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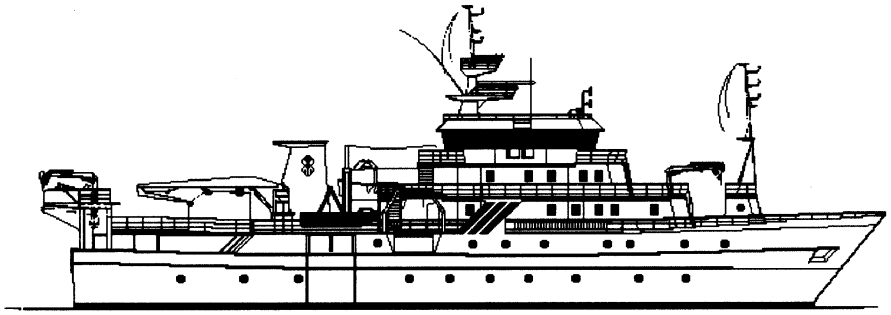
CRUISE REPORT DR. FRIDTJOF NANSEN



REGIONAL CO-OPERATIVE SURVEYS, SOUTH WEST AFRICA

Cruise Report No 3/96

Acoustic investigations of pilchard and sardinella schooling behaviour in Namibia and Angola

Part I and Part II

25 June - 13 July

Ministry of Fisheries & Marine Resources
Republic of Namibia

Sea Fisheries Research Institute
South Africa

Instituto de Investigação Pesqueiro
Republic of Angola

Institute of Marine Research
Norway

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ACOUSTIC INVESTIGATIONS OF PILCHARD AND SARDINELLA SCHOOLING BEHAVIOUR IN NAMIBIA AND ANGOLA

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Acoustic biomass survey of Clupeiformes in the northern Benguela using echo-sounder and sonar

Part II

Comparison of sonar and echo sounder density estimates of sardinella (*Sardinella maderensis* and *Sardinella aurita*) in Angolan waters.

by

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CHAPTER 1 INTRODUCTION

1.1 Background

The sardinella stocks are a major pelagic fish resource off Angola, and are mainly managed on the basis of biomass estimates of the adult stocks obtained by the standard hydro acoustic method. To acquire reliable absolute biomass estimates by this method, the entire stock must be surveyed by a vessel carrying a calibrated echo integration, regular sampling of the acoustic recordings must be conducted by trawling, the echo values originating from fish must be allocated to species identified by the trawling, and the echo intensity reflected from individual fish of the actual species must be known. If these criteria are fulfilled, the biomass of fish stocks can be estimated by the acoustic method with an accuracy of about 25 %.

However, there are several possible sources of errors in acoustic abundance estimation of fish. During the last two decades most methodological and technical problems related to the methods have been investigated and solved by introduction of reliable instruments and special procedures to calibrate the instruments. Still there are substantial concern of the effects of fish behaviour on acoustic abundance estimates. Especially if pelagic fish are schooling close to surface or performing vessel avoidance, substantial underestimation may occur.

Nevertheless, a horizontal guided sonar may be used to record schools that are vessel avoiding or occurring close to surface. The sonar should be of the multibeam type so that whole schools may be insonified for each ping, and recordings of schools should be done automatically by special software implemented in a computer that is connected to the sonar. To be able to convert the sonar recordings to fish biomass, relationships between the geometric dimensions or echo intensity of schools and school biomass must be established. At present a sonar that can measure the absolute echo intensity of schools is not developed, and the conversion of sonar recordings to biomass has to be done through relationships between the horizontal extent and biomass of schools.

1.2 Objectives

The main objective of this cruise was to investigate the possibility of using the sonar method to improve the reliability of acoustic abundance estimation of the sardinella resources of Angola. This was done by conducting comparative surveys by operating a multibeam sonar system with computer based school recording and a calibrated echo integration unit simultaneously. To convert the sonar recordings to fish biomass, relationships between the horizontal area and biomass of schools were established.

CHAPTER 2 METHODS

2.1 Hydrography

Wind (direction and speed), air temperature, global radiation and sea surface temperature (5 m) data were collected throughout the survey area and logged automatically every nautical mile using an Anderaa meteorological station. In addition, a Seabird 911 CTD plus was used to obtain a general overview and standard vertical profiles of temperature, salinity and oxygen at 12 stations. The profiles were taken from the surface down to within a few metres of the bottom. Current measurements were also made at these 12 stations as well as during the survey at times when the vessel slowed down sufficiently to obtain reliable readings. These measurements were made with the use of the ship born Acoustic Doppler Current Profiler (ADCP) from RD Instruments. All measurements were made at depths greater than 20 m and where bottom tracking was obtainable, i.e., at bottom depths less than 350 m. The ADCP was set to ping every 8 seconds, the depth cell was set to 4 m and the number of cells to 40. Transducer misalignment was kept at 0^0 and averaging time was 300 seconds. Only processed data files were stored to disk and current vectors were plotted for each data point.

2.2 Survey area

The DR FRIDTJOF NANSEN left Luanda on the 1 st of July 1996 at 17h00 and surveyed southwards. The survey area used for the comparison between echo sounder and sonar estimates was restricted to the area between Luanda and just south of Pta. Morro ($08^0$45' S to $11^0$20' S). A zig-zag grid with turning points spaced 10 NM apart was followed between Luanda and just north of Cabo Ledo ($09^0$50' S) whereafter a systematic parallel grid with an inter-transect spacing of 10 NM was surveyed south to $11^0$20' S. Throughout the survey the innermost turning point was at 20 m (or shallower, conditions permitting) and the offshore turning point was at the 200 m isobath. This corresponded to an average transect length of about 30 nautical miles and a total area of 4500 NM^2. After completion of the survey, the vessel returned to an area abundant in fish schools off Pta. Day Palmeirinhas ($09^0$10' S) to complete the

sardinella schooling behaviour experiments. Towards the end of the survey, another southward survey was done between Pta. das Palmeirinhas and Cabo Ledo to do trawling in areas where fish had previously been detected and to continue with shoal tracking experiments. The DR FRIDTJOF NANSEN then returned to Luanda on the 13 the of July at 13 h 00. The course track with the fishing and hydrological stations is shown in figure 1.

2.3 Acoustic sampling methods and data analysis

A description of the acoustic instruments and their standard settings are given in Annex I. Fish densities averaged over a distance of 5 NM were collected continuously using the EK 500 echo sounder throughout the survey. The mean integrator values were then allocated to various species or species groups on the basis of the species composition of trawl catches and echo trace characteristics. Further scrutinising of the data and omission of unwanted echoes (noise, plankton) was performed using the Bergen Echo Integrator (BEI). The integrator values were allocated to the following 4 groups of species:

- sardinella (*S. maderensis and S. aurita*)
- horse mackerel (*Trachurus trecae*)
- other carangids (mostly *Selene dorsalis*, *Trachinotus ovatus* and *(Chloroscombrus chrysurus*)
- other pelagics (scombrids, barracudas, and hairtails)

Integrator values obtained whilst conducting school measurements and trawling (against the course) were excluded from the data set. The rest of the S_A - values were then averaged within localised areas. The area of each localised fish distribution was then measured in NM^2 with the use of a planimeter.

In the absence of other reliable target strength values, the following target strength function of the North Sea herring was applied to convert S_A-values (mean integrator value for a given area) to biomass of fish:

$$TS = 20 \log L - 72 \text{ [dB]}$$

where the total length of the fish, L is expressed in centimetres.

Although this target strength to size relationship has been used for a number of fish species (horse mackerel, pilchard, anchovy and sardinella), it is probably not ideal for some of the species encountered during this survey such as some of the laterally compressed carangids. For the purposes of solely comparing sonar and acoustic relative density estimates it should, however, not have an effect on the accuracy of these measurements.

As the purpose of this survey was not to produce a reliable biomass estimate of the fish resources of Angola, but rather to do shoaling behavioural studies, the integrator values were not split up into numbers of fish per length class as was the case in previous surveys. This would also have been misleading due to the large variations in total length of the various species. Instead a mean length of each species or species group was calculated and used to convert S_A-values to total number of fish through the following conversion formula:

$$N = S_A * A * C_F$$

where N = number of fish

A = area in ~~NM^2~~ nmi^2

and

$$C_F = 1.26*10^6 * L^{-2}$$

where L = mean total length of fish

The number of fish for each localised fish distribution was then summed for each

species or species group to obtain a total number of fish for each species or species group in the entire survey area. The total number of fish per species or species group was then multiplied by the mean weight of the species or group to obtain a biomass in tonnes.

2.4 Sonar recordings

The Simrad SA950 sonar was operated continuously throughout the survey. The sonar was directed 90^0 to either port or starboard and the maximum detection range was set at 300 m. The sonar was set to full transmission power, gain step 6 - 7, display gain 8 - 9, and with the AGC, Normalization and Ping-to-Ping filters set to step weak. The tilt was kept from - 3° to - 8° depending on the bottom depth and surface reverberation. To detect and measure schools recorded by the sonar, the school detection programme on the HP work station was run continuously, and with the following settings; min range 25 m, max range 300 m, threshold 15, min interval 8, min width 10, min gap 5, detection window 30, detection counts 4.

The sonar recordings were analysed by a programme written in the SAS-software. For each school, the maximum school area was identified, and the number of schools and maximum school areas summed for five nautical mile intervals. According to the species composition in the trawl catches, the school size, and the relative density, the school recordings were allocated provisionally to pelagic mix. The pure clupeoid schools were typically larger and denser than those containing a mix of pelagic species.

2.5 Trawl sampling strategy

Trawls were targeted on unidentified dispersions or shoals of fish that were detected by the EK500. A random sample of fish representative of the total catch was taken from the trawl, the size of the sample depending on the size of the catch. In cases where the catch was small, the total catch was sampled. To determine the catch composition of the trawl the number and weight for each species in the random sample was recorded. This sample was then raised to the total catch. A random

sample of about 100 fish, if available, were measured to the nearest 0.5 cm below total length to obtain the size composition of the catch. The size and species composition of all trawls was pooled per area by simple adding. The species composition of fish recorded for the comparative biomass survey was calculated only from the trawls done during that time interval and did not include later trawls done to identify shoals during the school measurement, school tracking and small boat experiments.

In many cases, especially during trawling on discreet shoals, the SA950 sonar was used to guide the vessel onto shoals. It was also possible to track the path of the shoals after passing underneath the vessel and in the direction of the trawl so as to ascertain whether any trawl avoidance was occurring. In total 33 trawls were done during the entire cruise and their positions are indicated in figure 1.

2.6 School measurements

To make a representative quantification of the structure of fish schools occurring near surface off Angola, the following strategies were applied. A regular acoustic abundance estimation survey using both a horizontal guided, multibeam sonar, and conventional echo integration was performed. When an area with frequent recordings of schools both at the sonar and the echo sounder were encountered, the regular survey was stopped for conducting special acoustic measurements of the schools in the area. The speed of the vessel was reduced to 5 - 8 knots, and when the sonar detected distinct schools in front of the vessel, the vessel was turned as precisely as possible to pass directly over the school. The school detection program connected to the sonar was operating continuously, and both the sonar and the school detection program was operating with the same settings as during the regular survey. When a selected school was recorded by the school detection program, the school number given by the detection program was noted on the sonar echogram so that the actual school could be identified during postprocessing of the sonar data. If the vessel was successfully manouvered over the school so that it was recorded on the echo sounder, the same school number was also noted on the echo sounder echogram. The sonar recordings where then analysed by a program written in the SAS software to find the

maximum area (A) of the selected schools when being recorded from 75 m to 300 m in front of the vessel. The S_A-value of the selected schools was found by delimiting the schools by the school box option when postprocessing the echo sounder recordings by the BEI-system. The vertical extent (H), average depth (D) and recorded transect length (TL') of the selected schools recorded by the echo sounder were then measured by a ruler on the echogram and scaled to real dimensions. The transect length (TL) was then corrected for the beam pattern by the equation:

$$TL = TL' - 2 * D * (\tan (\varphi/2)) \quad (m)$$

where φ is the beam width (-3 dB points) of the echo sounder.

The fish density (ρ) of the schools was found by the equation:

$$\rho = S_A/(4\pi * \sigma * 1852 * TL * H) \quad (n\ m^{-3})$$

where $\sigma = 10^{(20 \log L - 72)/10}$, and L is the average length of the fish in the schools. The volume (V) of the schools was estimated by assuming and ellipsoid shape and using the equation:

$$V = 4/3 * \pi * A * H/2 \quad (m^3)$$

Finally, the biomass of the schools was found by multiplying the volume, fish density, and average weight of the fish in the schools.

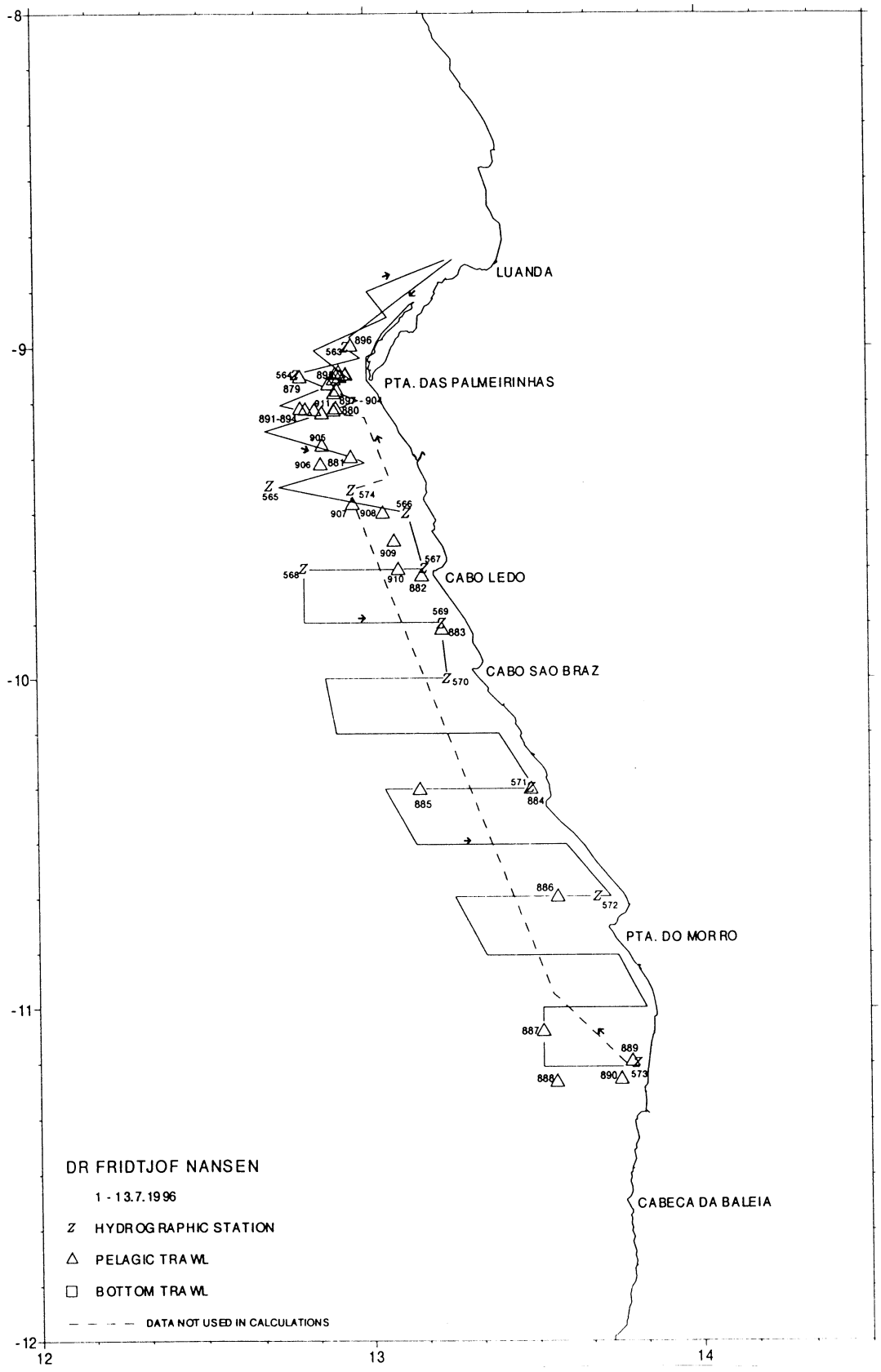


Figure 1. Course track, fishing stations and hydrographic stations.

2.7 School tracking

To study the swimming behaviour of pelagic, schooling fish off Angola, it was attempted to track selected schools for a longer period. The observation strategy was then to let the vessel approach a selected school as gently as possible until the school was at a distance of about 150 m, and then stop carefully. The vessel was then manouvered carefully to keep the school within a distance of 100 to 250 m. If the school came closer the vessel was stopped. During the tracking the sonar was trained and tilted to obtain an optimal recording of the school. When a tracking situation was established with the school in a rather stable distance from the vessel, the school detection program was started, and given the same settings as during the survey. The sonar data for the actual tracking was logged to a separate file. A reporter followed the school tracking together with a sonar operator, and filled out a record on the events that occurred to the school. A drawing of the outline of the school was made each time the school changed shape significantly. The tracking was stopped when the school disappeared or had lasted for more than one hour. On one occasion a school was tracked for more than one hour. The sonar recordings of tracked schools will be analysed by programs written in the SAS software to visualize the swimming behaviour of the schools, and quantify the swimming speed and swimming direction of the schools.

