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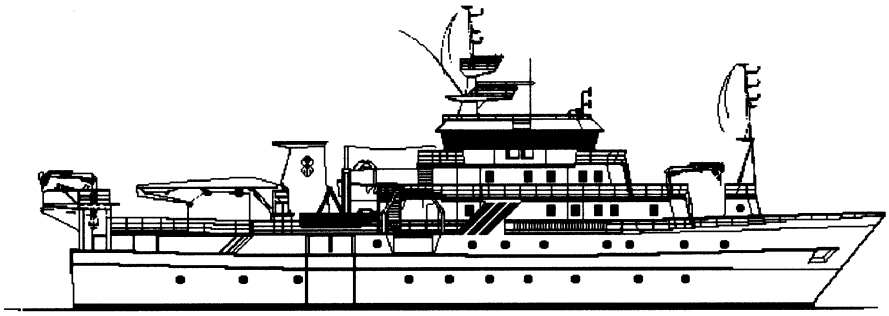
CRUISE REPORT DR. FRIDTJOF NANSEN



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

CRUISE REPORT DR. FRIDTJOF NANSEN

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

Cruise Report No 3/96

25 June - 13 July

Part I

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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Part I

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

TABLE OF CONTENTS

CHAPTER 1 INTRODUCTION

1.1 General Objectives

The Namibian pilchard is managed mainly on the basis of biomass estimates of the adult stock obtained by the standard hydro acoustic method. To acquire reliable absolute biomass estimates using this method, the entire stock must be surveyed by a vessel carrying a calibrated echo integrator. In addition, 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 met, 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 error 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 the effects of fish behaviour on acoustic abundance estimates are of great concern. This is of particular importance if pelagic fish are schooling close to the surface or performing vessel avoidance, in which case substantial underestimation of the fish abundance may occur.

Nevertheless, a horizontal guided sonar may be used to record schools that are avoiding the vessel or occurring close to surface. The sonar should be of the multi beam 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.

The main objective of this cruise was therefore to investigate the possibility of using the sonar method to improve the reliability of acoustic abundance estimation of the pilchard and the sardinella resources of Namibia and Angola, respectively. This was done by conducting comparative surveys and by operating a multi beam 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 have to be established.

1.2 Participation

The scientific staff consisted of :

From the NatMIRC, Namibia:

David BOYER (Team leader from 25/6/96 - 1/7/96), Rudi CLOETE, Deon van VUUREN, Michael EVENSON and Antoinette HEITA.

From IIP, Luanda, Angola:

N'Kosi LUYEYE and Miguel Andrei ANTONIO (from 1/79/6)

From Sea Fisheries Research Institute, Cape Town, South Africa:

Janet COETZEE

From IMR, Bergen, Norway:

Ole Arve MISUND (Cruise leader), Svein FLOEN, Bjarte KVINGE and Jarle KRISTIANSEN.

1.3 Schedule

The DR. FRIDTJOF NANSEN departed from Walvis Bay harbour on the 25 th of June 1996 at 21:15 and started to survey northwards along the Namibian coast in search of suitable pilchard shoals on which to conduct behavioural experiments. The survey of the Namibian and southern Angolan pelagic stocks was completed on the 29 th of June. The DR. FRIDTJOF NANSEN then steamed straight to Luanda, arriving on the 1 st of July at 07:00 to obtain a research permit for Angola and to collect the Angolan participants.

1.4 Background

In order to perform experiments on schooling behaviour suitable concentrations of fish had to be found. Previous surveys had indicated that the northern Benguela pilchard population was at such a low level that such concentrations of this species were unlikely to be available. However, during the horse mackerel survey immediately prior to this survey several dense shoals of pelagic fish were recorded between $19^{0}00$ and $20^{0}00$. No trawl samples were taken, but from the density they were assumed to be pilchard.

It was therefore decided to search for suitable shoals within the Namibian region and if found to spend the rest of the time available working on these shoals. If such shoals were not found, the DR. FRIDTJOF NANSEN would sail to Luanda, collect a permit to work in Angola together with two Angolan scientists and then study the shoaling behaviour of sardinella.

Two and half days were available to determine whether sufficient pilchard shoals could be found in Namibian waters, after which a decision to travel to Angola to work on sardinella had to be taken (by midday on 28 th June).

As a thorough search of the distributional area of pilchard was to be conducted, it was decided to use the data collected to estimate the biomass of the Clupeiforme species; pilchard, anchovy and round herring, occurring in the northern Benguela. The DR. FRIDTJOF NANSEN had to leave the Namibian region by the morning of 29 th in order to arrive in Luanda timorously, therefore only four days were available to complete the survey. Because of the short time available the resulting biomass estimate will probably be imprecise but it will at least provide an indication of the biomass of each species.

1.5 Objectives

The inshore region north of Walvis Bay was surveyed to:

- find suitable pilchard shoals for behaviour experiments

- estimate the total biomass of pilchard, anchovy and round herring in the northern Benguela.

CHAPTER 2 METHODS

2.1 Hydrography

The only hydrographic information collected during this part of the survey wasea temperature using the on-board temperature probe.

2.2 Survey area

In order to make maximum use of the time available, the main target area of the survey was restricted to the distribution of pilchard, anchovy and roundhering fish recorded by the DR. FRIDTJOF NANSEN during the horse mackerel survey of the previous weeks, i.e. between 21°00=S and 19°00=S, and from the coast to the 100 m isobath. North of this area, and into southern Angola was to be searched if time permitted, although commercial fishing vessels had failed to find any fish of catchable quantities during the previous month in this region. The region south of Walvis Bay was not searched at all, as both the DR. FRIDTJOF NANSEN and fishing vessels had reported only a few scattered shoals of juvenile fish occurring in this region during the previous month.

The DR. FRIDTJOF NANSEN left Walvis Bay at 21h00 on 25th June 1996 and steamed northwards. The following search patterns were used:

23°00'S - 21°00'S - A zig-zag course between the 20 and 120 m isobaths with course changes every 15= latitude.

21°00'S - 19°40'S- A zig-zag course between the 20 and 120 m isobaths with course changes every 10= latitude.

19°40'S - 18°40'S - A Z-shaped course between the 20 m and 100 to 120 m isobaths with 10= latitude between the perpendicular legs.

18°40'S - 16°30'S - A zig-zag course between the 20 and 100 m isobaths with 10= latitude intervals.

16°30'S - 16°00'S - A zig-zag course between the 20 and 75 m isobaths with course changes every 10= latitude.

Special searches inside of Cape Frio reef and in Baía dos Tigres were made.

The DR. FRIDTJOF NANSEN arrived at 16°00 at 15h00 on 29th June 1996 and proceeded directly to Luanda arriving at 08h00 on 1st July. A total of 870 NM were travelled during the survey and a further 430 NM in transit to Luanda.

The course track with the trawling stations is shown in Figure 1a and b.

2.3 Acoustic sampling methods and data analysis

A description of the acoustic instruments and their standard settings are given in Annex I, including a description of the fishing gear used.

The EK 500 system provided measurements of fish densities, averaged over 5 NM intervals. The scrutinising process of the Bergen Echo Integrator, BEI, was used to partition integrator data to species or species groups by separating echo recordings horizontally or vertically. Integrator data from fish targets were allocated to the following groups on the basis of trawl sampling and acoustic character, as recognised from the echo recordings: Pilchard, Anchovy, Round herring, Horse mackerel, Plankton and mesopelagic, including mixed layers of mesopelagic organisms containing horse mackerel.

The average S_A-values within an area were then obtained by averaging all intervals measured during the coverage of that area, excluding those values obtained during searching off the transact or trawling against the course line. The area was calculated in cm^2 with a planimeter and converted to NM^2.

n mi²

Det skal ikke være NM^2 men n mi². Det står for: (nautical mile)². Kun på 2.23 i del II er dette riktig. Ellers må det rettes opp i hele rapporten.

