected during each cruise. Documentation will include the cruise track, timing, geo-referenced and time-referenced records of every sampling site and station. All specimens and samples collected will be described and documented electronically during each cruise.

Wherever possible, duplicate or triplicate voucher specimens of macrofauna will be preserved.

The IMR Cruise Leader and the ASCLME Chief Scientist will be jointly responsible for ensuring the accurate documentation of activities, preservation of samples and backup of electronic data.

The primary custodians of data sets shall be the Institute of Marine Research, Bergen (on behalf of the FAO EAF-Nansen project,) the UNDP/GEF ASCLME Project and the member-countries of the ASCLME Project. The primary contact points and archive locations for the survey data shall be at nationally appointed data centres as well as through the ASCLME Project Coordination Unit. The intellectual property of new data, associated metadata, information collection activities and resulting products resides with the principal investigator (in the case of a scientific investigation), the Institution to which the scientist belongs, the participating countries, the ASCLME Project and FAO.

Timing of cruise data reports and products

Specimens

Morphological specimens which are preserved as voucher specimens will be fixed in formalin during the cruises. These will be transferred to ethanol after fixing, also during the cruises. At least one voucher will be lodged at each of:

1) the South African Institute of Aquatic Biodiversity in South Africa (SAIAB). This is an African collection where specimens will be preserved for the use and study by scientists throughout the region.
2) The National collection or National focal point institution for the ASCLME Project of the country from which the collection was made. This will ensure that countries also keep voucher collections. Where feasible, appropriate support will be provided by the ASCLME Project to the countries that do not currently have good capacity for specimen curation.

Specimens will be lodged at institutions *within three months of the conclusion of the 2008 cruises (18 March 2009)*

Electronic data from the cruises

A provisional cruise report and completed data report (containing documentation of all measurements and samples collected during each cruise, include the cruise track, timing, geo-referenced and time-referenced records of every sampling site and station) will be provided to the ASCLME PCU *within 21 days of end of that particular cruise*. It is accepted that biological samples may not be identified and sorted before the end of the cruises, but those data that are captured must be included in the report. Together with this, an electronic version (in Excel) of all activity/site/station records, and video & photographic inventories will be given to the PCU.

The provisional cruise reports and completed data reports will be made available to the ASCLME participating countries *within six weeks of the conclusion of the 2008 cruise schedule (21st February 2009).*

A final draft cruise report will be made within three months of the completion of the survey. The Cruise Leader and the Chief Scientist are responsible for finalising the report which will be distributed to ASCLME and FAO for final editing and approval. After approval this will be named the Final Cruise Report and will be printed and be available in electronic copies in pdf format.

Processed data from the cruises

A complete set of all processed data collected on the 2008 ASCLME cruises will be made available to the PCU *within three months of the conclusion of the cruise (18 March 2009).* Examples of these data will include CTD, ADCP, multibeam data sets, as well as inventories of identified specimens. It is recognized that some data sets may not be processed by this time. In that case, any raw electronic data must be provided to the PCU together with a report on the steps (and timing) that will be taken to process the data.

The provision of flagged (data to be published) data sets to the PCU will be safely retained offline until either

a) Chief scientists agree to the dissemination of data sets OR
b) Publications are submitted OR
c) Eighteen months has passed since the conclusion of the cruise, whichever is the soonest.

As soon as processed data sets are distributable, they will be lodged at nationally appointed data centres for the ASCLME.
Raw OR processed data collected by scientists under the ASCLME Project shall be immediately available to the Regional Information Working Group (made up of national D&I Coordinators) for the sole purpose of (*internally*, not for distribution) informing the TDA/SAP, should it be necessary.

Proposed time line for delivery of data products

During each cruise	All sampling activities are carefully documented, geo-and time-referenced.
	Voucher specimens are fixed.
Final day of the 2008 cruise schedule. 18 December	Provisional cruise reports, and final data report (containing a record of sampling activities) is delivered to the PCU. Electronic inventories are provided to the PCU.
After completion of the 2008 cruise schedule (ongoing)	Public domain data sets are reviewed, checked and made available to the PCU and National data centres.
Six weeks after that. 21st February	Provisional reports, and the final data reports are sent to ASCLME countries.
Three months from the conclusion of the 2008 cruise schedule. 18 March 2009	Voucher specimens are lodged at National Collections.
	All processed data (or raw data sets + report if not yet processed) provided to the PCU.
	Draft Final Cruise Report submitted to FAO and ASCLME
Eighteen months from the conclusion of the 2008 cruise schedule. 11th June 2010.	The last of the processed data sets are made available to National data centres.