2.8 Small boat experiments

A set of 7 experiments using a small (5.3 m) man - over - board boat equipped with a portable scientific echo sounder (Simrad EY500) were conducted to study near-surface schooling and vessel avoidance. A complete list of the boat and echo sounder specifications and settings used is shown in Annex II.

All seven surveys took place in the same area (west of Pta. das Palmeirinhas) in an area of abundant sardinella schools. During each experiment the small boat kept a parallel course with the DR FRIDTJOF NANSEN. A constant speed of 4.5 or 5 knots (depending on conditions) and an inter-vessel spacing of 0.3 NM was maintained. Synchronised intervals of equal length (1 NM) were surveyed by both vessels. The

SA950 sonar onboard the DR FRIDTJOF NANSEN was directed 90^0 to starboard (directly at the small boat).

Three of the experiments were conducted during daylight hours and totalled a distance of 22 nautical miles. The remaining four surveys were done during darkness and totalled a distance of 25 NM, although only 20 NM of data were of value due to problems with data storage on the EY 500 during one of the experiments. The EY500 was set to record from a depth of 5 m down to the bottom and the EK500 from 10 m down to the bottom. Each interval was printed out in 10 m vertical channels. The data collected by the EK500 were scrutinised on board using the BEI processing software to exclude plankton and to allocate S_A values to the various species. The data collected by the SA950 sonar were also processed on board and number of schools and area of schools per NM^2 was calculated. The scrutinising of the EY500 data will be done at the Institute of Marine Research in Bergen.

CHAPTER 3 RESULTS

3.1 Hydrography

Throughout the survey, weather conditions were calm with relatively little or no wind. Typical wind speeds throughout the survey never exceeded 10 knots. The sea surface temperature varied substantially within the survey area (figure 2). In the southern part of the survey area inshore temperatures were as high 24^{0}C whilst in the north closer to Luanda inshore surface temperatures were only around 21^{0}C. In the south the temperature gradient was very low in the offshore direction only increasing by a degree to 25^{0}C at a distance of 40 NM from the coast. A relatively steeper temperature gradient existed at around 10^{0}00' S where a 2 degree difference was noted within a distance of 10 nautical miles. In general the temperatures appear to be normal when compared to conditions observed during previous surveys.

Vertical profiles of temperature, salinity and oxygen of a few selected stations are presented in figure 3. Generally a layer of warm surface water (> 20^{0}C) was observed in the upper 20 m of the water column and then decreasing gradually with depth with a well developed thermocline present. As can be expected the corresponding oxygen profiles showed little difference between stations and a layer of high oxygen (> 4 ml/l) was found in the upper 20 to 30 m and then a sudden decline down to about 70 m. Salinities at the surface were relatively high (in excess of 35.5 psu) and showed little change with depth. Overall the hydrographic regime seemed normal when compared to previous years.

Current measurements made by the ADCP were plotted at a depth of 26 m (1st reliable depth bin) and are indicated in figure 4. Generally a very weak flow not exceeding 0.1 m.s-1 was observed close inshore with the flow generally being of a southerly direction south of Cabo Ledo and north to north westerly inshore north of Cabo Ledo. Further offshore current speed accelerated to a maximum of 0.6 m.s-1 with most flow being in a southerly direction.

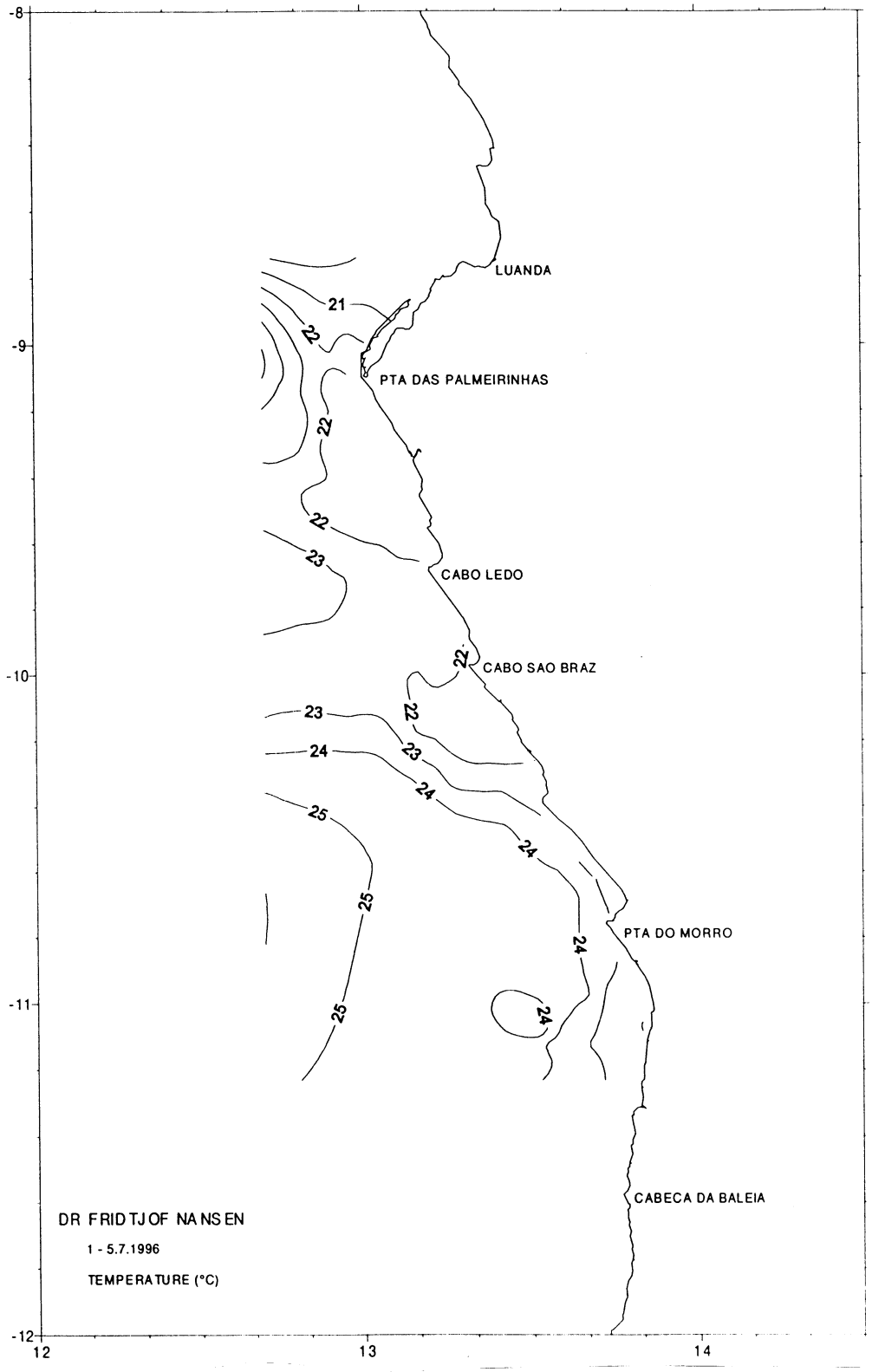


Figure 2. Sea surface distribution maps recorded at a depth of 5 m.

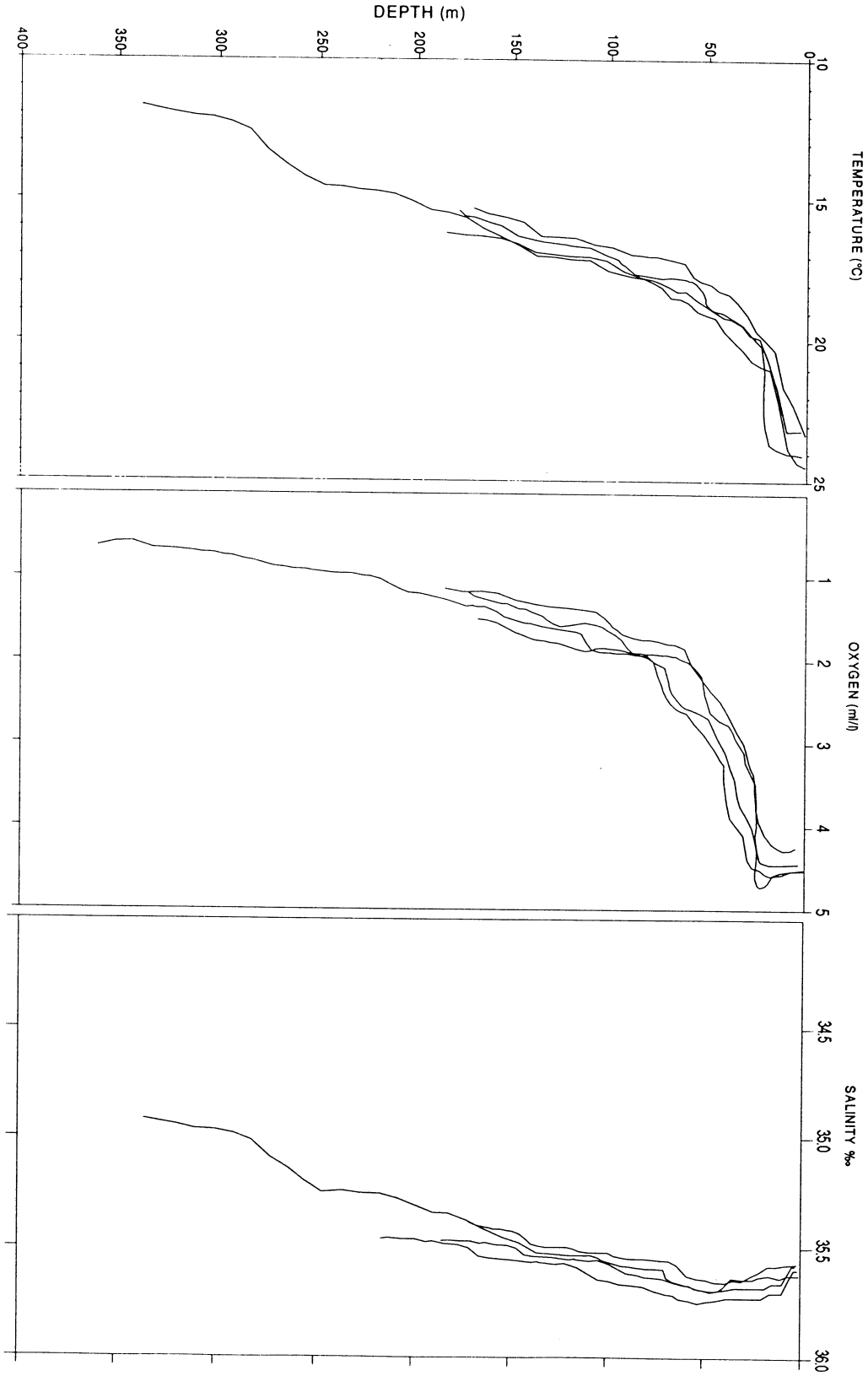


Figure 3. Vertical profiles of temperature, oxygen and salinity.

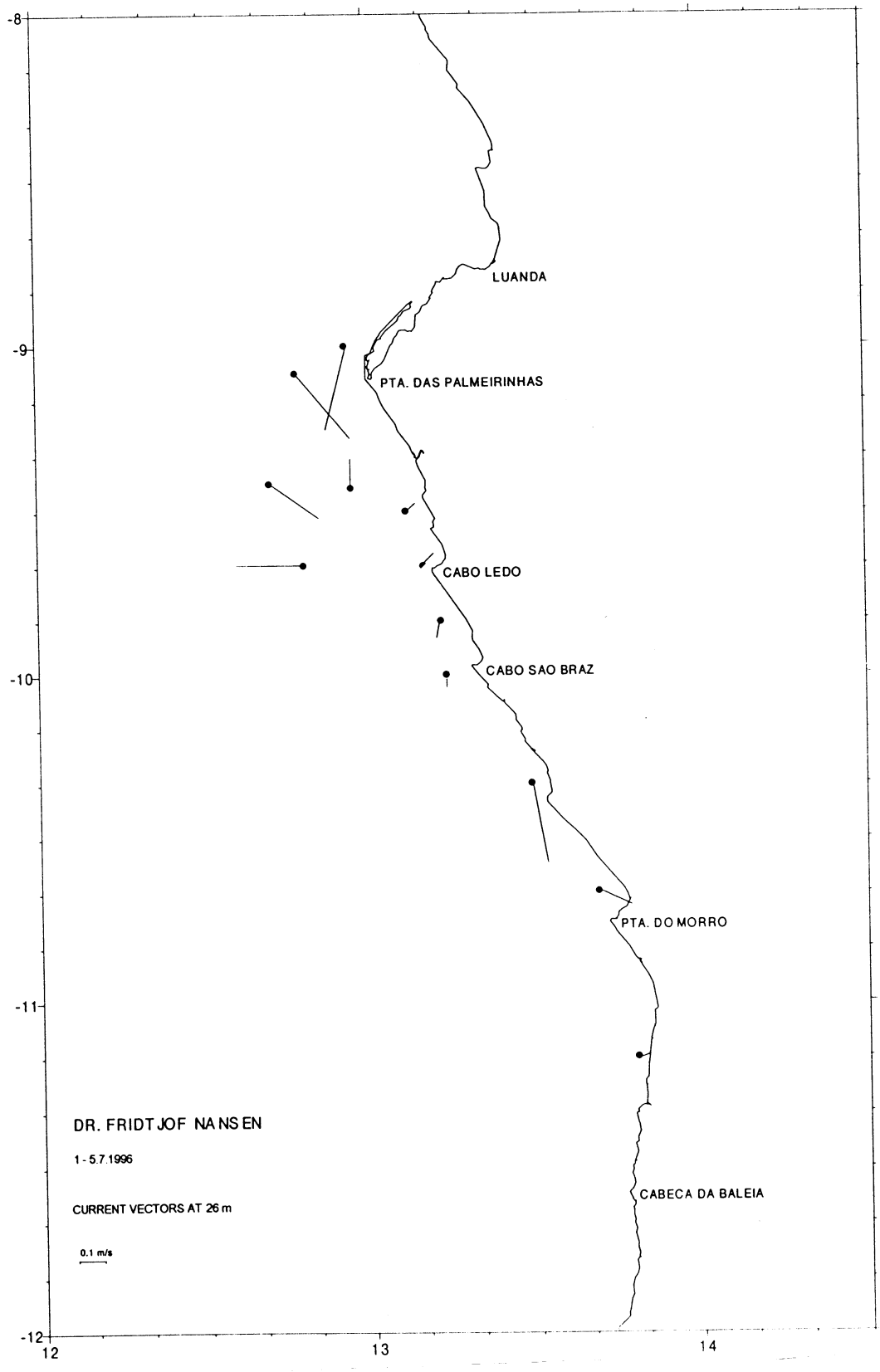


Figure 4. Current vectors as measured by the ADCP at a depth of 26 m.

3.2 Survey area and distribution

The distribution of pelagic fish as observed during the survey isa shown in figures 5a-d. As this was not intended to be a routine biomass estimate, it is important to note that this is not the entire distribution of pelagic fish in the region, but merely in the area covered. The distribution of the pelagic fish in the survey area was very complex as the number of species is so vast. In addition they exhibit various changes in behaviour, thereby making it very difficult to assign density values to individual species on the basis of echo characteristics. Furthermore, they are extremely fast swimmers which made it virtually impossible to catch any large shoals in the trawl during the survey, thereby further diminishing the chances of accurate and reliable species identification. The only reasonable way of partitioning the densities between species was therefore to pool the trawls done within an area and calculate a mean species composition. The result of this was that the distribution maps of all the species groups is very similar in most areas and less patchy than would normally be expected with dense shoaling species such as sardinellas.

The vertical distribution of the various pelagic species also varied greatly with the sardinellas and probably some of the carangids forming schools during the day and dispersing close to the surface at night. The sardinella schools during the day were generally also very close to or at the surface and could often be seen performing skimming movements across the surface at great speed. Surface school counts performed during 4 days of the survey revealed that shoals were seen in large numbers at the surface throughout the day (figure 6). In contrast the horse mackerel shoals seemed to be deeper in the water column during the day, often close to the bottom. At night the horse mackerel dispersed together with the other pelagic species just below the surface.