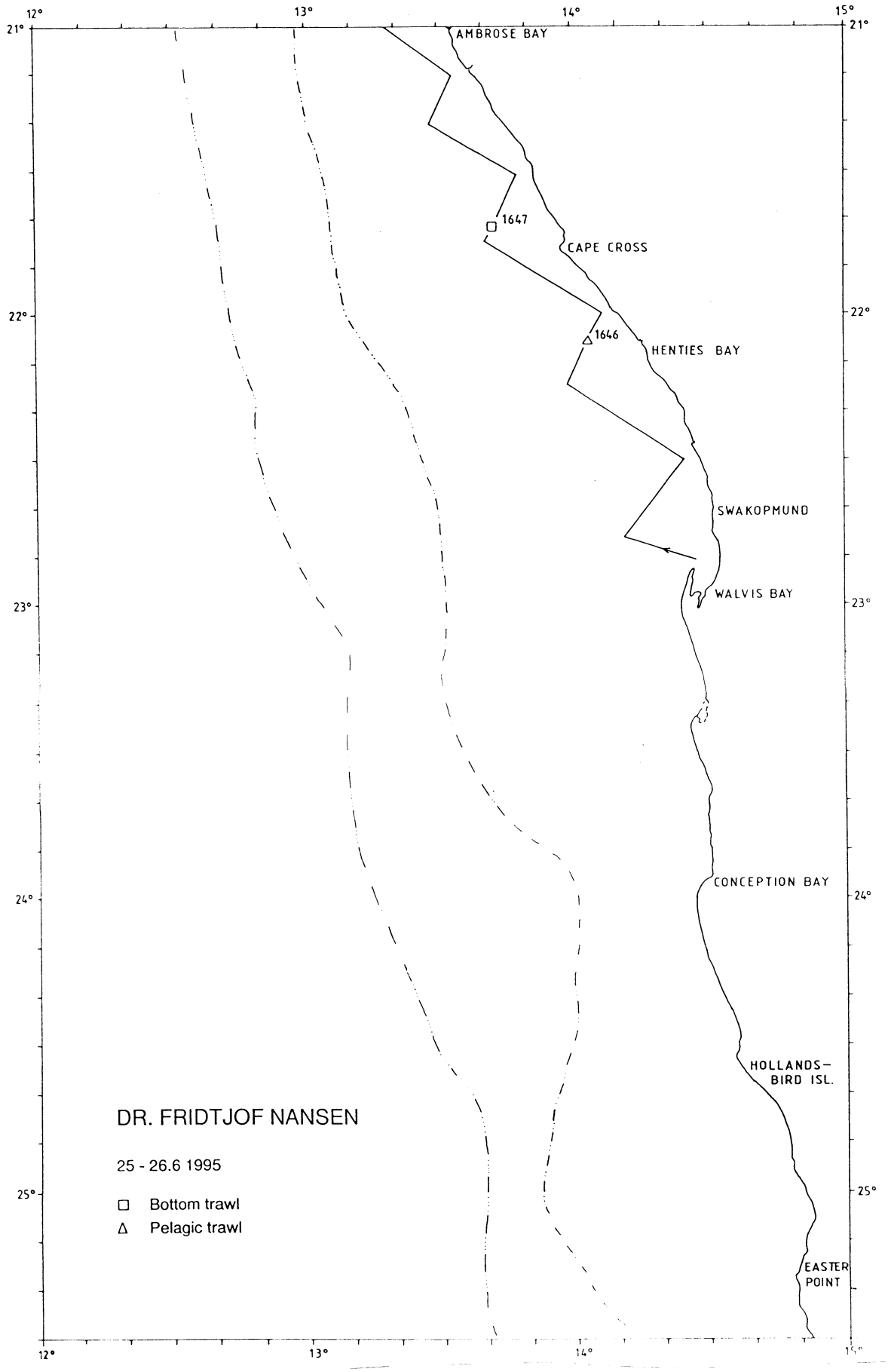


Figure 1a. Course track and fishing stations, Walvis Bay to Ambrose Bay.

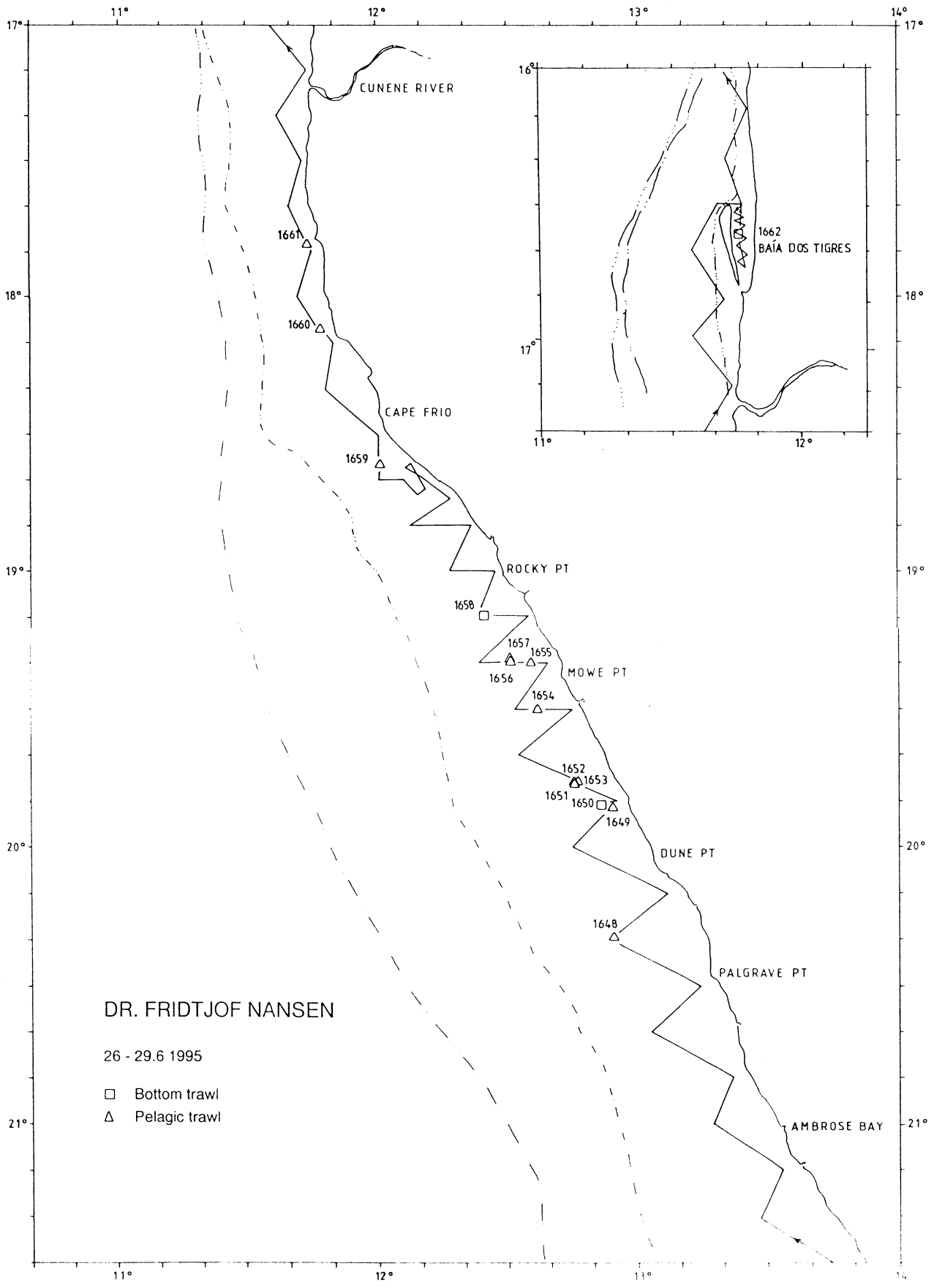


Figure 1b. Course track and fishing stations, Ambrose Bay to Báa dos Tigres.

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

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

where the total length of the fish, L is expressed in centimetres. This target strength to size relationship has been used for a number of fish species (horse mackerel, pilchard, anchovy and round herring), although originally derived from early measurements of North Sea herring.

The number of fish in each length group in an area was calculated by applying the following formula:

$$N_i = S_A * A * P_i / \Sigma^{n}_{I=1} (P_i / C_{Fi})$$

where

N_i = number of fish in length group I

A = area in NM^2 n mi^2

S_A = mean integrator value in the area

P_i = proportion of fish in length group I in samples from the area

C_{Fi} = fish conversion factor for length group I

The fish conversion factor was calculated from the measured length/weight relationship of similar sized fish obtained during a previous survey at the same time of year (June 1994):

Pilchard	$W = 0.0050\ L^{3.0871}$
Anchovy	$W = 0.0061\ L^{2.9850}$
Round herring	$W = 0.0051\ L^{3.0618}$

The number per length group was then summed and the total number of fish obtained. The total biomass of fish was computed using the mean weight per length group.

2.4 Sonar recording

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, Normalisation and Ping-to-Ping filters set to step weak. The tilt was kept from - 3^0 to - 8^0 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 clupeoids or mixed pelagic species. 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. 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 composition of all trawls was pooled per area by simple adding.

CHAPTER 3 RESULTS OF THE ACOUSTIC AND TRAWL SURVEY

3.1 Hydrography

During the horse mackerel survey (4/6 to 23/6) strong upwelling was recorded throughout the entire region surveyed. Reduced winds and calm conditions during this survey had resulted in an increase in the sea surface temperature by approximately 1^0C, particularly in the north. The distribution of sea temperature is shown in figure 2 a and b. The detection range of the sonar SA950 was particularly good during this survey, also indicating that the upwelling intensity was reduced and that the relatively steep thermoclines recorded earlier in June had become flatter.

3.2 Distribution

The distributions of pilchard, round herring and anchovy are shown in Figures 3a-c. The scale used in the distribution charts to illustrate different levels of density is presented in absolute acoustic units, which is the mean integrator value S_A for a given area. Three regions of Clupeiforme fish were found. A relatively large region of dispersed pelagic shoals occurred from Rocky Point to Dune Point. The trawl samples indicated that these fish were predominantly juvenile pilchard. Several fairly large shoals were recorded by sonar in this region, but did not coincide with the random course track and so are excluded from the biomass estimate calculated from the echo-sounder system.

Two smaller areas of fish were found; mixed round herring and anchovy north of Cape Frio, and in BaRa dos Tigres. A single trawl in BaRa dos Tigres was attempted, but due to debris on the bottom (possibly wrecks) it was not possible to obtain a representative sample. The few fish caught were mostly anchovy, Cunene horse mackerel and large eye dentex.

Juvenile horse mackerel were dispersed throughout the regions where the Clupeiforme fish occurred, usually between the shoals. Few trawls were targeted on

horse mackerel as a survey targeted specifically on this species had just been completed. No fish targets of any sort were seen in Angolan waters south of Baía dos Tigres.

3.3 Abundance

The abundance estimates obtained during the survey are probably imprecise as the areas with fish were only surveyed once. The total estimated biomass of pilchard, anchovy and round herring is summarised in Table 1 and provided in weight and number of fish per area in Annex II.

Table 1 The biomass estimates (in tonnes) per area of the Clupeiforme fish in Namibia and southern Angola

Area	Pilchard	Anchovy	Round herring
Baía dos Tigres	0	1 500	0
17°30 - 18°30	100	1 500	4 200
19°00 - 20°00	14 900	1 700	7 800
Total	15 000	4 700	12 000

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 S_A values, number of schools and summed maximum school area were then scaled to one square nautical mile. The summed maximum school area allocated to clupeoids were then allocated to anchovy, round herring or pilchard according the species allocation of the S_A values for each five nautical mile.

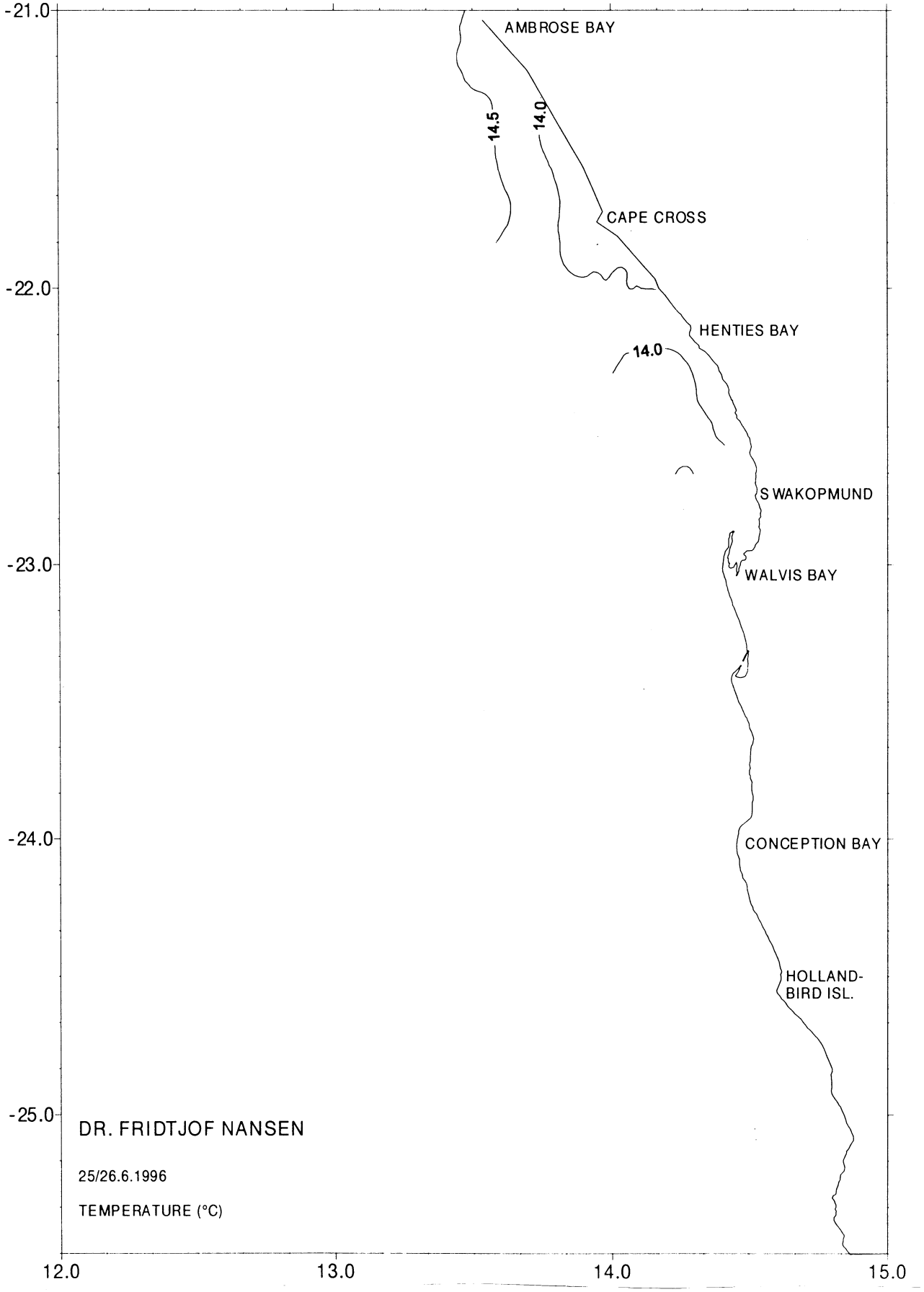


Figure 2a: Sea surface temperature, Walvis Bay to Ambrose Bay.