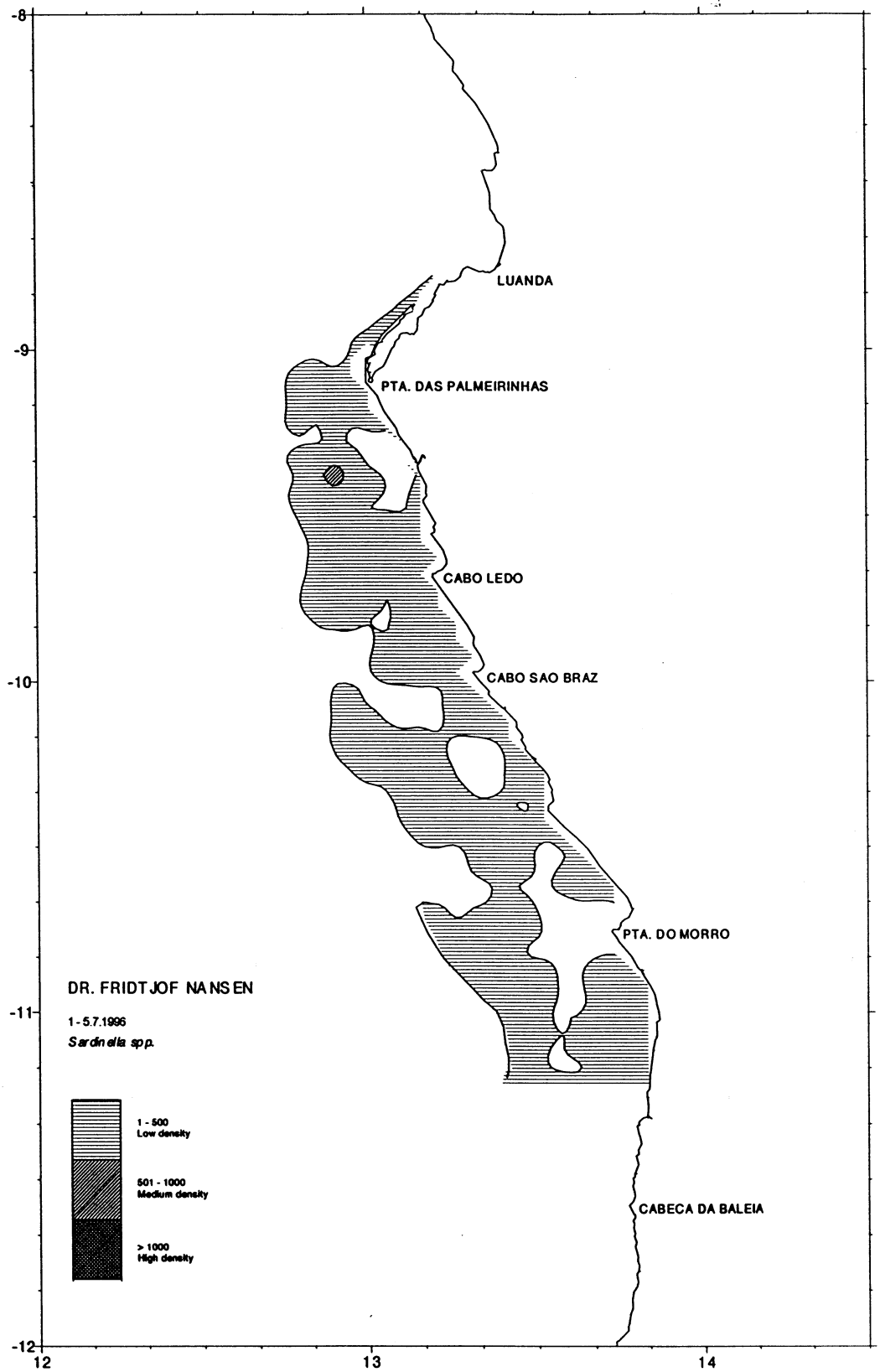


Figure 5a. Distribution and relative abundance of *Sardinella maderensis* and *Sardinella aurita.*

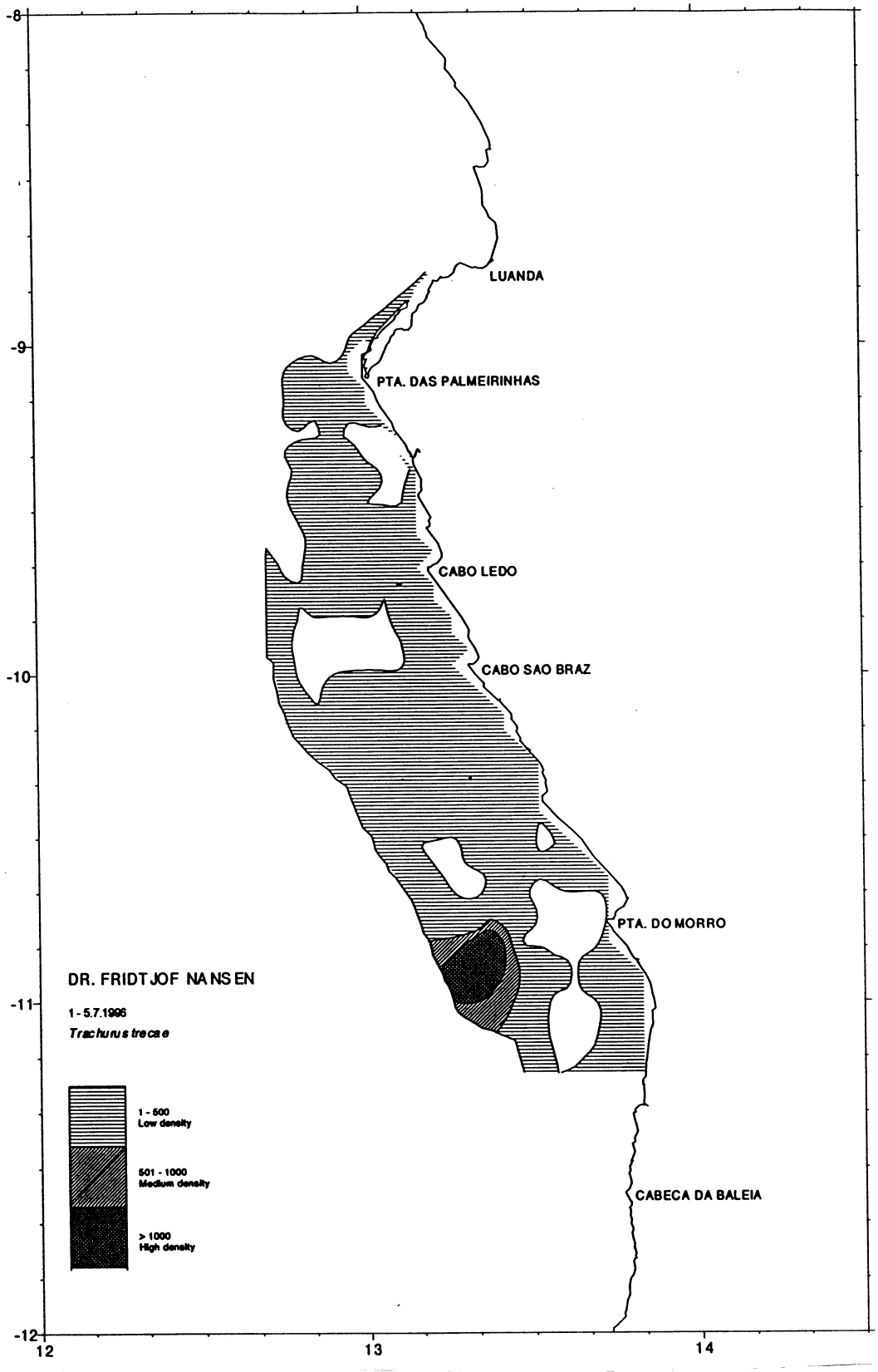


Figure 5b. Distribution and relative abundance of horse mackerel (*Trachurus trecae*).

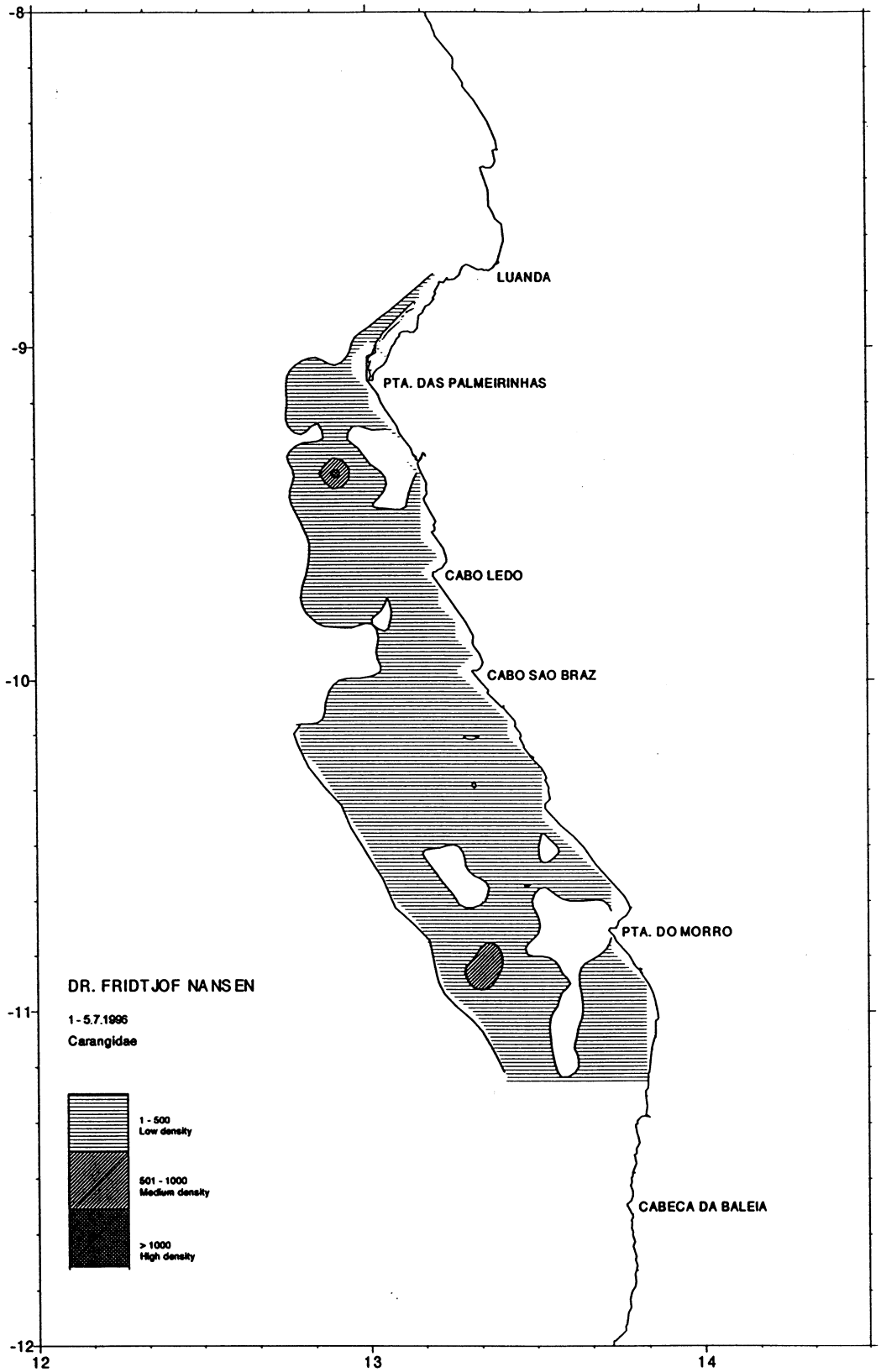


Figure 5c. Distribution and relative abundance of all other Carangidae.

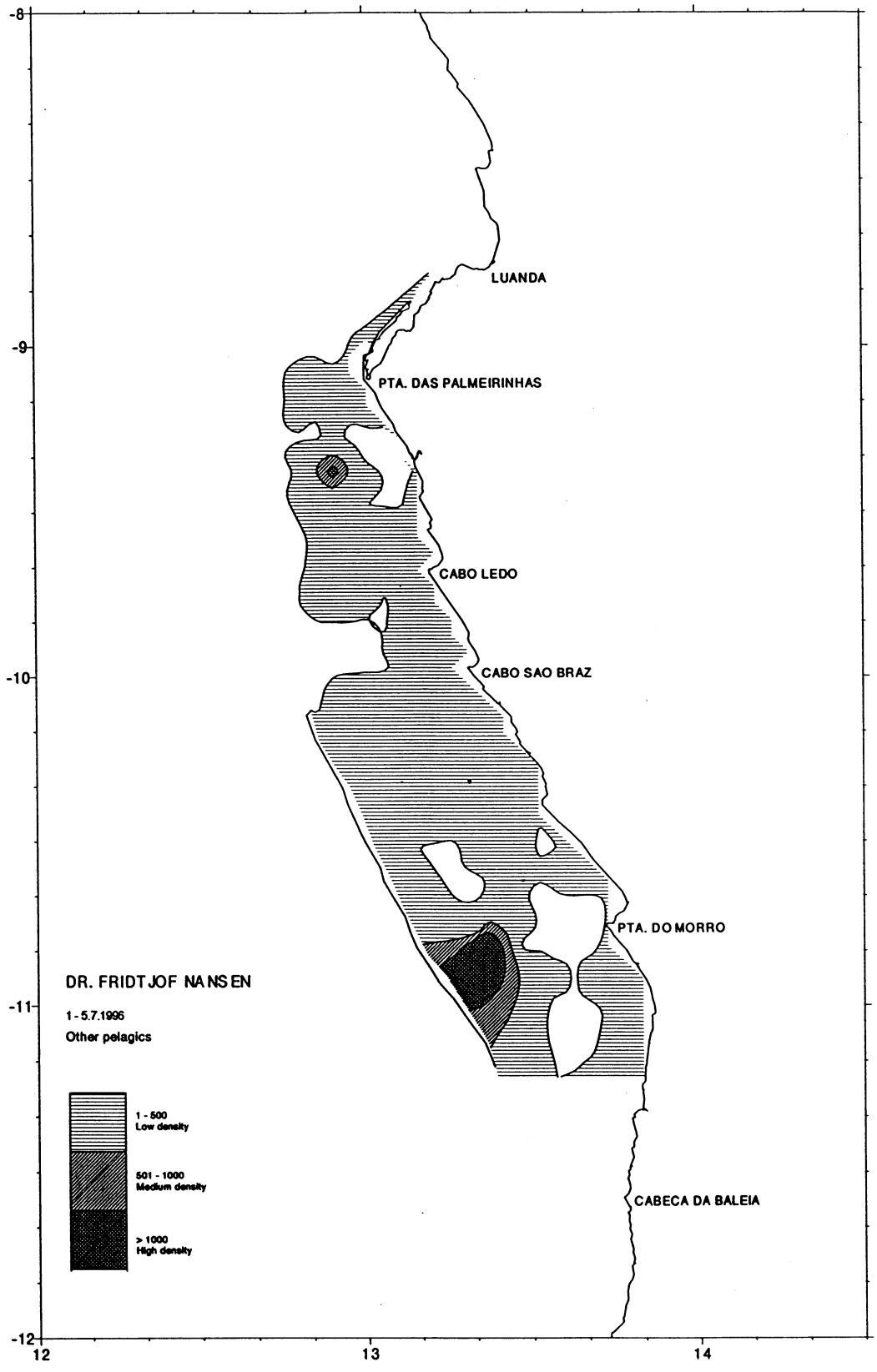


Figure 5d. Distribution and relative abundance of all other pelagic species.