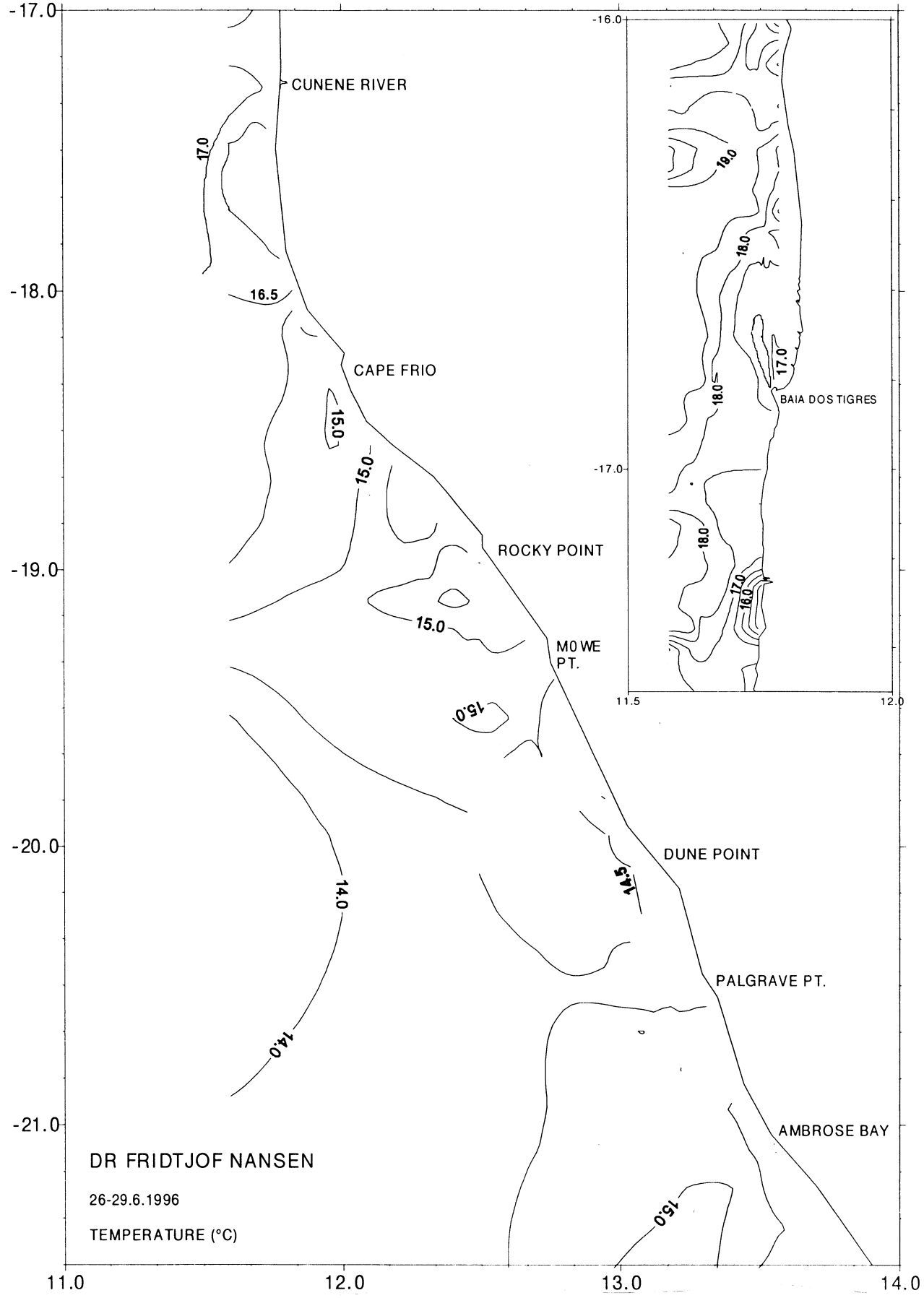


Figure 2b: Sea surface temperature, Ambrose Bay to Baía dos Tigres.

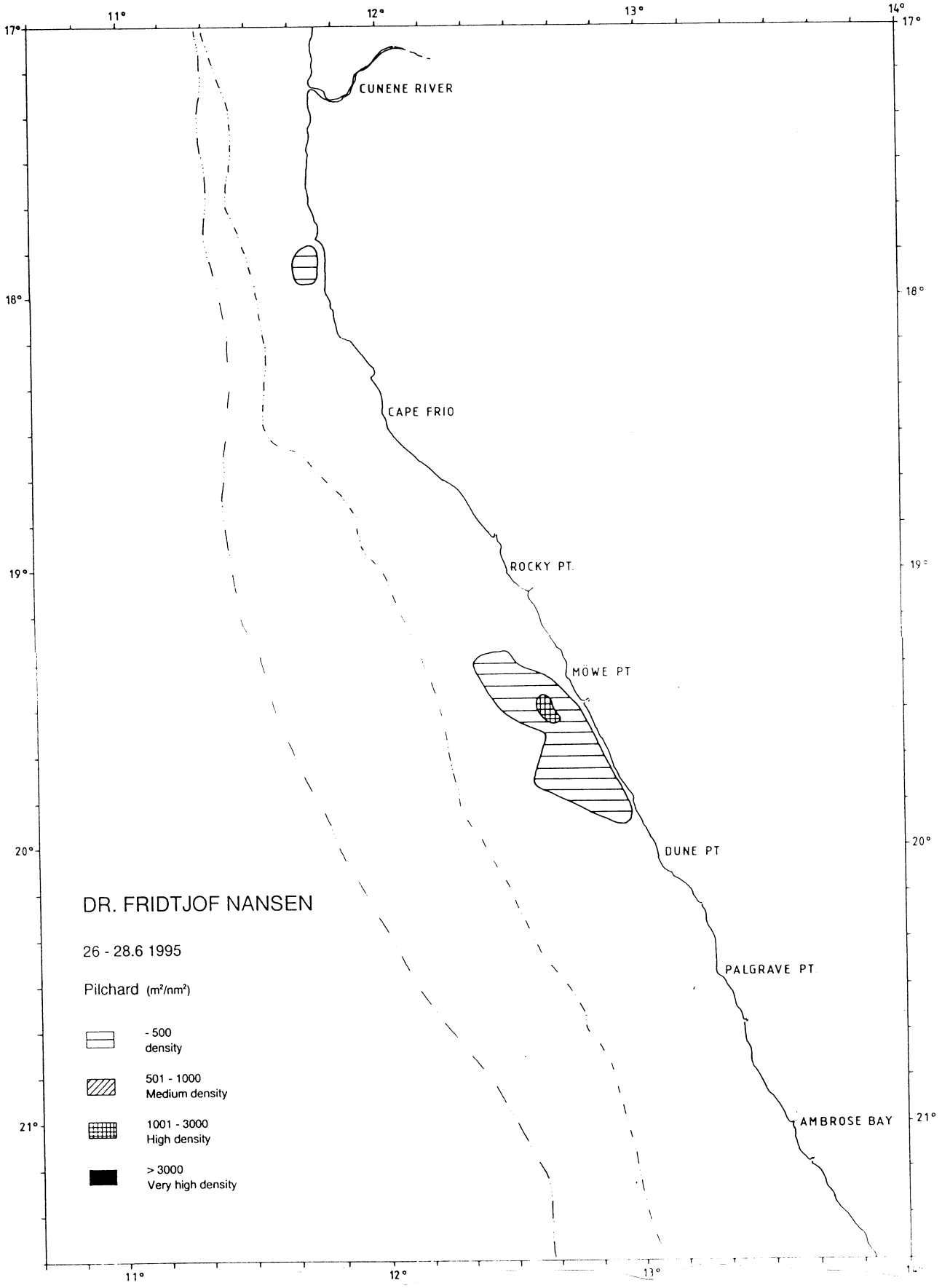


Figure 3a: Distribution of pilchard, Ambrose Bay to Cunene River

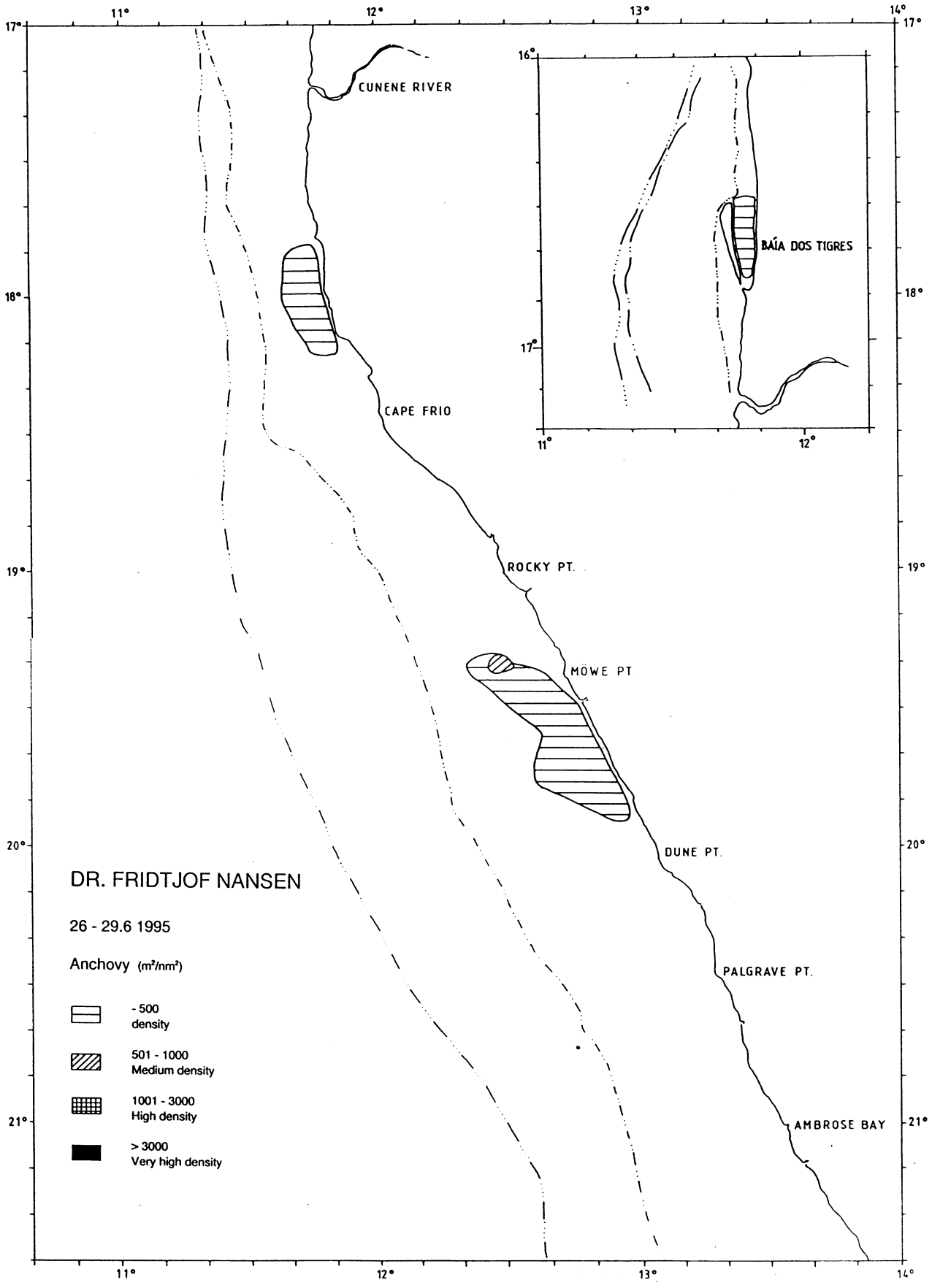


Figure 3b: Distribution of anchovy, Ambrose Bay to Cunene River, and southern Angola. (insert)

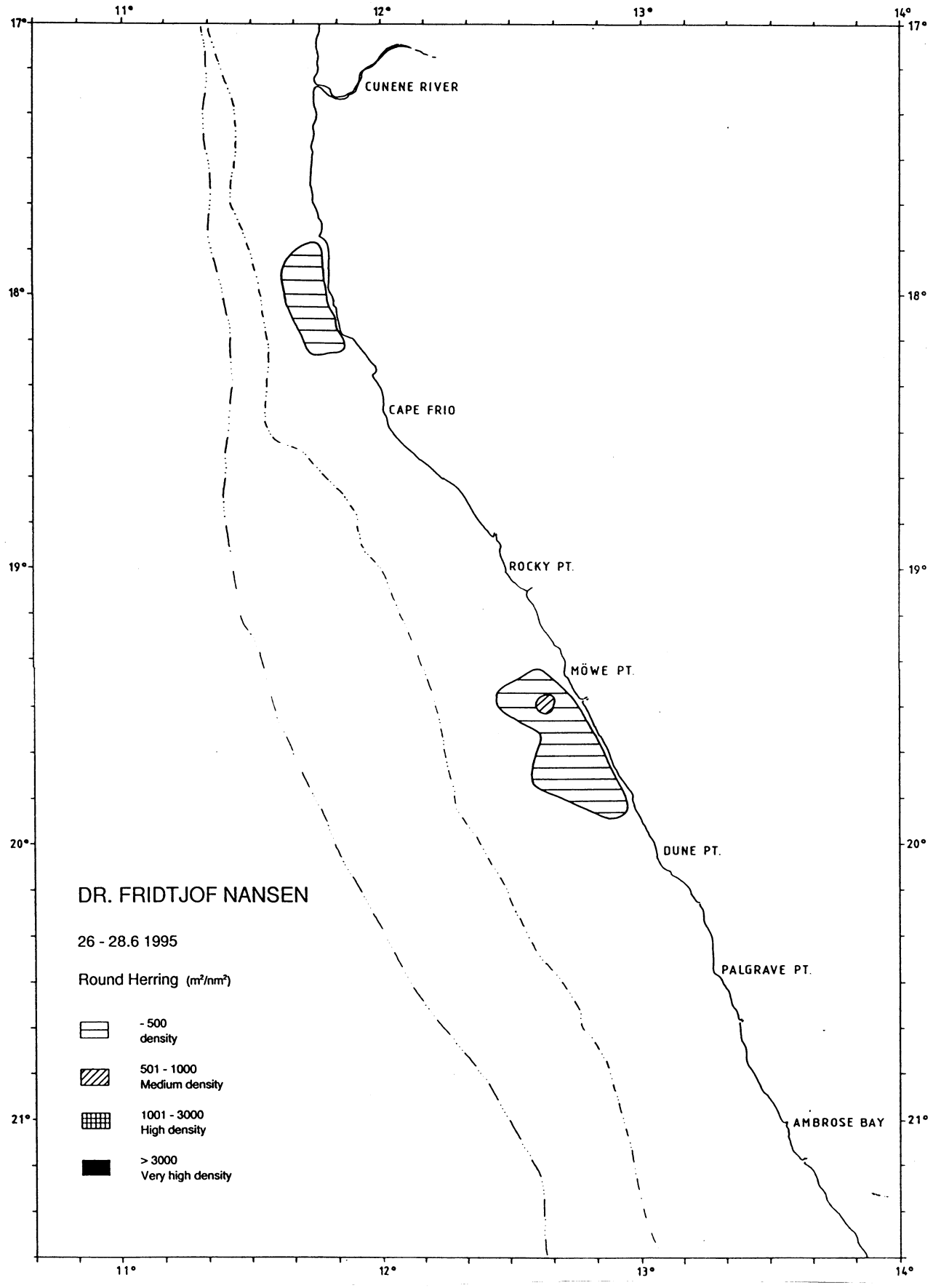


Figure 3c: Distribution of round herring, Ambrose Bay to Cunene River.

The S_A - values allocated to pilchard were then converted to fish density (ρ_{echo}) using the following equations;

$$\rho_{echo} = (S_A / \sigma) * w/1000 \qquad \text{(tonnes NM}^{-2}\text{)}$$

where

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

and $$w = (0.005 * {}^{L3.0871})/1000$$

The fish length/weight (w) -equation for pilchard was established during a previous survey by DR. FRIDTJOF NANSEN off Namibia in June 1994.

The summed maximum school area allocated to pilchard was converted to fish density (ρ_{sonar}) using the equation;

$$(\rho_{sonar} = ((\text{school area}) * 10.4)/1000 \qquad \text{(tonnes NM}^{-2}\text{)}$$

This relationship was established by sonar measurements and echo integration of pilchard schools during a cruise by DR. FRIDTJOF NANSEN in False Bay, South Africa, October 1995.

Significant pilchard recordings were found within a limited area off M we Point only, and the comparison of the sonar and echo integration estimates of pilchard density is limited to that region which was explored from vessel log 750 to 900. In general there was a good correspondence, and a significant correlation ($r=0.83$, $p < 0.05$) between the sonar and echo integration estimates of pilchard density (Figure 4). The average density of pilchard within the area as recorded by echo integration was 19.3 tonnes.NM^{-2}, while the average density of pilchard as recorded by the sonar method was 17.2 tonnes. NM^{-2}. However, there was no significant difference (Wilcoxon test, $p > 0.05$) between the average density of pilchard as measured by echo integration or the sonar method.

3.5 Length-frequency

Annex V shows the length-frequency of the three target species.