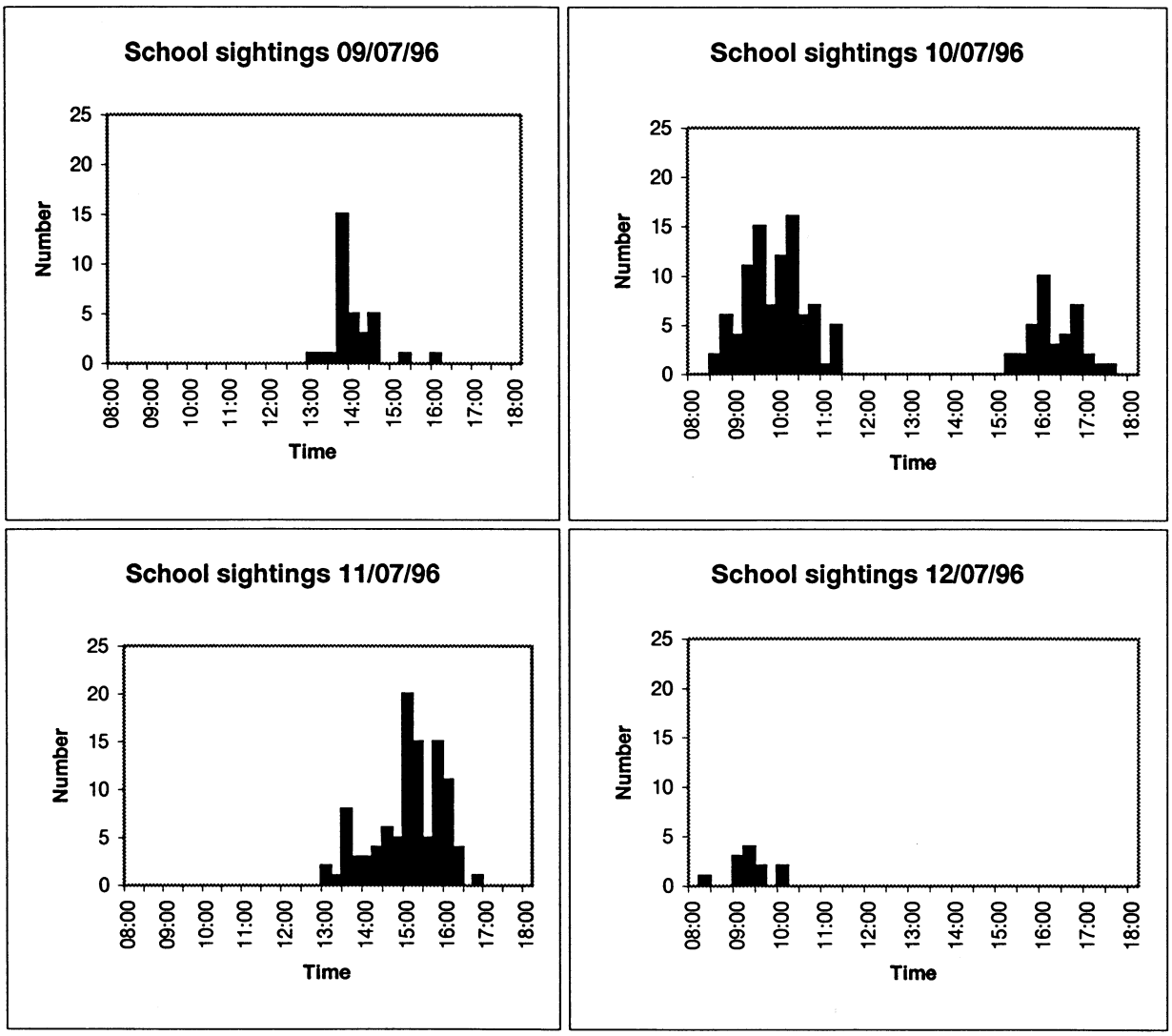


Figure 6. Frequency of surface school observations on four consecutive surveys.

3.3 Abundance

The EK500 results of the survey to compare the fish densities recorded by echo sounder and sonar are presented in Table 1. The total biomass recorded for all pelagic fish in the survey area was approximately 250 000 tonnes. Of this total, the highest biomass was allocated to other pelagic species, although it is possible that a large part of this biomass was in fact sardinella. The highest sardinella biomass was recorded in the area between Luanda and Cabo Sao Braz, with very little being recorded further south. Horse mackerel were, however, more abundant in the area between Cabo Sao Braz and Pta. do Morro. The area north of Cabo Sao Braz ($10^0$00') was dominated by other carangids and pelagic species.

Table 1 Biomass estimates obtained by the EK500 for the various species/species groups as observed during the comparative biomass survey. Biomass in tonnes per degree latitude.

Latitude (°S)	*Sardinella* sp	*Trachurus trecae*	Other Carangidae	Other pelagics	Total
09°00' - 10°00'	36 500	4 500	40 000	42 000	123 000
10°00' - 11°00'	1 200	55 000	20 000	59 000	135 200
11°00' - 12°00'	700	300	1 400	200	2 600
Total	38 400	49 800	61 400	101 200	250 800

3.4 Comparison of sonar and echo integration estimates

To compare the echo integration and sonar recordings, the number of schools and summed maximum school area were merged with the BEI-report containing the S_A - values allocated to each species at five nautical mile intervals. The number of schools and summed maximum school area were then scaled to one square nautical mile. To enable a comparison of echo sounder and sonar recordings, the S_A-values allocated to pelagic fish, the number of schools and summed maximum school area were all assumed to be sardinella.

The S_A - values allocated to sardinella were then converted to fish density (ρecho) using the equations;

$$\rho echo = (S_A / \sigma) * w/1000 \qquad \text{(tonnes n. mi}^{-2}\text{)}$$

where

$$\sigma = 4\pi * 10^{(20 \log L - 72)/10}$$

The average length (L) of the sardinella was 29.5 cm, and the average weight (w) was 0.295 kg. The summed maximum school area was converted to fish density (ρ_{sonar}) using the equation;

$$\rho_{sonar} = ((\text{summed school area}) * 4.6)/1000 \qquad \text{(tonnes n.mi}^{-2}\text{)}$$

This relationship was established by sonar measurements and echo integration of selected schools recorded during the survey.

Significant sardinella recordings were found within a limited area south of Ponta das Palmeirinhas between 9° and 10° south. This region was surveyed twice, southwards from vessel log 1800 to 2000, and northwards from vessel log 2500 to 2615. The first coverage was made mainly in darkness at night, the second mostly in daytime. In the first coverage there was little correspondence (Figure 7) and no correlation ($r = 0.03$, $p > 0.05$) between the density of sardinella as recorded by echo sounder or sonar. The average density of sardinella as recorded by the echo sounder or the sonar during the first coverage was 104 tonnes n mi^{-2} and 128 tonnes n mi^{-2}, respectively, but not significantly different (Wilcoxon test, $p > 0.05$). In the second coverage there was also no correspondence (Figure 8), and no significant correlation ($r = 0.26$, $p > 0.05$) between the density of sardinella as recorded by echo sounder or sonar. The average density of sardinella as recorded by sonar was about 10 times that recorded by the echo sounder, or 250 and 21 tonnes n mi^{-2}, respectively.

SARDINELLA RECORDINGS, 1ST COVERAGE, ANGOLA, JULY 96

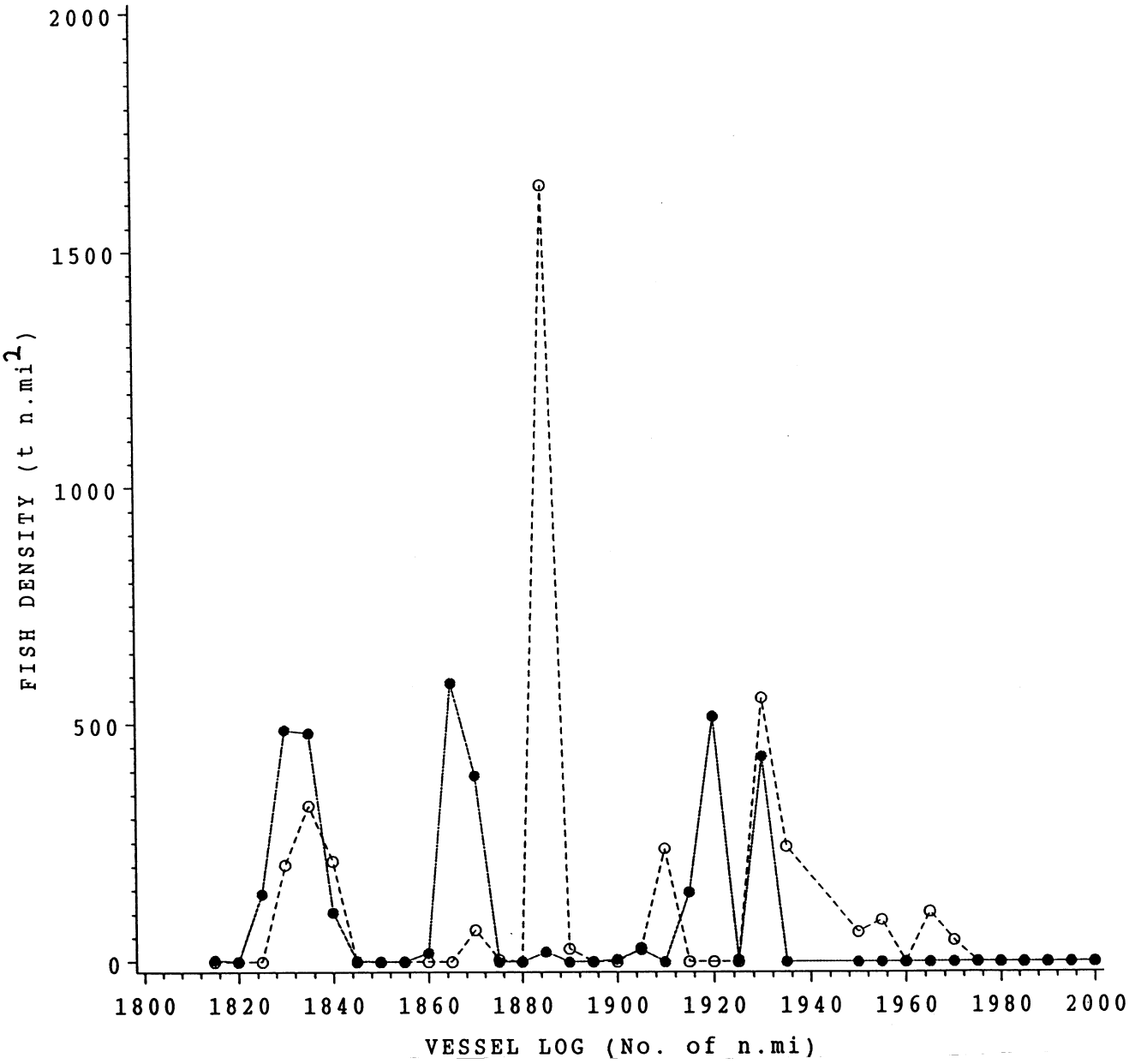


Figure 7. Comparison of fish density as recorded by echo sounder and sonar during the 1st survey. (Solid lines = sonar recordings, broken lines = echo sounder recordings).

SARDINELLA RECORDINGS, 2ND COVERAGE, ANGOLA, JULY 1996

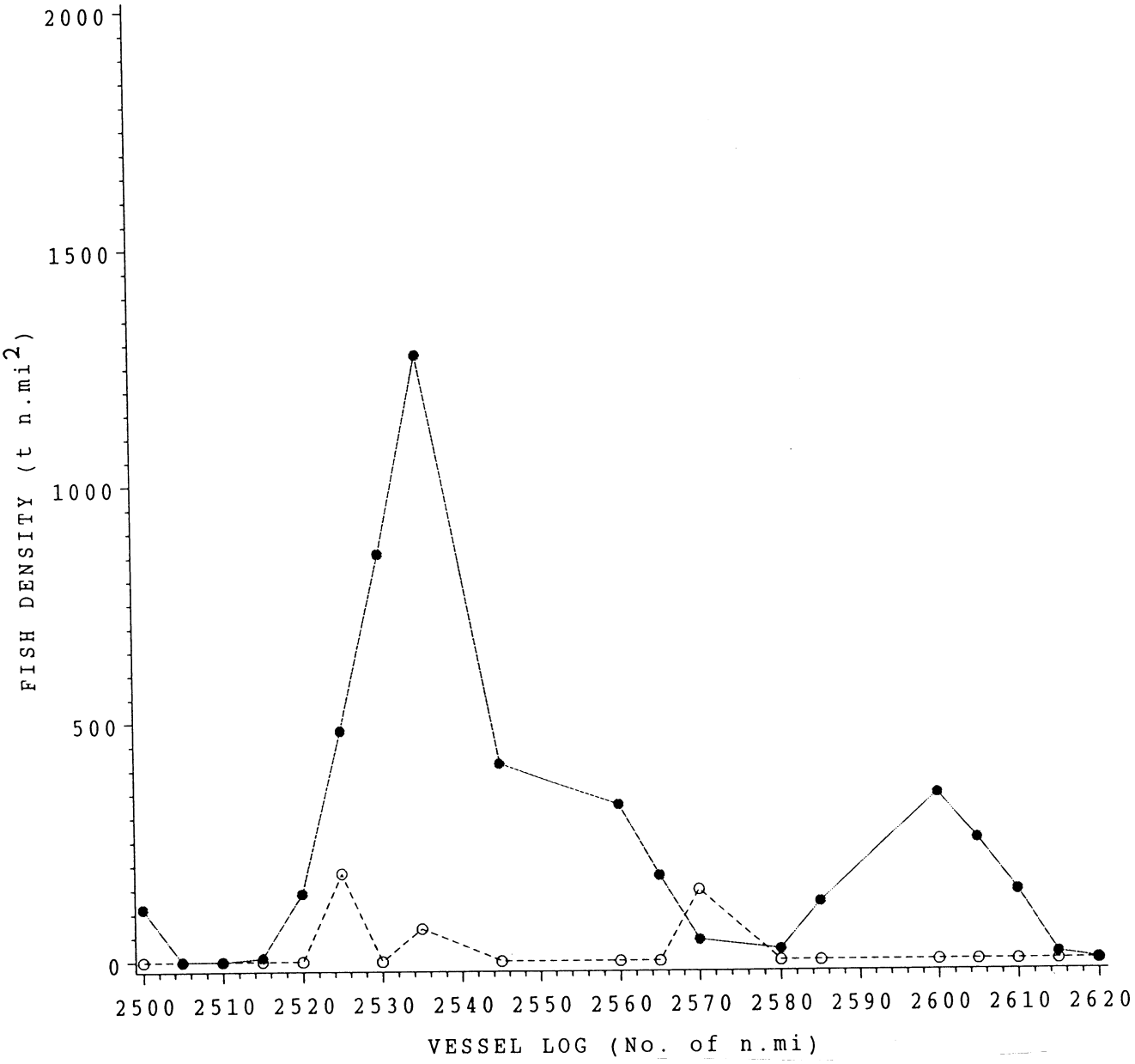


Figure 8. Comparison of fish density as recorded by echo sounder and sonar during the 2 nd survey. (Solid lines = sonar recordings, broken lines = echo sounder recordings).

3.5 Trawl sampling, species composition and length-frequencies

The details of all the trawls done during this survey are shown in Annex III. A total of 33 trawls were done for the purposes of target identification and length frequency measurement. Of these only the first 20 trawls were used to assign density values to the various species. A summary of the species composition of these trawls is shown in table 2. The remaining trawls were done so as to identify shoals observed during school measurement and school tracking exercises and to gain an improved understanding of the shoaling dynamics of the observed fish concentrations.

More trawls were done in areas of high fish abundance and as a result most of the trawls were done in the area north of Cabo Ledo ($08^0$50' S - $09^0$00' S). As most of the fish seemed to be distributed inshore of the 100 m isobath, only 6 of the trawls were done further offshore of 100 m bottom depth. Approximately equal amounts of trawling was done in the region between 50 and 100 m bottom depth and inshore of 50 m bottom depth (figure 1).

Table 2. Species composition used to assign Sa values to species in different areas.

LATITUDE	TRAWL No.	N	COMBINED SPECIES COMPOSITION (%)			
			Sardinella sp.	*Trachurus t.*	Other CARANGIDAE	Other pelagics
$8^0$30 - $10^0$00	879 - 883 891 - 899	13	24	4	35	37
$10^0$00- $11^0$00	884 - 886	3	0.7	41	15	43
$11^0$00- $12^0$00	886 - 890	4	21	12	58	10
Total		20	15	19	36	30

The majority of the trawls (26) done were at the surface or very close to the surface with buoys attached to the headrope of the trawl. This was as a result of the near surface shoaling of most of the species, both during the day and during the night. Technical details regarding the towing speed, headrope depth, vertical opening and duration are shown in Annex IV.

Large trawl catches resulted mainly from trawling on dispersed targets close to the surface for a long duration (±1 hour). Trawls targeting on dense shoals (presumed to be sardinella) in most cases failed to catch large shoals. On many occasions large shoal traces were seen on the net sonde recorder for long periods of time. It is presumed that these fast swimming fish were able to maintain a speed equal to that of the towing speed for long durations. Trawling for longer periods of time seemed to alleviate this problem temporarily and the fish then dropped back in the trawl and disappeared from the net sonde recording. On many occasions, however, these fish then reappeared on the net sonde recording as soon as the trawl started to be hauled in, probably as a result of the slower vessel speed during hauling of the trawl. It is therefore presumed that large schools of fish (most likely sardinella), escaped from the trawl on many occasions.

Experiments with faster towing speed, up to nearly 6 knots, failed to improve the catch ability of large shoals of fish. Trawl avoidance was also observed by way of the SA950 sonar. This was done by directing the sonar back towards the trawl doors after passing over a shoal and then tracking its path towards the trawl. Although this did not give an indication of the vertical aspect of the fish passage, it was possible to observe whether schools actually passed between the doors or avoided to the outside of the doors. Recordings of vertical trawl avoidance (mostly diving under the trawl) were obtained by way of the net sonde. Shoals that were at trawl depth as the vessel passed over were often observed far below the footrope of the trawl.

Further analysis of the trawl catches (figure 9) revealed that during the day Sardinella were caught both inshore and further offshore, whilst at night they were only caught inshore. During the day , most species were abundant in the inshore areas except for

horse mackerel which was caught further offshore. The only fish caught far offshore at night was other pelagics, of which myctophids made up the bulk of the samples. At night the proportion of horse mackerel in the inshore areas increased substantially.