PILCHARD RECORDINGS OFF MOEVE POINT, NAMIBIA, JUNE 1996

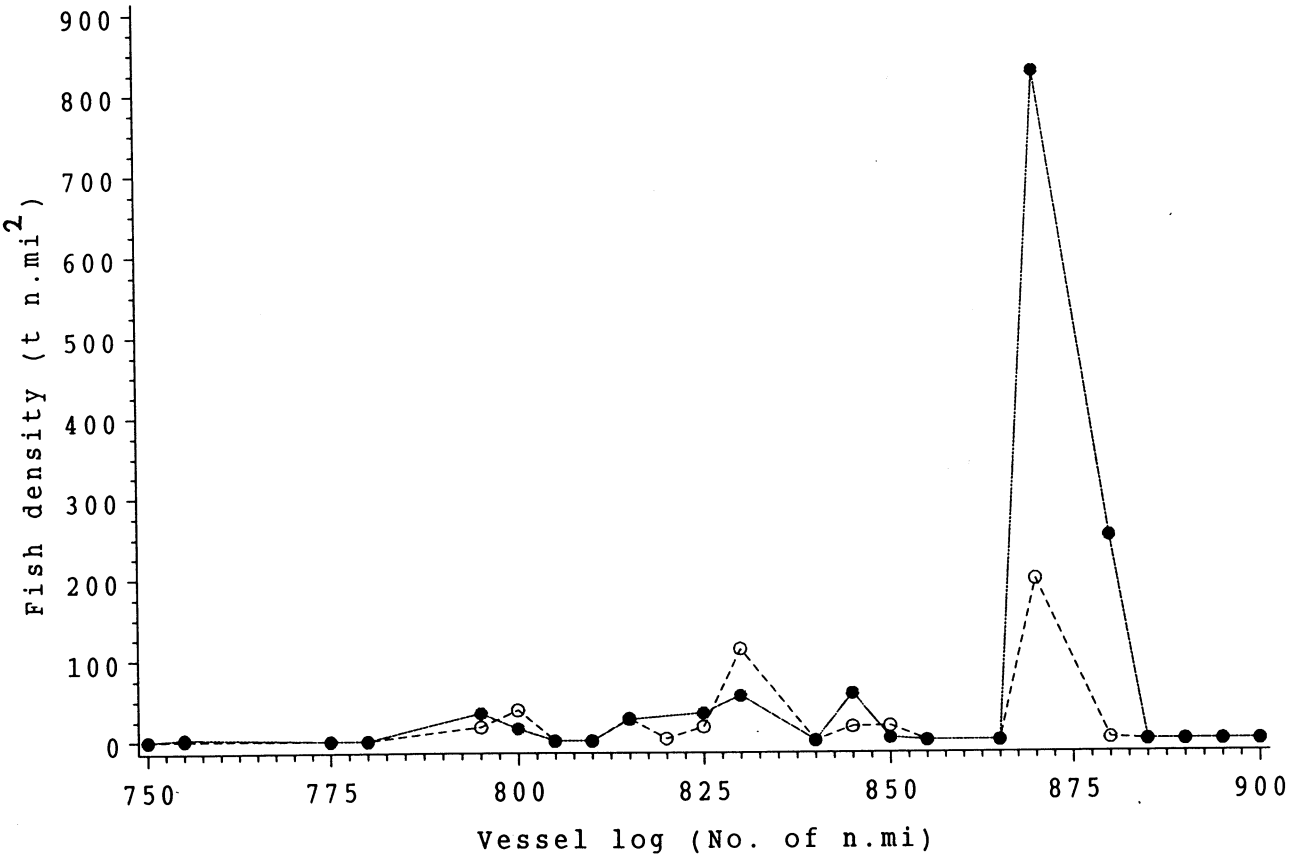


Figure 4. Comparison of the sonar and echo integration estimates of pilchard density.

(Solid lines = sonar recordings, broken lines = echo sounder recordings).

CHAPTER 4 CONCLUDING REMARKS

This survey was a very brief assessment of the assumed area of distribution of pilchard, anchovy and round herring in the northern Benguela. While the results may not be as precise as previous acoustic abundance estimates, they should be indicative of the general state of these stocks.

Conditions were favourable for an acoustic survey throughout the survey period. Weather conditions were good and in general the fish seemed to be distributed within the transducer range both day and night. One incidence of fish moving to the surface, and above the transducer range, occurred just after sunset indicating that some fish may have been missed during the night. All of the areas where fish were found were surveyed just once, hence it is not possible to assess by comparative surveys whether fish were missed due to diurnal migrations taking the fish outside of the transducer range. However continual use of the scientific sonar Simrad SA950 showed that fish did not move to the surface in large quantities and it can therefore be assumed that the assessed fish was a representative sample of the population.

In general the biomass estimates were low for all species. The total absence of adult pilchard supports previous surveys that the stock is in a critical situation. A few adult pilchard were found during the horse mackerel survey a few days before this survey.

It should however be noted that when the stock size of a shoaling species such as pilchard becomes extremely low the chances of detecting the few shoals remaining becomes highly variable and any resulting estimate can be subject to large errors.
This is well illustrated by comparing the biomass estimates from this survey with those recorded during the horse mackerel survey earlier in the month (Table 2).

Table 2. Comparison of biomass estimates (in tonnes) from two consecutive surveys					
Survey	Period	Pilchard	Anchovy	R.herring	Total
Clupeiforme survey	25-29/6	15 000	3 000	12 000	30 000
H.mackerel survey	4-23/6	7 000	16 000	49 000	72 000

Parallel transacts were used during the horse mackerel survey and only data collected on the transacts which were perpendicular to coast were used to calculate these biomasses. The acoustic data from the horse mackerel survey were analysed and the integration values for the Pelagic 1 mix were then divided between pilchard, anchovy and round herring. It should be noted however that some dense shoals, possibly of adult pilchard, were observed during the shoreward passage between transacts which were not seen in the subsequent Clupeiforme survey some 10 days later. The integration values from these dense shoals were not used in the biomass calculations as they did not occur on the parallel transacts.

Additionally, rather few trawls were made on these species during both of these surveys, thus the species identification is rather tenuous. The total biomass of all three species combined should not be affected by this limitation.

Only juvenile pilchard and round herring, and mixed adult and juvenile anchovy, were found during this survey. One shoal containing some adult pilchard was sampled in 124 m of water at $21^{0}00$ during the preceding horse mackerel survey, together with another trawl which contained a few individual adult pilchard in a round herring shoal at $17^{0}41$. Even if these data were incorporated into the biomass calculations of adult pilchard, the total biomass remains extremely small.

In comparison to estimates made in June of previous years, the number of juvenile pilchard is higher this year. The errors in estimating juvenile fish prior to October have been outlined in previous reports and therefore it may be dangerous to read too much into this comparison. The indications are however promising for a better recruitment than has occurred for several years.

Apart from some Cunene horse mackerel and anchovy in BaRa dos Tigres, no pelagic fish were recorded north of the Cunene River, indicating that even though the horse mackerel survey did not include southern Angolan, little fish was missed.

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. Complete drawings of the trawls used are included.

Annex II Biomass And Number Of Fish Per Area

Total biomass (tonnes) of Clupeiform fish, and total number per 1 cm length class (in millions) per area

Area		Pilchard			Anchovy			Round herring		
		17°30'-18° 30'	19°00'-20°00	Total	17°30'-18° 30'	19°00'-20°00	Total	17°30'-18° 30'	19°00'-20°00	Total
Size of area (nm²)		20	544		92	500		235	465	
Mean SA value (m²/nm²)		47	362		196	46		219	178	
Total biomass (tonnes)		81	14894	**14975**	1526	1719	**3244**	4252	7804	**12056**
	cm									
No. of fish per length class (mill.)	6	0	0	0	0	0	0	0	0	0
	7	0	10	10	0	0	0	1	0	1
	8	1	15	16	0	8	8	6	0	6
	9	0	49	49	0	63	63	42	0	42
	10	2	1009	1011	10	80	89	121	72	193
	11	0	739	739	33	60	93	145	118	263
	12	1	122	123	57	22	78	65	82	147
	13	4	78	82	41	9	50	55	174	229
	14	0	0	0	5	4	9	29	126	155
	15	0	0	0	0	0	0	6	34	40
	16	0	0	0	0	0	0	1	6	7
	17	0	0	0	0	0	0	0	0	0
Total		8	2 022	**2 030**	145	247	**392**	472	612	**1 084**

Annex III Summary Of Trawl Stations

Trawl number	Latitude (°S)	Bottom depth (m)	Headrope depth (m)	Catch by species (% of total catch)				Total catch (kg)
				Sardinops o.	*Engraulis c.*	*Etrumeus w.*	*Trachurus sp.*	
1646	22.06	59	30	-	1	-	1	11
1647	21.42	89	89	-	-	-	-	No catch
1648	20.19	122	0	2	1	19	78	10
1649	19.51	42	16	5	9	72	14	149
1650	19.51	64	64	-	-	-	100	733
1651	19.50	84	18	-	-	-	100	76
1652	19.46	86	33	-	-	-	100	60
1653	19.46	86	40	55	44	-	1	8000
1654	19.30	86	53	48	1	46	6	480
1655	19.20	68	23	-	-	-	100	45
1656	19.19	102	13	1	37	2	60	15
1657	19.19	103	7	80	20	-	-	85
1658	19.09	102	102	-	-	-	100	150
1659	18.36	74	20	-	-	-	100	13
1660	18.06	49	30	1	17	76	7	14
1661	17.50	36	0	3	30	59	8	107
1662	16.37	22	22	-	22	-	41	16

Annex IV Records Of Fishing Stations

PROJECT STATION:1646
DATE:26/ 6/96 GEAR TYPE: PT No:1 POSITION:Lat S 2206
start stop duration Long E 1403
TIME :04:25:00 04:35:00 10 (min) Purpose code: 1
LOG : 509.00 509.60 0.60 Area code : 2
FDEPTH: 30 33 GearCond.code: 1
BDEPTH: 59 57 Validity code: 1
Towing dir: 30° Wire out: 120 m Speed: 30 kn*10

Sorted: Kg Total catch: 10.97 CATCH/HOUR: 65.82

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Sufflogobius bibarbatus	60.00	57270	91.16	
Trachurus capensis	5.28	636	8.02	5411
Chelidonichthys capensis	0.36	6	0.55	
Cynoglossus capensis	0.12	6	0.18	
Engraulis capensis	0.06	12	0.09	5412
J E L L Y F I S H	0.00			
Total	65.82		100.00	

PROJECT STATION:1647
DATE:26/ 6/96 GEAR TYPE: BT No:1 POSITION:Lat S 2141
start stop duration Long E 1342
TIME :09:38:00 09:47:00 9 (min) Purpose code: 1
LOG : 558.10 558.50 0.40 Area code : 2
FDEPTH: 89 90 GearCond.code: 1
BDEPTH: 89 90 Validity code:
Towing dir: 225° Wire out: 300 m Speed: 3 kn*10

Sorted: Kg Total catch: CATCH/HOUR:

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
N O C A T C H	0.00			
Total				

PROJECT STATION:1648
DATE:26/ 6/96 GEAR TYPE: PT No:2 POSITION:Lat S 2019
start stop duration Long E 1254
TIME :23:04:00 23:10:00 6 (min) Purpose code: 1
LOG : 700.00 700.30 0.30 Area code : 3
FDEPTH: 0 0 GearCond.code: 9
BDEPTH: 122 119 Validity code: 1
Towing dir: 236° Wire out: 120 m Speed: 30 kn*10

Sorted: 10 Kg Total catch: 9.81 CATCH/HOUR: 98.10

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus capensis	76.20	8520	77.68	5414
Etrumeus whiteheadi	18.60	1710	18.96	5413
Sardinops ocellatus	2.10	210	2.14	5416
Engraulis capensis	1.20	120	1.22	5415
J E L L Y F I S H	0.00	8000		
Total	98.10		100.00	

PROJECT STATION:1649
DATE:26/ 6/96 GEAR TYPE: PT No:1 POSITION:Lat S 1950
start stop duration Long E 1254
TIME :04:47:00 05:05:00 18 (min) Purpose code: 1
LOG : 758.80 759.90 1.10 Area code : 3
FDEPTH: 16 10 GearCond.code: 1
BDEPTH: 42 53 Validity code: 1
Towing dir: 224° Wire out: 100 m Speed: 35 kn*10

Sorted: Kg Total catch: 149.20 CATCH/HOUR: 497.33

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Etrumeus whiteheadi	356.00	30050	71.58	5420
Trachurus capensis	68.50	8000	13.77	5418
Engraulis capensis	43.50	4200	8.75	5417
Sardinops ocellatus	24.00	2100	4.83	5419
Galeichthys feliceps	5.33	17	1.07	
J E L L Y F I S H	0.00	4000		
Total	497.33		100.00	

PROJECT STATION:1650
DATE:27/ 6/96 GEAR TYPE: BT No:1 POSITION:Lat S 1951
start stop duration Long E 1252
TIME :05:45:00 05:58:00 13 (min) Purpose code: 1
LOG : 761.80 762.50 0.70 Area code : 3
FDEPTH: 64 65 GearCond.code: 1
BDEPTH: 64 65 Validity code:
Towing dir: 330° Wire out: 250 m Speed: 30 kn*10

Sorted: 30 Kg Total catch: 733.06 CATCH/HOUR: 3383.35

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus capensis	3375.00	199731	99.75	5422
Trigla lyra	5.17	9	0.15	
Merluccius sp.	2.77	115	0.08	
Galeichthys feliceps	0.42	5	0.01	
Total	3383.36		99.99	

PROJECT STATION:1651
DATE:27/ 6/96 GEAR TYPE: PT No:1 POSITION:Lat S 1950
start stop duration Long E 1255
TIME :07:54:00 08:09:00 15 (min) Purpose code: 1
LOG : 780.50 781.50 1.00 Area code : 3
FDEPTH: 18 20 GearCond.code: 1
BDEPTH: 84 85 Validity code:
Towing dir: 110° Wire out: 120 m Speed: 30 kn*10

Sorted: 22 Kg Total catch: 76.48 CATCH/HOUR: 305.92

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus capensis	305.92	30284	100.00	5423
J E L L Y F I S H	0.00	16800		
Total	305.92		100.00	

PROJECT STATION:1652
DATE:27/ 6/96 GEAR TYPE: PT No:1 POSITION:Lat S 1946
start stop duration Long E 1245
TIME :09:10:00 09:25:00 15 (min) Purpose code: 1
LOG : 785.90 786.80 0.90 Area code : 3
FDEPTH: 33 40 GearCond.code: 1
BDEPTH: 86 85 Validity code:
Towing dir: 24° Wire out: 120 m Speed: 30 kn*10

Sorted: 6 Kg Total catch: 60.00 CATCH/HOUR: 240.00

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus capensis	240.00	24376	100 00	5424
J E L L Y F I S H	0.00	4800		
Total	240.00		100.00	

PROJECT STATION:1653
DATE:27/ 6/96 GEAR TYPE: PT No:1 POSITION:Lat S 1946
start stop duration Long E 1245
TIME :10:10:00 10:16:00 6 (min) Purpose code: 1
LOG : 789.50 789.80 0 30 Area code : 3
FDEPTH: 40 50 GearCond.code: 1
BDEPTH: 86 85 Validity code: 1
Towing dir: 295° Wire out: 150 m Speed: 31 kn*10

Sorted: 38 Kg Total catch: 8000.00 CATCH/HOUR: 80000.00

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Sardinops ocellatus	44390.00	4361920	55 49	5425
Engraulis capensis	35420.00	4445370	44 28	5426
Trachurus capensis	190.00	18770	0.24	5427
Total	80000.00		100 01	

PROJECT STATION:1654
DATE:27/ 6/96 GEAR TYPE: PT No:1 POSITION:Lat S 1930
start stop duration Long E 1237
TIME :14:38:00 14:42:00 4 (min) Purpose code: 1
LOG : 830.10 830.30 0.20 Area code : 3
FDEPTH: 53 50 GearCond.code: 9
BDEPTH: 86 85 Validity code: 1
Towing dir: 84° Wire out: 170 m Speed: 30 kn*10

Sorted: 8 Kg Total catch: 480.00 CATCH/HOUP: 7200.00

SPECIES	CATCH/HOUR weight	numbers	% OF TOT C	SAMP
Sardinops ocellatus	3422.70	328845	47.54	5428
Etrumeus whiteheadi	3288.45	176400	45.67	5429
Trachurus capensis	421.80	63270	5.86	5430
Engraulis capensis	67.05	5745	0.93	5431
Aequorea aequorea	0.00	76695		
Total	7200.00		100.00	

PROJECT STATION:1655
DATE:27/ 6/96 GEAR TYPE: PT No:1 POSITION:Lat S 1920
start stop duration Long E 1235
TIME :17:40:00 17:45:00 5 (min) Purpose code: 1
LOG : 858.60 858.90 0 30 Area code : 3
FDEPTH: 23 23 GearCond.code: 1
BDEPTH: 68 67 Validity code:
Towing dir: 90° Wire out: 100 m Speed: 31 kn*10

Sorted: 7 Kg Total catch: 45.00 CATCH/HOUR: 540.00

SPECIES	CATCH/HOUR weight	numbers	% OF TOT C	SAMP
Trachurus capensis	540.00	35076	100 00	5432
Aequorea aequorea	0.00	22440		
Total	540.00		100.00	

PROJECT STATION:1656

DATE:27/ 6/96 GEAR TYPE: PT No:1 POSITION:Lat S 1919
start stop duration Long E 1230
TIME :19:03:00 19:13:00 10 (min) Purpose code: 1
LOG : 869.20 869.80 0.60 Area code : 3
FDEPTH: 13 15 GearCond.code: 1
BDEPTH: 102 98 Validity code:
Towing dir: 90° Wire out: 100 m Speed: 31 kn*10

Sorted: 5 Kg Total catch: 15.00 CATCH/HOUR: 90.00

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus capensis	54.06	10722	60.07	5434
Engraulis capensis	33.36	4632	37.07	5433
Etrumeus whiteheadi	1.38	138	1.53	5436
Sardinops ocellatus	1.20	174	1.33	5435
Aequorea aequorea	0.00	3600		
Total	90.00		100.00	

PROJECT STATION:1657

DATE:27/ 6/96 GEAR TYPE: PT No:1 POSITION:Lat S 1919
start stop duration Long E 1229
TIME :19:48:00 19:51:00 3 (min) Purpose code: 1
LOG : 871.20 871.30 0.10 Area code : 3
FDEPTH: 7 7 GearCond.code: 1
BDEPTH: 103 103 Validity code:
Towing dir: 285° Wire out: 50 m Speed: 30 kn*10

Sorted: 9 Kg Total catch: 85.38 CATCH/HOUR: 1707.60

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Sardinops ocellatus	1363.40	111280	79.84	5437
Engraulis capensis	344.20	38820	20.16	5438
Total	1707.60		100.00	

PROJECT STATION:1658

DATE:27/ 6/96 GEAR TYPE: BT No:9 POSITION:Lat S 1909
start stop duration Long E 1224
TIME :23:37:00 23:54:00 17 (min) Purpose code: 1
LOG : 909.00 909.70 0.70 Area code : 3
FDEPTH: 102 97 GearCond.code: 1
BDEPTH: 102 97 Validity code: 1
Towing dir: 80° Wire out: 400 m Speed: 30 kn*10