It can also be seen that the most sardinella catches were made in the afternoon and night and not as many in the mornings. All species were well represented in the catches made at night.

When the species composition of the catches at different depths are split up into areas, it is clear that except for other pelagics (mostly myctophids), no other species were abundant further offshore than the 100 m isobath in the area north of $10^{0}00'$ S. All species were abundant in inshore areas although in the area south of $10^{0}00'$ S, other pelagics and carangids dominated. Horse mackerel was also mainly found further offshore in the southern area.

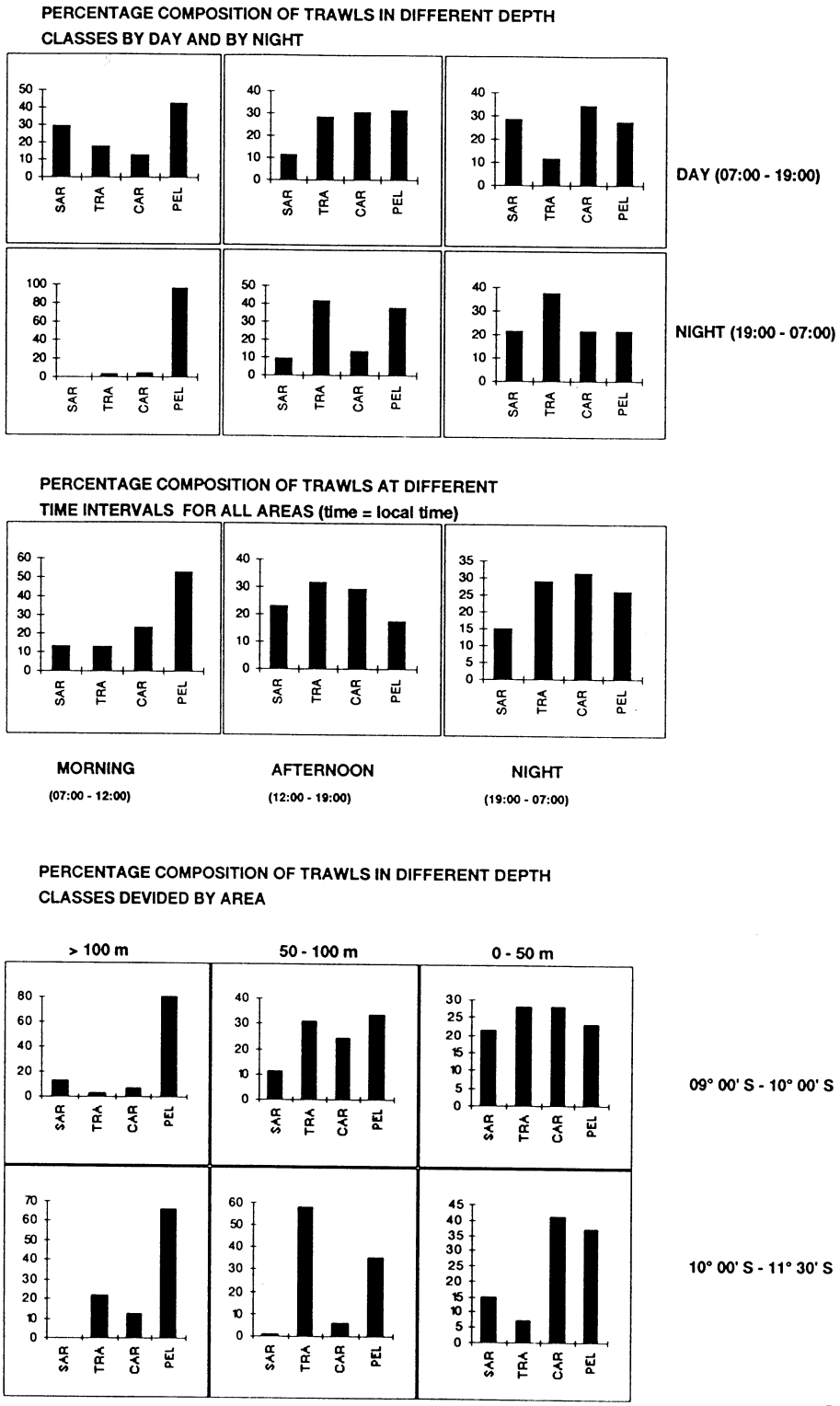


Figure 9. Analysis of trawl catch data by area, species, time of day and depth.

3.6 School measurements

Altogether 96 schools were measured by sonar and echo sounder during the survey in Angola. Most schools were measured off Ponta das Palmeirinhas, but schools were also measured off Cabo Ledo and off the city of Sumbe between Punta Do Morro and Cabeca da Baleia.

The schools measured were distributed at a depth from 11 to 35 m (average depth 17 m), and the area of the schools varied from 33 to 1777 m^2 (average area 504 m^2). The vertical extent of the schools averaged 6.5 m, and varied from only 1 m up to 25 m.

Assuming that all schools measured were sardinella with a mean length of 29.5 cm and a mean weight of 0.295 kg (average length and weight of sardinella in 17 of the trawl samples), the fish density in the schools varied from minimum 0.1 fish m^{-3} to maximally 11.8 fish m^{-3} (Figure 10). The average density of the schools was 2.8 fish m^{-3}, which is remarkably similar to the average fish density in herring schools on the northern hemisphere. The estimated biomass of the schools varied from about 10 kg to about 20 000 kg.

The biomass definitely increased with an increase in the area of the schools (Figure 11). This relationship is expressed through a significant regression ($r2 = 0.60$, $p < 0.05$) between the area and biomass of the schools which follow the equation:

$$\text{School biomass} = 4.6 * (\text{School area}) \qquad \text{(kg)}$$

The relationship between schools area and school biomass is additive and can therefore be used to convert summed school area per nautical distance as measured by sonar to fish density per nautical distance. The relationship established was therefore used when converting summed school area per five nautical mile to fish density per five nautical mile for the comparison between the sonar and echo sounder recordings described in section 3.2

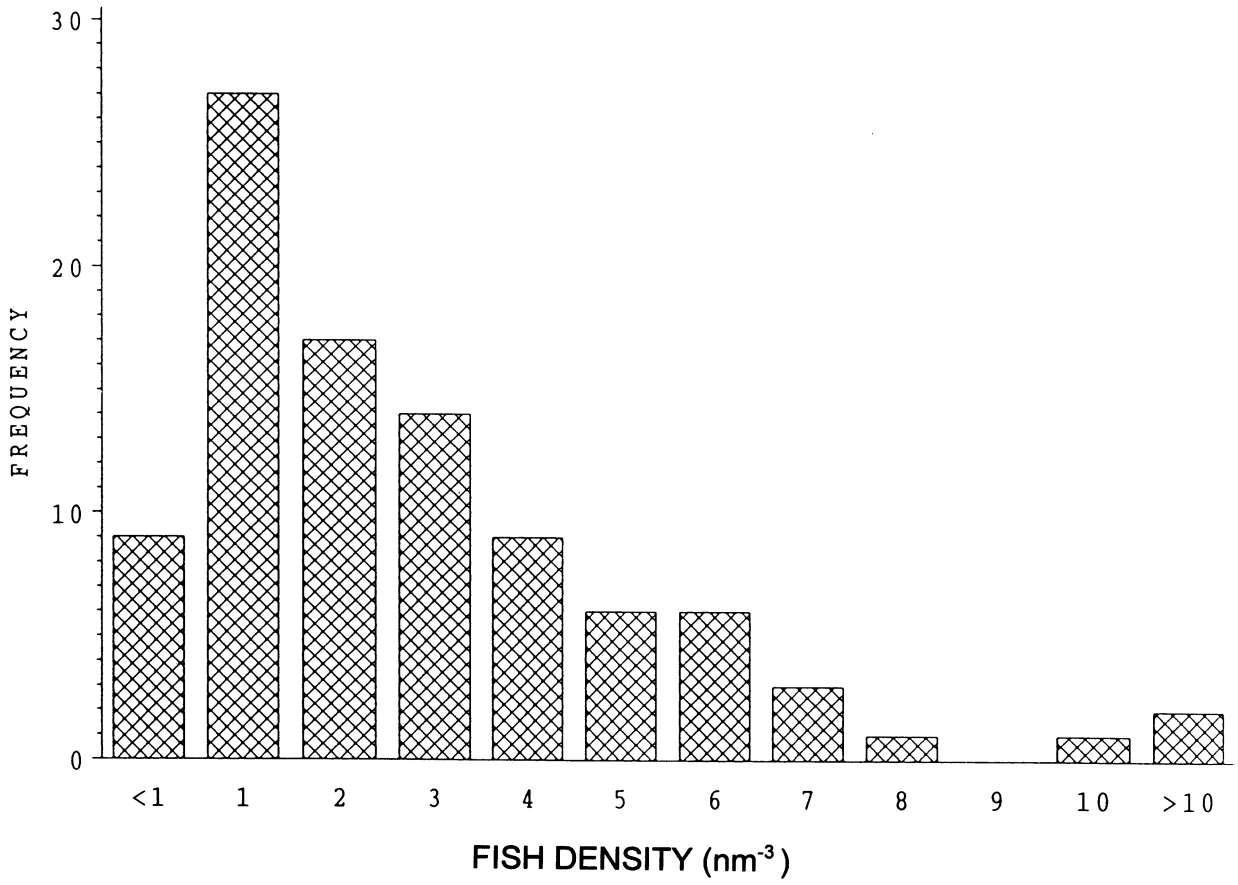


Figure 10. Frequency distribution of fish density per NM^{-3}.

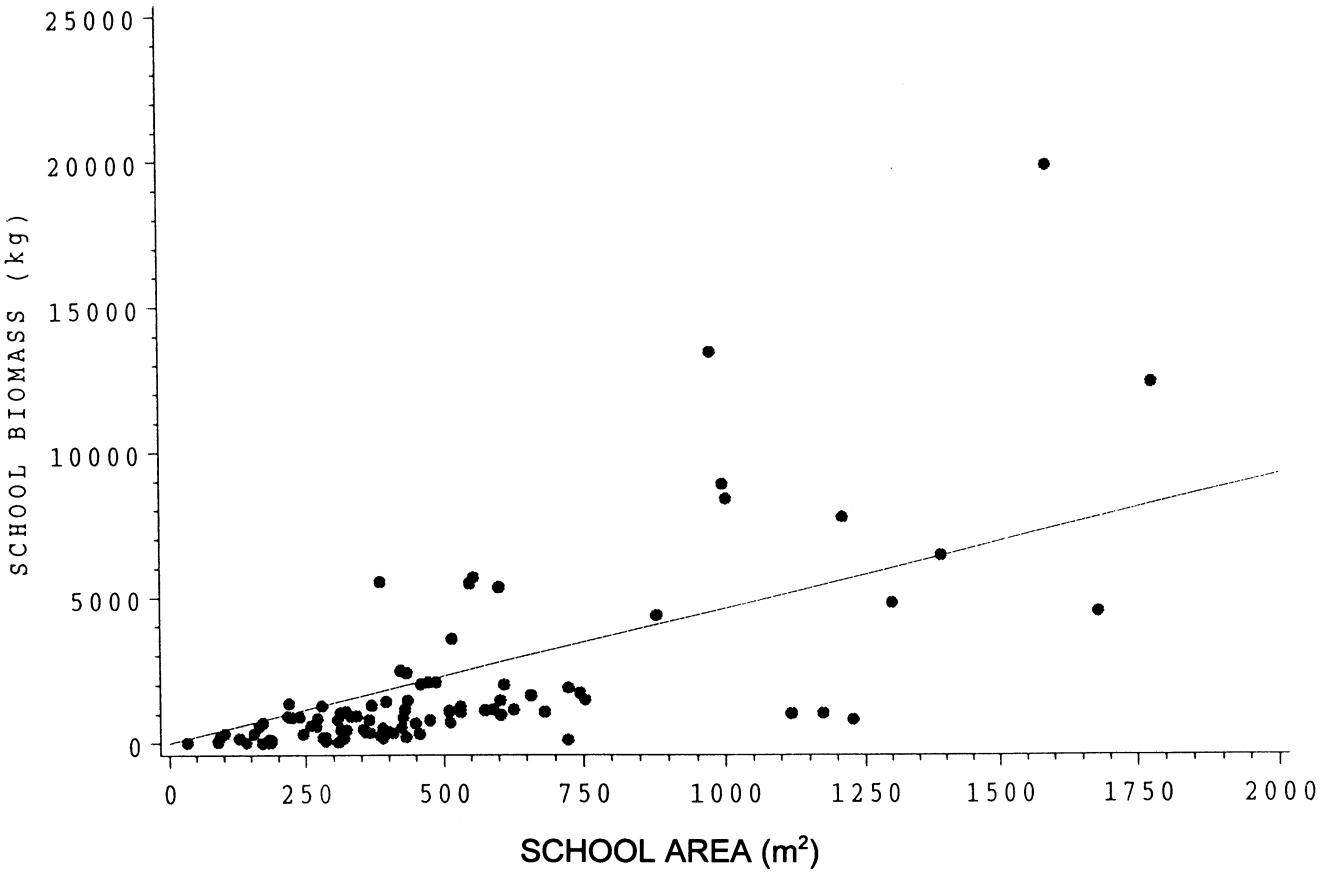


Figure 11. Relationship between school area and school biomass.

3.7 School tracking

Altogether 17 schools were tracked in the sardinella area off Ponta Das Palmeirinhas during the survey. The schools were tracked from about 2 min and up to 75 min. Generally, the schools were rather fluctuating, and the tracking of most schools lasted less than 30 min because the schools dispersed. Only 3 schools were tracked consistently for 60 min or more. An example of the swimming behaviour of a sardinella school off Ponta Das Palmeirinhas that was tracked for about one hour is given in Figure (13).

3.8 Small boat experiments

As it was not possible to scrutinise the data collected by the EY500 on board, these results will only be available at a later stage. Preliminary findings, however, indicate a large difference in the number of schools detected close to the surface with the small boat when compared to the EK500. Sonar recordings also indicate that shoals might be avoiding the small boat less than is the case with the DR FRIDTJOF NANSEN.

CHAPTER 4 CONCLUDING REMARKS

The methodological survey on the pelagic schooling fish resources off central Angola has confirmed earlier observations during pelagic surveys in the area by DR. FRIDTJOF NANSEN (e.g. DR. FRIDTJOF NANSEN - cruise report No 2/95) that surface schooling of sardinella cause significant underestimation of fish abundance by conventional echo integration in the area. In addition, the fast swimming and substantial avoidance behaviour of the sardinella make species identification by conventional survey trawls rather uncertain.

During the survey, systematic recordings of fish schools near surface were made by a horizontally guided, multibeam sonar, connected to a workstation with software for computerbased school detection. By converting the sonar recordings of the area of the schools to fish density by applying a linear relationship between the area and biomass of schools, it was shown that the density of sardinella in an area as recorded by sonar could be a factor of about 10 larger than the density of sardinella recorded by conventional echo integration in daytime. The sonar method record fish schools above the upper blind zone of the echo sounder (upper 10 m of the water column), and also schools that avoid the vessel horizontally. At night, the density of pelagic shoaling fish near surface as recorded by sonar and conventional echo integration was about the same.

The linear relationship between school area and school biomass was established by sonar measurment and echo integration of selected schools. The relationship has predictable capability and is additive so that summed school area over a nautical distance as recorded by sonar can be converted to fish density. The measurements were conducted in three different areas with a high number of schools close to surface encountered during the survey. The relationship is therefore based on a representative selection of schools close to surface off Angola, and can therefore be used to convert daytime sonar recordings of school area to school biomass in later abundance estimation surveys in the area. The sardinella seem to maintain rather dense shoals at

night, but if indeed a different relationship between the area and biomass of the night-time and daytime shoals exists, it was not investigated. The school measurments revealed an average packing density of about 3 fish m^{-3} in the sardinella schools which is comparable to that of schools of herring of similar length.

Annex I Instruments And Fishing Gear

The Simrad scientific echo sounder EK 500/38 kHz, was used during the survey for estimation of fish density. The Bergen Echo Integrator system (BEI) logging raw data from the echo sounder, was used to scrutinise the acoustic records, and to allocate integrator data to fish species. All raw data were stored to tape, and a backup of the database of scrutinised data, stored. The details of the settings of the 38 kHz echo sounder were as follows:

Transceiver-1 menu

Transducer depth	5 m
Absorption coeff.	10 dB/km
Pulse length	medium
Bandwidth	wide
Max. power	2 000 W
Angle sensitivity	21.9
2-way beam angle	-21.0 dB
SV transducer gain	28.1 dB
TS transducer gain	28.0 dB
3 dB Beamwidth	6.8 deg
Alongship offset	0.00 deg
Athwartship offset	0.04 deg

Display menu

Echogram	1
Bottom range	12 m
Bottom start	10 m
TVG	20 log R
SV Colour minimum	-72 dB
TS Colour minimum	-65 dB

Printer settings

Range	0-100, 0-250 m, 0-500 m
TVG	20 log R
SV Colour minimum	-72 dB

Bottom detection menu

Minimum level	-45 dB

Fishing Gear

The small "Åkrehamn" pelagic trawl and "Gisund super" bottom trawl was used for sampling pelagic fish. Tyborøn, 7.8 (1670 kg) trawl doors were used for both trawls.

Annex II Specifications And Settings For Small Boat Experiments

The Simrad EY500/38 kHz portable scientific echo sounder fitted with a split beam transducer was opperated from a small boat during several exercises to study fish schooling behaviour. All raw data were stored to tape and a colour printout of echograms was generated. The details of the settings of the portable 38 kHz echo sounder were as follows:

Transceiver menu

Transducer type	ES38
Transducer depth	1 m
Absorption coeff.	10 dB/km
Pulse length	wide
Max. power	125W
2-way beam angle	-15.8 deg
SV transducer gain	22.7 dB
TS transducer gain	22.7 dB
3 dB Beamwidth along.	11.9 deg
3 dB Beamwidth athw.ship	11.7
Alongship offset	0.01 deg
Athwartship offset	0.02 deg

Man - over - board boat

Length	5.3 m
Width	2.1 m
Power	40 Hp
Draught	1.2 m
Weight	2000 kg

Annex III Summary Of Species Composition Of Trawl Stations

Trawl number	Latitude (°S)	Bottom depth (m)	Headrope depth (m)	Catch by species (% of total catch)				Total catch (kg)
				Sardinella sp.	*Trachurus t.*	Other Carangidae	Other Pelagics (*myctophidae)	
879	9.05	258	25	-	4	5	91*	135
880	9.11	39	0	1	5	61	33	205
881	9.19	43	0	27	-	57	16	84
882	9.41	26	0	4	-	48	48	87
883	9.51	20	0	10	1	3	86	359
884	10.20	25	0	1	1	4	94	479
885	10.20	108	60	-	64	36	-	11
886	10.40	61	0	1	58	6	35	175
887	11.04	293	03	-	-	-	100*	243
888	11.13	222	180	-	3	-	97*	211
889	11.09	48	5	6	6	76	12	150
890	11.12	44	5	37	15	42	6	268
891	9.11	99	0	32	-	59	9	59
892	9.12	66	25	6	-	6	88	15
893	9.11	82	5	28	-	52	20	186
894	9.11	93	0	1	23	56	20	360
895	9.06	57	20	34	18	40	8	743
896	8.59	177	5	93	-	7	-	674
897	9.08	34	5	24	-	18	58	54
898	9.05	118	20	24	-	7	69	33
899	9.04	38	5	79	-	8	13	250
900	9.05	39	0	20	36	41	3	450
901	9.06	63	25	-	98	1	1	67
902	9.05	50	5	70	10	9	11	470
903	9.03	51	0	11	81	7	1	1660
904	9.10	33	0	21	-	79	-	12
905	9.17	76	0	0	44	7	49	175
906	9.21	86	0	0	49	8	43	269
907	9.28	63	0	0	0	4	96	45
908	9.29	40	0	1	81	2	16	145
909	9.34	42	0	1	92	2	5	223
910	9.40	47	0	7	83	4	6	183
911	9.11	33	0	7	64	24	5	6384

Annex IV Summery Of Technical Details Of Trawl Stations

												Catch composition (% of Total catch)				
STA.No.	G.type	Position		Time		B.Depth	Wire out	Speed	Gear depth	Vert.open	Net S.Rec	TOT.CAT	SARD.	TRACH	Other Car.	Other Pel.
		South	East	start	end											
879	PT 1	09°05	12° 48	21:41	22:11	107	120	3,1	25	16	0.0	134.69	0.0	5.31	7.32	9.32
880	PT 2	09° 11	12° 54	23:54	00:14	52	120	3.0	0		0.0	205.94	2.1	10.12	126.29	0.0
881	PT 2	09° 19	12° 57	03:11	03:31	44	120	3.0	0		0.0	83.62	19.72	0.0	50.76	0.3
882	PT 9	09° 41	13° 09	12:40	13:10	56	120	3.5	0	0	0.0	86.59	2.17	0.0	41.46	13.31
883	PT 2	09° 50	13° 13	21:03	21:36	22	150	3.5	0	0	0.0	358.5	49.5	2.94	22.29	14.22
884	PT 2	10° 20	13° 29	07:15	07:45	21	150	3.4	0	10	0.9	478.45	3.15	2.9	19.8	52.75
885	PT 5	10° 20	13°09	11:38	12:08	103	200	3.0	50			11.52	0.0	7.33	4.19	0.0
886	PT 6	10°40	13° 34	19:41	20:11	53	120	3.1	0			174.83	1.81	101.0	10.85	52.40
887	PT 5	11° 04	13° 31	05:45	06:15	295	500	3.2				242.75	0.0	0.0	0.0	0.0
888	PT 5	11° 13	13° 33	08:15	08:23	222	500	3.1	180			211.43	0.0	7.20	0.0	0.0
889	PT 6	11° 09	13° 47	13:15	13:55	30	120	4.2	5			150.04	8.90	9.33	113.54	0.0
890	PT 6	11° 12	13° 45	15:17	16:57	37	150	4.0	4	14	13.9	268.39	99.61	38.54	112.19	0.0
891	PT 6	09° 11	12° 48	08:47	09:40	79	150	4.5	0	16	47.6	59.4	19.15	0.0	35.15	5.10
892	PT 5	09° 18	12° 52	11:10	11:50	87	150	4.2	30	16	11.2	15.28	0.84	0.0	0.94	0.0
893	PT 6	09° 11	12° 50	12:18	13:28	28	160	4.5	5	12	0.0	185.79	52.2	0.0	96.99	0.0
894	PT 6	09° 11	12° 49	17:40	18:30	193	150	3.2	0	15	4.9	360.10	2.05	81.40	208.75	47.63
895	PT 5	09° 06	12° 53	21:08	21:36	45	120	3.0	18	20	0.0	743.74	251.08	134.17	285.74	0.0
896	PT 6	08° 59	12° 57	12:06	13:06	166	300	5.0	5	12	4.7	674.55	633.76	0.0	40.48	0.0
897	PT 6	09° 08	12° 55	15:09	15:45	37	150	4.5	5	14	23.3	53.74	13.21	0.0	9.35	0.0
898	PT 5	09° 04	12° 54	09:51	10:50	204	250	5.0	20	7	0.0	32.98	7.8	0.0	2.25	22.9
899	PT 6	09° 05	12° 56	15:40	16:10	34	150	5.0	5	16	19.4	249.29	197.73	0.0	18.95	10.51
900	PT 6	09° 05	12° 56	19:23	20:23	54	150	4.5	0	19	0.7	449.86	89.25	162.94	181.17	10.51
901	PT 5	09° 05	12° 54	10:03	10:49	180	300	4.7	50	10	0.0	67.46	0.0	66.30	0.33	0.76
902	PT 6	09° 05	12° 55	15:38	16:38	40	120	4.7	5	15	15.8	470.23	326.56	47.67	40.56	55.44
903	PT 6	09° 04	12° 55	21:35	22:35	35	140	4".2	0	18	0.0	1657.1	186.74	1341.1	123.32	0.0
904	PT 2	09° 10	12° 55	10:34	11:34	51	150	4.9	0	20	0.0	12.21	2.61	0.0	9.60	0.0
905	PT 2	09° 18	12° 52	18:41	19:11	79	150	4.3	0	21	0.3	175.47	0.0	76.80	12.9	17.28
906	PT 2	09° 21	12°51	19:57	20:27	86	150	4.2	0	21	0.0	269.28	0.0	130.8	20.52	54.48
907	PT 2	09° 28	12° 57	22:16	22:46	55	150	3.6	0	21	0.0	45.25	0.0	0.0	1.55	0.0
908	PT 2	09° 29	13° 03	23:44	00:14	45	160	4.3	0	18	0.0	145.21	1.02	118.5	2.04	19.6
909	PT 2	09° 35	13° 05	01:10	01:40	42	120	4.4	0	25	0.6	222.79	0.84	204.92	9.58	8.15
910	PT 2	09° 40	13° 05	02:29	02:59	52	120	4.5	0	15	0.2	182.97	12.03	152.55	6.69	5.25
911	PT 2	09° 10	12° 55	17:22	18:22	54	150	4.1	0	18	8.4	6384.0	443.0	4095.0	1555.0	52.0

Annex V Records Of Fishing Stations

PROJECT STATION: 879

DATE: 7/ 1/96 GEAR TYPE: PT No:1 POSITION:Lat S 905
start stop duration Long E 1247
TIME :21:41:00 22:11:00 30 (min) Purpose code: 1
LOG :1819.60 1821.50 1.90 Area code : 3
FDEPTH: 25 25 GearCond.code: 1
BDEPTH: 258 107 Validity code:
Towing dir: 115° Wire out: 120 m Speed: 31 kn*10

Sorted: Kg Total catch: 134.69 CATCH/HOUR: 269.38

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
MYCTOPHIDAE	220.00	157142	81.67	
Sarda sarda	15.06	6	5.59	
Selene dorsalis	14.64	58	5.43	
Trachurus trecae	10.62	18	3.94	
Trichiurus lepturus	5.36	58	1.99	
Auxis thazard	3.58	8	1.33	
Macroparalepis macrogeneion	0.12	6	0.04	
Total	269.38		99.99	

PROJECT STATION: 880

DATE: 1/ 7/96 GEAR TYPE: PT No:2 POSITION:Lat S 911
start stop duration Long E 1253
TIME :23:54:00 24:14:00 20 (min) Purpose code: 1
LOG :1836.00 1837.30 1.30 Area code : 3
FDEPTH: 0 0 GearCond.code: 1
BDEPTH: 39 52 Validity code: 1
Towing dir: 252° Wire out: 120 m Speed: 30 kn*10

Sorted: 59 Kg Total catch: 205.94 CATCH/HOUR: 617.82

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Selene dorsalis	345.99	1587	56.00	
Sphyraena guachancho	161.70	285	26.17	
Trachurus trecae	30.36	138	4.91	1787
Chloroscombrus chrysurus	18.81	105	3.04	
Trichiurus lepturus	16.50	84	2.67	
Lagocephalus laevigatus	8.82	12	1.43	
Selar crumenophthalmus	7.35	12	1.19	
Sardinella maderensis	6.30	21	1.02	1788
Lithognathus aureti	6.21	12	1.01	
POOPO02	5.16	42	0.84	
Galeoides decadactylus	3.90	12	0.63	
Decapterus punctatus	3.78	12	0.61	
Trachinotus ovatus	2.94	12	0.48	
Total	617.82		100.00	

PROJECT STATION: 881

DATE: 2/ 7/96 GEAR TYPE: PT No:2 POSITION:Lat S 919
start stop duration Long E 1256
TIME :03:11:00 03:31:00 20 (min) Purpose code: 1
LOG :1866.40 1867.60 1.20 Area code : 3
FDEPTH: 0 0 GearCond.code: 1
BDEPTH: 43 44 Validity code: 1
Towing dir: 178° Wire out: 120 m Speed: 30 kn*10

Sorted: 30 Kg Total catch: 83.62 CATCH/HOUR: 250.86

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Selene dorsalis	114.75	396	45.74	
Sphyraena guachancho	41.22	72	16.43	
Sardinella maderensis	40.50	132	16.14	1790
Chloroscombrus chrysurus	37.53	153	14.96	
Sardinella aurita	14.43	36	5.75	1789
Pomadasys incisus	1.53	18	0.61	
Ilisha africana	0.90	9	0.36	
Total	250.86		99.99	

PROJECT STATION: 882

DATE: 2/ 7/96 GEAR TYPE: PT No:9 POSITION:Lat S 941
start stop duration Long E 1309
TIME :12:40:00 13:10:00 30 (min) Purpose code: 1
LOG :1938.10 1940.10 2.00 Area code : 3
FDEPTH: 0 0 GearCond.code: 1
BDEPTH: 26 56 Validity code: 1
Towing dir: 28° Wire out: 120 m Speed: 35 kn*10

Sorted: 87 Kg Total catch: 86.65 CATCH/HOUR: 173.30

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Chloroscombrus chrysurus	61.30	460	35.37	1791
Sphyraena guachancho	33.40	78	19.27	
Scomberomorus tritor	25.60	16	14.77	
Trachinotus ovatus	20.30	58	11.71	1792
Stromateus fiatola	5.88	8	3.39	
Pomadasys jubelini	4.74	6	2.74	
Brachydeuterus auritus	4.04	56	2.33	
Sardinella maderensis	4.00	14	2.31	1794
Galeoides decadactylus	3.30	8	1.90	
Drepane africana	2.38	2	1.37	
Trichiurus lepturus	1.88	6	1.08	
Sardinella aurita	1.54	4	0.89	1793
Pomadasys incisus	1.36	4	0.78	
Selene dorsalis	1.32	6	0 76	
Ilisha africana	1.02	24	0.59	
Ephippion guttifer	0.70	2	0.40	
Pentanemus quinquarius	0.54	6	0.31	
Total	173.30		99.97	

PROJECT STATION: 883

DATE: 2/ 7/96 GEAR TYPE: PT No:2 POSITION:Lat S 950
start stop duration Long E 1313
TIME :21:03:00 21:36:00 33 (min) Purpose code: 1
LOG :2009.00 2011.20 3.20 Area code : 3
FDEPTH: 0 0 GearCond.code: 1
BDEPTH: 20 22 Validity code:
Towing dir: 180° Wire out: 150 m Speed: 35 kn*10

Sorted: 164 Kg Total catch: 358.50 CATCH/HOUR: 651.82

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Sphyraena guachancho	139.64	393	21.42	
Sphyraena sphyraena	117.82	5	18.08	
Sardinella maderensis	90.00	862	13.81	1795
Brachydeuterus auritus	64.36	1149	9.87	
Galeoides decadactylus	58.09	316	8.91	
Rhizoprionodon acutus	35.73	11	5.48	
Ilisha africana	25.25	785	3.87	
Chloroscombrus chrysurus	21.00	371	3.22	
Trichiurus lepturus	18.38	44	2.82	
Spondyliosoma cantharus	17.45	33	2.68	
Pomadasys peroteti	12.55	49	1.93	
Arius parkii	10.80	11	1.66	
Pomadasys jubelini	10.09	16	1.55	
Alectis alexandrinus	9.93	22	1.52	
Trachurus trecae	5.35	49	0.82	
Pteroscion peli	4.64	136	0.71	
Hemicaranx bicolor	4.36	27	0.67	
Selene dorsalis	4.09	76	0.63	
Trachinotus ovatus	1.15	5	0.18	
Engraulis encrasicolus	0.60	131	0.09	
Pseudotolithus typus	0.55	5	0.08	
Total	651.83		100.00	

PROJECT STATION: 884

DATE: 3/ 7/96 GEAR TYPE: PT No:2 POSITION:Lat S 1020
start stop duration Long E 1329
TIME :07:15:00 07:45:00 30 (min) Purpose code: 1
LOG :2100.90 2102.60 1.70 Area code : 3
FDEPTH: 0 0 GearCond.code: 1
BDEPTH: 25 21 Validity code:
Towing dir: 15° Wire out: 150 m Speed: 34 kn*10

Sorted: 111 Kg Total catch: 478.45 CATCH/HOUR: 956.90

SPECIES	CATCH/HOUR weight	numbers	% OF TOT C	SAMP
Brachydeuterus auritus	452.50	9130	47 29	1798
Ilisha africana	105.50	3180	11.03	1797
Galeoides decadactylus	93.00	350	9.72	1799
Trichiurus lepturus	86.00	1080	8.99	
Pomadasys jubelini	55.50	100	5.80	
Pseudotolithus typus	39.50	170	4.13	
Polydactylus quadrifilis	38.80	2	4.05	
Chloroscombrus chrysurus	20.10		2.10	
Pteroscion peli	16.00	940	1.67	
Selene dorsalis	13.20	290	1.38	
Parapenaeus longirostris	10.10	2810	1.06	
Sardinella maderensis	6.30	160	0.66	1796
Trachurus trecae	5.80	40	0.61	
Trachinotus goreensis	4.00	10	0.42	
Sepia officinalis hierredda	3.90	10	0.41	
Alectis alexandrinus	2.30	40	0.24	
Dicologoglossa cuneata	2.20	30	0.23	
Pentanemus quinquarius	1.70	40	0.18	
Eucinostomus melanopterus	0.50	10	0.05	
Total	956.90		100.02	

PROJECT STATION: 885

DATE: 3/ 7/96 GEAR TYPE: PT No:5 POSITION:Lat S 1020
start stop duration Long E 1309
TIME :11:38:00 12:08:00 30 (min) Purpose code: 1
LOG :2130.50 2132.70 2.20 Area code : 3
FDEPTH: 60 50 GearCond code: 1
BDEPTH: 108 103 Validity code: 1
Towing dir: 90° Wire out: 200 m Speed: 30 kn*10

Sorted: 12 Kg Total catch: 11.52 CATCH/HOUR: 23.04

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus trecae	14.66	36	63.63	1800
Selene dorsalis	8.38	22	36.37	1801
Total	23.04		100 00	

PROJECT STATION: 886

DATE: 3/ 7/96 GEAR TYPE: PT No:6 POSITION:Lat S 1039
start stop duration Long E 1333
TIME :19:41:00 20:11:00 30 (min) Purpose code: 1
LOG :2207.80 2209.60 1.80 Area code : 3
FDEPTH: 0 0 GearCond.code: 1
BDEPTH: 61 53 Validity code:
Towing dir: 90° Wire out: 120 m Speed: 3 kn*10

Sorted: 97 Kg Total catch: 174 83 CATCH/HOUR: 349.66

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus trecae	202.00	1186	57.77	1802
Euthynnus alletteratus	104.80	46	29.97	
Trachinotus ovatus	11.62	40	3.32	
Brachydeuterus auritus	10.76	80	3.08	
Selene dorsalis	10.08	32	2.88	
Trichiurus lepturus	5.88	46	1.68	
Sardinella maderensis	2.62	32	0.75	1803
Sardinella aurita	1.00	6	0.29	
Sphyraena guachancho	0.90	10	0.26	
Total	349.66		100.00	

PROJECT STATION: 887

DATE: 1/ 7/96 GEAR TYPE: PT No:5 POSITION:Lat S 1104
start stop duration Long E 1331
TIME :05:45:00 06:15:00 30 (min) Purpose code: 1
LOG :2304.40 2305.80 1.40 Area code : 3
FDEPTH: 0 0 GearCond.code: 1
BDEPTH: 293 295 Validity code:
Towing dir: 175° Wire out: 500 m Speed: 32 kn*10

Sorted: Kg Total catch: 242.75 CATCH/HOUR: 485.50

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
MYCTOPHIDAE	480.00	252632	98.87	
Zenopsis conchifer	2.76	20	0.57	
Dentex macrophthalmus	2.20	6	0.45	
Trichiurus lepturus	0.50	4	0.10	
Macroparalepis macrogeneion	0.04	4	0.01	
Total	485.50		100.00	

PROJECT STATION: 888

DATE: 4/ 7/96 GEAR TYPE: PT No:5 POSITION:Lat S 1113
start stop duration Long E 1333
TIME :08:15:00 08:23:00 8 (min) Purpose code: 1
LOG :2317.40 2317.80 0.40 Area code : 3
FDEPTH: 180 180 GearCond.code: 1
BDEPTH: 222 222 Validity code:
Towing dir: 180° Wire out: 500 m Speed: 31 kn*10

Sorted: Kg Total catch: 211 43 CATCH/HOUR: 1585.73

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
MYCTOPHIDAE	1500.00	624998	94.59	
Trachurus trecae	54.00	105	3.41	1804
Zenopsis conchifer	16.20	225	1.02	
Dentex macrophthalmus	8.33	60	0.53	
Trichiurus lepturus	7.20	30	0.45	
Total	1585.73		100.00	

PROJECT STATION: 889

DATE: 4/ 7/96 GEAR TYPE: PT No:6 POSITION:Lat S 1109
start stop duration Long E 1347
TIME :13:15:00 13:55:00 40 (min) Purpose code: 1
LOG :2350.40 2353.20 2.80 Area code : 3
FDEPTH: 5 5 GearCond.code: 1
BDEPTH: 48 30 Validity code: 1
Towing dir: 40° Wire out: 120 m Speed: 42 kn*10

Sorted: 56 Kg Total catch: 150.04 CATCH/HOUR: 225.06

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Chloroscombrus chrysurus	93.80	161	41.68	1809
Selene dorsalis	69.80	188	31.01	1808
Sphyraena guachancho	27.41	24	12.18	1810
Trachurus trecae	14.00	32	6.22	1806
Sardinella maderensis	13.35	44	5.93	1807
Trachinotus ovatus	6.72	15	2.99	1805
Total	225.08		100.01	

PROJECT STATION: 890

DATE: 4/ 7/96 GEAR TYPE: PT No:6 POSITION:Lat S 1112
start stop duration Long E 1345
TIME :15:57:00 16:57:00 60 (min) Purpose code: 1
LOG :2365.40 2369.40 4.00 Area code : 3
FDEPTH: 5 4 GearCond.code: 1
BDEPTH: 44 37 Validity code: 1
Towing dir: 45° Wire out: 150 m Speed: 40 kn*10

Sorted: 98 Kg Total catch: 268.39 CATCH/HOUR: 268 39

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Selene dorsalis	96.36	296	35.90	1812
Sardinella maderensis	94.59	375	35.24	1811
Trachurus trecae	38.54	106	14.36	1815
Brachydeuterus auritus	14.44	133	5.38	
Trachinotus ovatus	5.46	14	2.03	
Decapterus rhonchus	5.16	8	1.92	
Sardinella aurita	5.02	16	1.87	1813
Chloroscombrus chrysurus	2.90	16	1.08	1814
Trachinotus goreensis	2.31	5	0.86	
Pomatomus saltatrix	1.85	3	0.69	
Sphyraena guachancho	1.76	3	0.66	
Alopias superciliosus	0.00	1		
Total	268.39		99.99	

PROJECT STATION: 891

DATE: 5/ 7/96 GEAR TYPE: PT No:6 POSITION:Lat S 911
start stop duration Long E 1247
TIME :08:47:00 09:40:00 53 (min) Purpose code: 1
LOG :2526.60 2531.00 4.40 Area code : 3
FDEPTH: 0 0 GearCond.code: 1
BDEPTH: 99 79 Validity code:
Towing dir: 98° Wire out: 150 m Speed: 45 kn*10

Sorted: Kg Total catch: 59.40 CATCH/HOUR: 67.25

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachinotus ovatus	39.79	113	59.17	
Sardinella maderensis	21.34	77	31.73	1816
Euthynnus alletteratus	5.77	7	8.58	
Sardinella aurita	0.34	1	0.51	1817
Total	67.24		99.99	

PROJECT STATION: 892

DATE: 5/ 7/96 GEAR TYPE: PT No:5 POSITION:Lat S 911
start stop duration Long E 1251
TIME :11:10:00 11:50:00 40 (min) Purpose code: 1
LOG :2536.00 2538.40 2.40 Area code : 3
FDEPTH: 25 30 GearCond.code: 1
BDEPTH: 66 87 Validity code: 1
Towing dir: 270° Wire out: 150 m Speed: 42 kn*10

Sorted: 15 Kg Total catch: 15.28 CATCH/HOUR: 22.92

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trichiurus lepturus	20.25	54	88.35	
Sardinella maderensis	1.26	5	5.50	1818
Selene dorsalis	0.87	3	3.80	1819
Trachinotus ovatus	0.54	2	2.36	
Total	22.92		100.01	

PROJECT STATION: 893

DATE: 5/ 7/96 GEAR TYPE: PT No:6 POSITION:Lat S 911
start stop duration Long E 1250
TIME :12:18:00 13:28:00 70 (min) Purpose code: 1
LOG :2540.10 2545.90 5.80 Area code : 3
FDEPTH: 5 5 GearCond.code: 1
BDEPTH: 82 28 Validity code: 1
Towing dir: 90° Wire out: 160 m Speed: 45 kn*10

Sorted: 79 Kg Total catch: 185.79 CATCH/HOUR: 159.25

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Selene dorsalis	79.80	297	50.11	1820
Sardinella maderensis	44.74	147	28.09	1821
Sarda sarda	31.37	14	19.70	1822
Caranx crysos	1.80	2	1.13	1825
Chloroscombrus chrysurus	0.84	4	0.53	1824
Trachinotus ovatus	0.69	2	0.43	1823
Total	159.24		99.99	

PROJECT STATION: 894

DATE: 5/ 7/96 GEAR TYPE: PT No:6 POSITION:Lat S 911
start stop duration Long E 1249
TIME :17:40:00 18:30:00 50 (min) Purpose code: 1
LOG :2572.10 2576.00 3.90 Area code : 3
FDEPTH: 0 0 GearCond.code: 1
BDEPTH: 93 193 Validity code:
Towing dir: 272° Wire out: 150 m Speed: 32 kn*10

Sorted: 98 Kg Total catch: 360.10 CATCH/HOUR: 432.12

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Selene dorsalis	242.66	840	56.16	1826
Trachurus trecae	97.68	554	22.60	1827
Sarda sarda	42.24	18	9.78	
Saurida brasiliensis	16.19	3392	3.75	
Euthynnus alletteratus	13.42	22	3.11	
Trachinotus ovatus	7.84	18	1.81	1828
Trichiurus lepturus	6.60	18	1.53	
Sardinella maderensis	2.46	8	0.57	
Scomber japonicus	1.50	5	0.35	
Todaropsis sp.	0.74	71	0.17	
MYCTOPHIDAE	0.48	193	0.11	
Sepiella ornata	0.31	8	0.07	
Total	432.12		100.01	

PROJECT STATION: 895

DATE: 5/ 7/96 GEAR TYPE: PT No:5 POSITION:Lat S 906
start stop duration Long E 1252
TIME :21:08:00 21:36:00 28 (min) Purpose code: 1
LOG :2591.80 2593.90 2.10 Area code : 3
FDEPTH: 20 18 GearCond.code: 1
BDEPTH: 57 45 Validity code:
Towing dir: 120° Wire out: 120 m Speed: 30 kn*10

Sorted: 97 Kg Total catch: 743.74 CATCH/HOUR: 1593.73

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Selene dorsalis	590.61	2432	37.06	1830
Sardinella maderensis	538.03	1841	33.76	1829
Trachurus trecae	287.51	936	18.04	1831
Sepia orbignyana	52.07	49	3.27	
Trichiurus lepturus	35.81	180	2.25	
Decapterus rhonchus	33.02	49	2.07	
Sphyraena guachancho	28.59	66	1.79	
Caranx crysos	16.26	17	1.02	
Brachydeuterus auritus	6.09	81	0.38	
Chloroscombrus chrysurus	5.42	32	0.34	
Pagellus bellottii	0.32	13	0.02	
Total	1593.73		100.00	

PROJECT STATION: 896

DATE: 6/ 7/96 GEAR TYPE: PT No:6 POSITION:Lat S 859
start stop duration Long E 1257
TIME :12:06:00 13:06:00 60 (min) Purpose code: 1
LOG :2721.70 2726.10 4.40 Area code : 3
FDEPTH: 5 5 GearCond.code: 1
BDEPTH: 177 166 Validity code: 1
Towing dir: 63° Wire out: 300 m Speed: 50 kn*10

Sorted: 64 Kg Total catch: 674.55 CATCH/HOUR: 674.55

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Sardinella maderensis	627.25	1375	92.99	1832
Selene dorsalis	39.60	132	5.87	1833
Sardinella aurita	4.51	11	0.67	
MUGMU03	2.20	11	0.33	
Trachinotus ovatus	0.88	11	0.13	
Lagocephalus laevigatus	0.11	11	0.02	
Total	674.55		100.01	

PROJECT STATION: 897

DATE: 7/ 7/96 GEAR TYPE: PT No:6 POSITION:Lat S 908
start stop duration Long E 1254
TIME :15:09:00 15:45:00 36 (min) Purpose code: 1
LOG :2794.20 2796.90 2.70 Area code : 3
FDEPTH: 5 5 GearCond.code: 1
BDEPTH: 34 37 Validity code: 1
Towing dir: 180° Wire out: 150 m Speed: 45 kn*10

Sorted: 53 Kg Total catch: 53.74 CATCH/HOUR: 89.57

SPECIES	CATCH/HOUR weight	numbers	% OF TOT C	SAMP
Sphyraena sphyraena	37.67	2	42.06	
Sardinella maderensis	18.33	60	20.46	1838
Sphyraena guachancho	14.33	17	16.00	1837
Caranx crysos	5.85	7	6.53	
Trachinotus ovatus	4.92	10	5.49	1835
Selene dorsalis	4.78	15	5.34	1836
Sardinella aurita	3.68	10	4.11	1834
Total	89.56		99.99	

PROJECT STATION: 898

DATE: 8/ 7/96 GEAR TYPE: PT No:5 POSITION:Lat S 904
start stop duration Long E 1254
TIME :09:51:00 10:50:00 59 (min) Purpose code: 1
LOG :2843.70 2843.90 Area code : 3
FDEPTH: 20 20 GearCond.code: 1
BDEPTH: 118 204 Validity code: 1
Towing dir: 25° Wire out: 250 m Speed: 50 kn*10

Sorted: 32 Kg Total catch: 32.98 CATCH/HOUR: 33.54

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Sarda sarda	23.29	10	69.44	1841
Sardinella maderensis	7.93	25	23.64	1839
Selene dorsalis	2.29	7	6.83	1840
Lagocephalus laevigatus	0.02	1	0.06	
Total	33.53		99.97	

PROJECT STATION: 899

DATE: 8/ 7/96 GEAR TYPE: PT No:6 POSITION:Lat S 904
start stop duration Long E 1256
TIME :15:40:00 16:10:00 30 (min) Purpose code: 1
LOG :2869.50 2871.70 2.20 Area code : 3
FDEPTH: 5 5 GearCond.code: 1
BDEPTH: 38 34 Validity code: 1
Towing dir: 195° Wire out: 150 m Speed: 50 kn*10

Sorted: 24 Kg Total catch: 249.29 CATCH/HOUR: 498.58

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Sardinella maderensis	379.60	2008	76.14	1843
Sphyraena guachancho	43.60	62	8.74	
Trachinotus ovatus	19.30	40	3.87	
Sardinella aurita	15.86	40	3.18	1842
Sarda sarda	14.72	4	2.95	
Selene dorsalis	12.94	40	2.60	
Euthynnus alletteratus	6.30	10	1.26	
Caranx crysos	5.66	4	1.14	
Echeneis naucrates	0.60	4	0.12	
Total	498.58		100.00	

PROJECT STATION: 900

DATE: 8/ 7/96 GEAR TYPE: PT No:6 POSITION:Lat S 904
start stop duration Long E 1256
TIME :19:23:00 20:23:00 60 (min) Purpose code: 1
LOG :2880.20 2884.60 4.40 Area code : 3
FDEPTH: 0 0 GearCond.code: 1
BDEPTH: 39 54 Validity code:
Towing dir: 220° Wire out: 150 m Speed: 45 kn*10

Sorted: 119 Kg Total catch: 449.86 CATCH/HOUR: 449.86

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus trecae	162.94	416	36.22	1845
Selene dorsalis	160.69	600	35.72	1844
Sardinella maderensis	89.25	1526	19.84	1846
Decapterus rhonchus	16.50	34	3.67	
Sphyraena guachancho	9.75	30	2.17	
Caranx crysos	3.98	4	0.88	
Brachydeuterus auritus	3.75	128	0.83	
MYCTOPHIDAE	2.40	799	0.53	
Trichiurus lepturus	0.60	8	0.13	
Total	449.86		99.99	

PROJECT STATION: 901

DATE: 9/ 7/96 GEAR TYPE: PT No:5 POSITION:Lat S 905
start stop duration Long E 1254
TIME :10:03:00 10:49:00 46 (min) Purpose code: 1
LOG :2923.30 2926.60 3.30 Area code : 3
FDEPTH: 25 50 GearCond.code: 1
BDEPTH: 63 180 Validity code:
Towing dir: 45° Wire out: 300 m Speed: 47 kn*10

Sorted: 30 Kg Total catch: 67.46 CATCH/HOUR: 87.99

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus trecae	86.48	223	98.28	1847
Euthynnus alletteratus	0.99	1	1.13	
Selene dorsalis	0.43	1	0.49	
Pagellus bellottii	0.09	1	0.10	
Total	87.99		100.00	

PROJECT STATION: 902

DATE: 9/ 7/96 GEAR TYPE: PT No:6 POSITION:Lat S 905
start stop duration Long E 1255
TIME :15:38:00 16:38:00 60 (min) Purpose code: 1
LOG :2945.70 2950.10 4.40 Area code : 3
FDEPTH: 5 5 GearCond.code: 1
BDEPTH: 50 50 Validity code: 1
Towing dir: 178° Wire out: 120 m Speed: 47 kn*10

Sorted: 128 Kg Total catch: 470.23 CATCH/HOUR: 470.23

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Sardinella maderensis	322.67	1144	68.62	1848
Sarda sarda	52.62	22	11.19	
Trachurus trecae	47.67	128	10.14	1849
Selene dorsalis	36.85	110	7.84	1850
Sardinella aurita	3.89	11	0.83	
Euthynnus alletteratus	2.82	4	0.60	
Decapterus rhonchus	1.91	4	0.41	
Trachinotus ovatus	1.80	4	0.38	
Total	470.23		100.01	

PROJECT STATION: 903

DATE: 9/ 7/96 GEAR TYPE: PT No:6 POSITION:Lat S 904
start stop duration Long E 1254
TIME :21:35:00 22:35:00 60 (min) Purpose code: 1
LOG :2969.50 2973.70 4.20 Area code : 3
FDEPTH: 0 0 GearCond.code: 1
BDEPTH: 51 35 Validity code:
Towing dir: 190° Wire out: 140 m Speed: 42 kn*10

Sorted: 27 Kg Total catch: 1657.14 CATCH/HOUR: 1657.14

SPECIES	CATCH/HOUR weight	numbers	% OF TOT C	SAMP
Trachurus trecae	1341.10	4699	80.93	1851
Sardinella maderensis	171.60	5650	10.36	1852
Selene dorsalis	111.00	352	6.70	1853
Sardinella aurita	15.14	52	0.91	
Decapterus rhonchus	12.32	17	0.74	
Sphyraena guachancho	3.69	35	0.22	
Brachydeuterus auritus	2.29	17	0.14	
Total	1657.14		100.00	

PROJECT STATION: 904

DATE:10/ 7/96 GEAR TYPE: PT No:2 POSITION:Lat S 910
start stop duration Long E 1254
TIME :10:34:00 11:34:00 60 (min) Purpose code: 1
LOG :2995.00 2999.50 4.50 Area code : 3
FDEPTH: 0 0 GearCond.code: 1
BDEPTH: 33 51 Validity code: 1
Towing dir: 360° Wire out: 150 m Speed: 49 kn*10

Sorted: 12 Kg Total catch: 12.21 CATCH/HOUR: 12.21

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachinotus ovatus	9.60	22	78.62	
Sardinella aurita	1.44	4	11.79	1855
Sardinella maderensis	1.17	4	9.58	1854
Total	12.21		99.99	

PROJECT STATION: 905

DATE:10/ 7/96 GEAR TYPE: PT No:2 POSITION:Lat S 917
start stop duration Long E 1251
TIME :18:41:00 19:11:00 30 (min) Purpose code: 1
LOG :3030.60 3032.70 2.10 Area code : 3
FDEPTH: 0 0 GearCond.code: 1
BDEPTH: 76 79 Validity code:
Towing dir: 180° Wire out: 150 m Speed: 43 kn*10

Sorted: 58 Kg Total catch: 175.47 CATCH/HOUR: 350.94

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus trecae	153.60	384	43.77	1856
Trichiurus lepturus	135.30	516	38.55	
Euthynnus alletteratus	20.76	30	5.92	
Sarda sarda	13.80	6	3.93	
Trachinotus ovatus	13.26	36	3.78	
Selene dorsalis	12.54	36	3.57	
Brachydeuterus auritus	1.68	12	0.48	
Total	350.94		100.00	

PROJECT STATION: 906

DATE:10/ 7/96 GEAR TYPE: PT No:2 POSITION:Lat S 921

	start	stop	duration			
					Long	E 12514
TIME	:19:57:00	20:27:00	30	(min)	Purpose code:	1
LOG	:3034.90	3037.00	2.10		Area code :	3
FDEPTH:	0	0			GearCond.code:	1
BDEPTH:	86	86			Validity code:	

Towing dir: 138° Wire out: 150 m Speed: 42 kn*10

Sorted: 218 Kg Total catch: 269.28 CATCH/HOUR: 538 56

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus trecae	261.60	708	48.57	1857
Trichiurus lepturus	122.40	528	22.73	
Sarda sarda	98.04	48	18.20	
Trachinotus ovatus	31.92	96	5.93	
Euthynnus alletteratus	10.92	36	2.03	
Caranx crysos	9.12	12	1.69	
Brachydeuterus auritus	3.84	24	0.71	
Saurida brasiliensis	0.60	324	0.11	
Fistularia petimba	0.12	12	0.02	
Total	538.56		99.99	

PROJECT STATION: 907

DATE:10/ 7/96 GEAR TYPE: PT No:2 POSITION:Lat S 928

	start	stop	duration			
					Long	E 1257
TIME	:22:16:00	22:46:00	30	(min)	Purpose code:	1
LOG	:3045.90	3048.10	2.20		Area code :	3
FDEPTH:	0	0			GearCond.code:	1
BDEPTH:	63	55			Validity code:	

Towing dir: 150° Wire out: 150 m Speed: 36 kn*10

Sorted: 45 Kg Total catch: 45.25 CATCH/HOUR: 90.50

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trichiurus lepturus	87.40	374	96.57	
Decapterus rhonchus	3.10	18	3.43	1858
Total	90.50		100.00	

PROJECT STATION: 908

DATE:10/ 7/96 GEAR TYPE: PT No:2 POSITION:Lat S 929

	start	stop	duration			
					Long	E 1302
TIME	:23:44:00	00:14:00	30	(min)	Purpose code:	1
LOG	:3053 60	3055.80	2.20		Area code :	3
FDEPTH:	0	0			GearCond.code:	1
BDEPTH:	40	45			Validity code:	1

Towing dir: 160° Wire out: 120 m Speed: 43 kn*10

Sorted: 58 Kg Total catch: 145.21 CATCH/HOUR: 290.42

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus trecae	237.00	1010	81.61	1861
Euthynnus alletteratus	35.26	40	12.14	
Trichiurus lepturus	5.60	26	1.93	
Engraulis encrasicolus	3.94		1.36	1859
Decapterus rhonchus	3.84	6	1.32	
Sardinella maderensis	2.04	90	0.70	1860
Alloteuthis africana	1.50	600	0.52	
Sphyraena guachancho	1.00	6	0.34	
Decapterus punctatus	0.24	10	0.08	
Total	290.42		100.00	

PROJECT STATION: 909

DATE:11/ 7/96 GEAR TYPE: PT No:2 POSITION:Lat S 935

	start	stop	duration			
					Long	E 1305
TIME	:01:10:00	01:40:00	30	(min)	Purpose code:	1
LOG	:3061.50	3066.60	5.10		Area code :	3
FDEPTH:	0	0			GearCond.code:	1
BDEPTH:	42	42			Validity code:	1

Towing dir: 160° Wire out: 120 m Speed: 44 kn*10

Sorted: 64 Kg Total catch: 222.79 CATCH/HOUR: 445.58

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus trecae	409.84	2542	91.98	1863
Euthynnus alletteratus	16.30	22	3.66	
Caranx senegallus	8.74	8	1.96	
Trichiurus lepturus	7.98	42	1.79	
Sardinella maderensis	1.68	92	0.38	1862
Boops boops	0.62	64	0.14	
Decapterus punctatus	0.42	14	0.09	
Total	445.58		100.00	

PROJECT STATION: 910

DATE:11/ 7/96 GEAR TYPE: PT No:2 POSITION:Lat S 940

	start	stop	duration			
					Long	E 1305
TIME	:02:29:00	02:59:00	30	(min)	Purpose code:	1
LOG	:3068.20	3070.30	2.10		Area code :	3
FDEPTH:	0	0			GearCond.code:	1
BDEPTH:	47	52			Validity code:	1

Towing dir: 160° Wire out: 120 m Speed: 45 kn*10

Sorted: 61 Kg Total catch: 182.97 CATCH/HOUR: 365.94

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus trecae	305.10	1386	83.37	1865
Sardinella maderensis	20.88	72	5.71	1864
Selene dorsalis	13.38	36	3.66	
Euthynnus alletteratus	10.50	24	2.87	
Trichiurus lepturus	9.48	24	2.59	
Alloteuthis africana	3.42	996	0.93	
Sardinella aurita	3.18	6	0.87	
Total	365.94		100.00	

PROJECT STATION: 911

DATE:11/ 7/96 GEAR TYPE: PT No:2 POSITION:Lat S 910

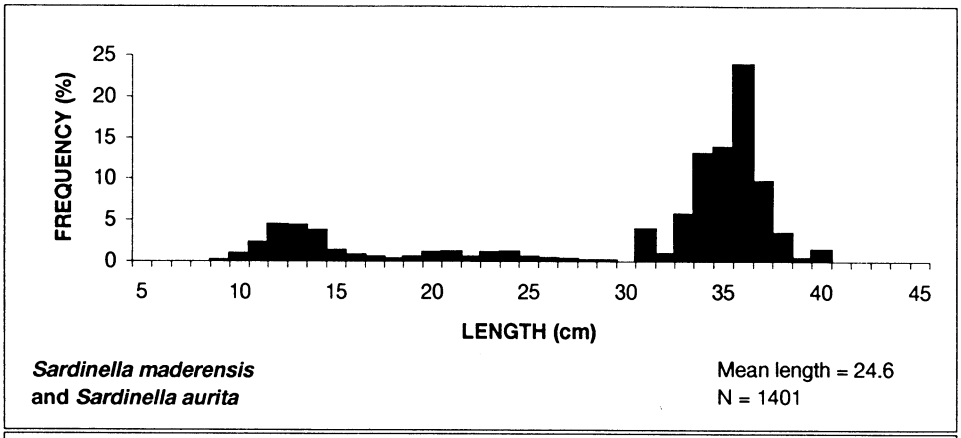
	start	stop	duration			
					Long	E 1254
TIME	:17:22:00	18:22:00	60	(min)	Purpose code:	1
LOG	:3147.30	3151.30	4.00		Area code :	3
FDEPTH:	0	0			GearCond.code:	1
BDEPTH:	33	54			Validity code:	

Towing dir: 360° Wire out: 150 m Speed: 41 kn*10

Sorted: 44 Kg Total catch: 6384.00 CATCH/HOUR: 6384.00

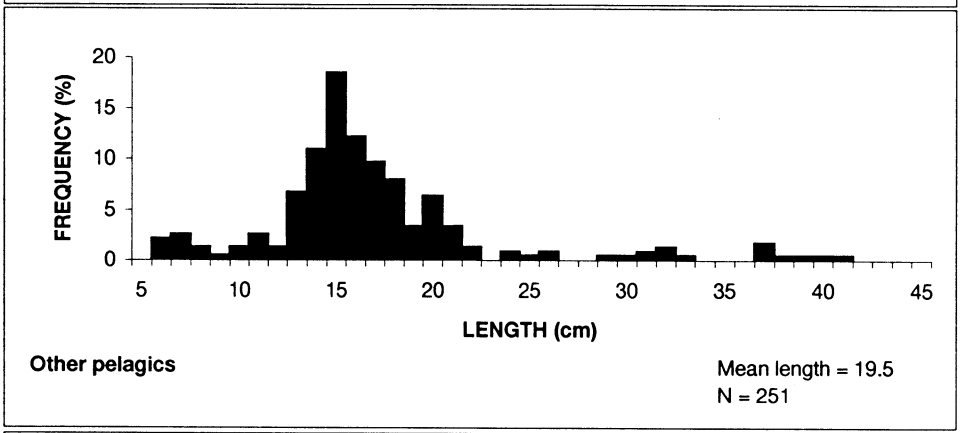
SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus trecae	4095.00	12000	64.14	1867
Selene dorsalis	960.00	3700	15.04	1868
Decapterus rhonchus	595.00	900	9.32	
Sardinella maderensis	399.00	1600	6.25	1866
Trichiurus lepturus	239.00	900	3.74	
Sardinella aurita	44 00	200	0.69	
Scomber japonicus	33.00	100	0.52	
Euthynnus alletteratus	19.00	100	0.30	
Total	6384.00		100.00	

Annex VI Size Distribution Per Species



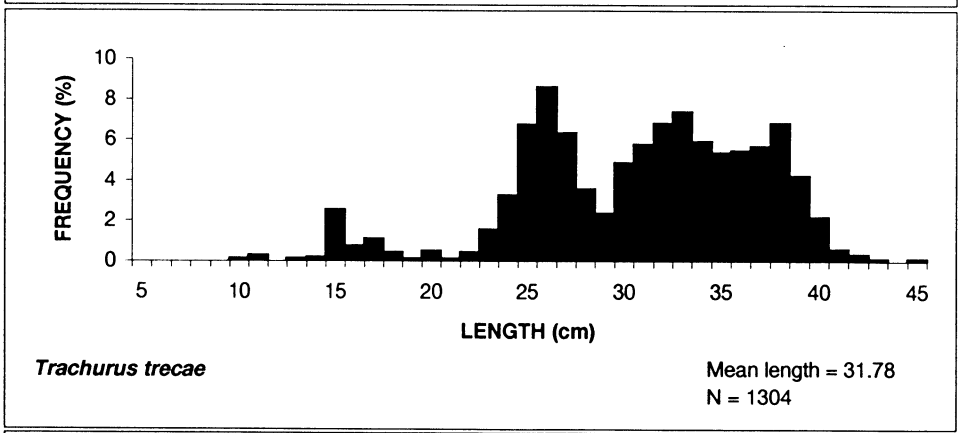
Sardinella maderensis and ***Sardinella aurita***

Mean length = 24.6
N = 1401



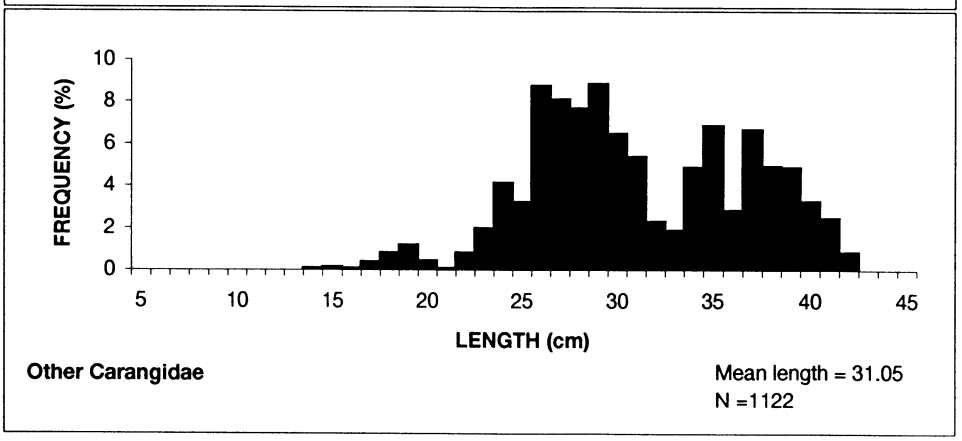
Other pelagics

Mean length = 19.5
N = 251



Trachurus trecae

Mean length = 31.78
N = 1304



Other Carangidae

Mean length = 31.05
N =1122

Annex VII Complete Species List For All Tawls

		(* no. of trawls present in)
ARIIDAE	*Arius parkii*	*
CARANGIDAE	*Caranx senegallus*	**
	Caranx chrysos	******
	Trachurus trecae	**********
	Trachinotus ovatus	**********
	Trachinotus goreensis	**
	Chloroscombrus chrysurus	**********
	Selar crumenophtalmus	*
	Decapturus punctatus	***
	Decapturus rhonchus	********
	Alectis alexandrinus	**
	Hemicaranx bicolor	*
	Selene dorsalis	**********
CLUPEIDAE	*Sardinella maderensis*	**********
	Sardinella aurita	**********
	Ilisha africana	*****
DREPANIDAE	*Drepane africana*	*
ECHENEIDAE	*Echeneis naucrates*	*
ENGRAULIDAE	*Engraulis encrasicolus*	**
FISTULARIIDAE	*Fistularia petimba*	**
GERREIDAE	*Eucinostomus melanopterus*	*
HAEMULIDAE	*Pomadasys incisus*	****
	Pomadasys jubelini	***
	Pomadasys peroteti	*
	Brachydeuterus auritus	**********
MUGILIDAE	*Mugil curema*	*
MYCHTOPHIDAE		****
PARALEPIDIDAE	*Macroparalepis macrogeneion*	*
POLYNEMIDAE	*Galeoides decadactylus*	****
	Pentanemus quinquarius	**
	Polydactylus quadrifilis	*
PTERADONTIDAE	*Lagocephalus laevigatus*	***
	Ephippion guttifer	*
POMATOMIDAE	*Pomatomus saltatrix*	*
SCIAENIDAE	*Pseudotolithus typus*	**
	Pteroscion peli	**
SCOMBRIDAE	*Sarda sarda*	********
	Auxis thazard	*
	Scomberomorus tritor	*
	Euthynnus alletteratus	**********
	Scomber japonicus	**

SOLEIDAE	*Dicologoglossa cuneata*	*
SPARIDAE	*Lythognathus mormyrus*	*
	Dentex macrophthalmus	**
	Pagellus bellottii	**
	Spondyliosoma canthurus	*
SPHYRAENIDAE	*Sphyraena guachancho*	**********
	Sphyraena sphyraena	**
STROMATEIDAE	*Stromateus fiatola*	*
SYNODONTIDAE	*Saurida braziliensis*	**
TRICHIURIDAE	*Trichiurus lepturus*	**********
ZEIDAE	*Zenopsis conchifer*	**
SHARKS		
ALOPIIDAE	*Alopias superciliosus*	*
CARCHRHINIDAE	*Rhizorionodon acutus*	*
SHRIMPS		
PENAEIDAE	*Parapenaeus longirostris*	*
SQUIDS		
OMMASTREPHIDAE	*Todaropsis eblanae*	*
SEPIIDAE	*Sepia officinalis*	*
	Sepia ornata	*
	Sepia orbignyana	*