Sorted: 12 Kg Total catch: 150.00 CATCH/HOUR: 529.41

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus capensis	512.26	9861	96.76	5439
Merluccius capensis	17.15	258	3.24	
Chrysaora sp.	0.00	635		
Total	529.41		100.00	

PROJECT STATION:1659

DATE:28/ 6/96 GEAR TYPE: PT No:1 POSITION:Lat S 1836
start stop duration Long E 1201
TIME :10:09:00 10:23:00 14 (min) Purpose code: 1
LOG :1015.30 1016.20 0.90 Area code : 3
FDEPTH: 20 25 GearCond.code: 1
BDEPTH: 74 80 Validity code:
Towing dir: 185° Wire out: 120 m Speed: 30 kn*10

Sorted: 7 Kg Total catch: 13.10 CATCH/HOUR: 56.14

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus capensis	56.14	6617	100.00	5440
Chrysaora sp.	0.00	159		
Total	56.14		100.00	

PROJECT STATION:1660

DATE:28/ 6/96 GEAR TYPE: PT No:1 POSITION:Lat S 1806
start stop duration Long E 1147
TIME :14:42:00 15:02:00 20 (min) Purpose code: 1
LOG :1059.20 1060.30 1.10 Area code : 3
FDEPTH: 30 25 GearCond.code: 1
BDEPTH: 49 49 Validity code: 1
Towing dir: 175° Wire out: 100 m Speed: 30 kn*10

Sorted: 13 Kg Total catch: 13.74 CATCH/HOUR: 41.22

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Etrumeus whiteheadi	19.29	1839	46.80	5441
Thyrsites atun	14.16	12	34.35	
Engraulis capensis	4.38	333	10.63	5442
Trachurus capensis	1.71	453	4.15	5443
SQUSE01	1.56	48	3.78	
Sardinops ocellatus	0.06	3	0.15	5444
SYGSY01	0.03	6	0.07	
Zeus faber	0.03	3	0.07	
Chrysaora sp.	0.00	54		
Total	41.22		100.00	

PROJECT STATION:1661

DATE:28/ 6/96 GEAR TYPE: PT No:2 POSITION:Lat S 1750
start stop duration Long E 1145
TIME :17:57:00 18:27:00 30 (min) Purpose code: 1
LOG :1087.60 1089.40 1.80 Area code : 3
FDEPTH: 0 0 GearCond.code: 1
BDEPTH: 36 52 Validity code:
Towing dir: 332° Wire out: 100 m Speed: 32 kn*10

Sorted: 11 Kg Total catch: 107.24 CATCH/HOUR: 214.48

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Etrumeus whiteheadi	185.22	12798	86.36	5448
Engraulis capensis	18.20	1520	8.49	5447
Trachurus capensis	4.70	168	2.19	5446
GEMYR01	4.42	4	2.06	
Sardinops ocellatus	1.88	132	0.88	5445
Todaropsis eblanae	0.06	4	0.03	
Total	214.48		100.01	

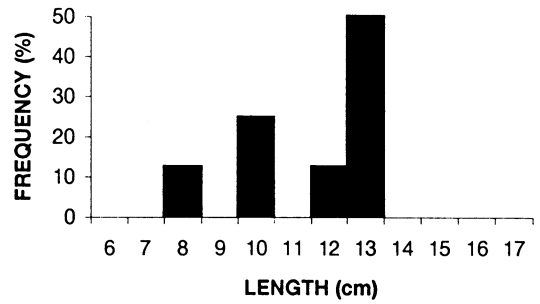
PROJECT STATION:1662

DATE:29/ 6/96 GEAR TYPE: BT No:1 POSITION:Lat S 1637
start stop duration Long E 1145
TIME :10:12:00 10:20:00 8 (min) Purpose code: 1
LOG :1233.30 1233.70 0.40 Area code : 3
FDEPTH: 22 22 GearCond.code: 1
BDEPTH: 22 22 Validity code:
Towing dir: 20° Wire out: 100 m Speed: 30 kn*10

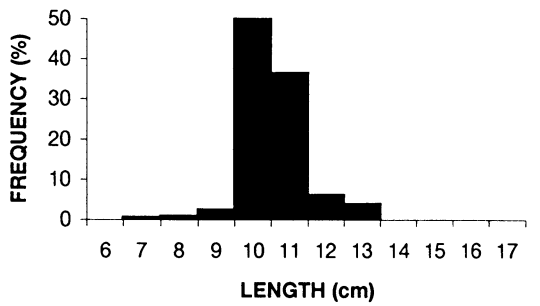
Sorted: Kg Total catch: 16.45 CATCH/HOUR: 123.38

SPECIES	CATCH/HOUR weight	numbers	% OF TOT. C	SAMP
Trachurus trecae	50.63	2370	41.04	5449
Dentex macrophthalmus	35.85	2798	29.06	
Engraulis capensis	27.08	1313	21.95	5450
Loligo reynaudi	9.15	270	7.42	
Lithognathus mormyrus	0.60	68	0.49	
Spondyliosoma cantharus	0.08	8	0.06	
Total	123.39		100.02	

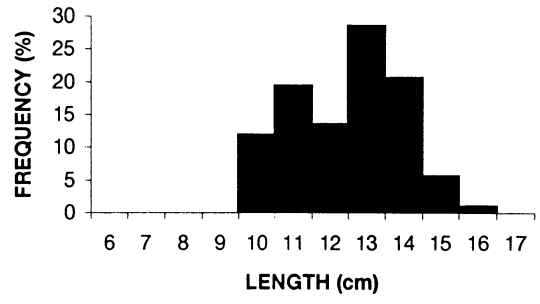
Annex V Size Distribution Per Area



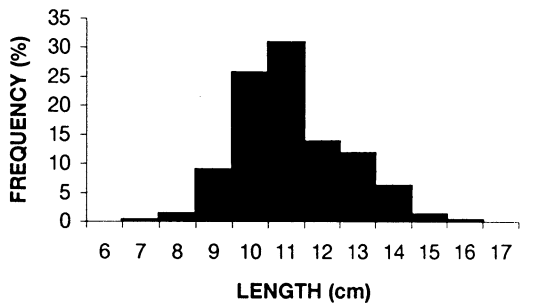
Sardinops ocellatus
17°30 - 18°00
Mean length = 12.0
N = 8



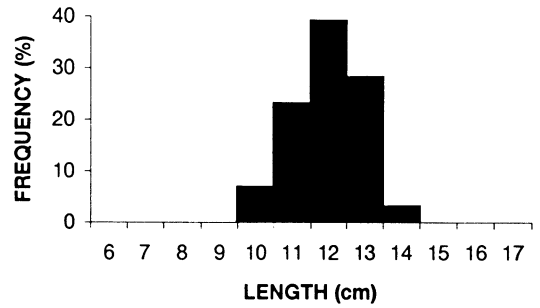
Sardinops ocellatus
19°00 - 20°00
Mean length = 11.05
N = 413



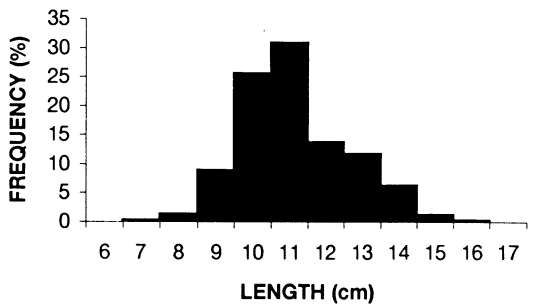
Etrumeus whiteheadi
17°30 - 18°30
Mean length = 11.64
N = 1710



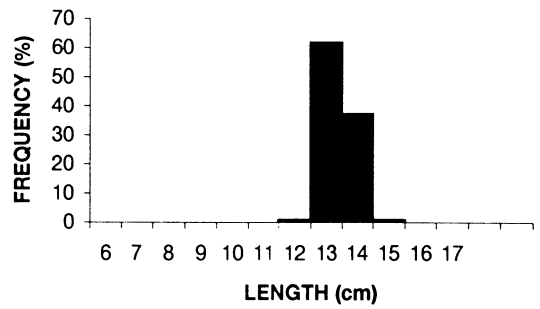
Etrumeus whiteheadi
19°00 -20°00
Mean length = 12.97
N = 306



Engraulis capensis
17°30 - 18°30
Mean length = 12.48
N = 192



Engraulis capensis
17°30 - 18°30
Mean length = 10.77
N = 555



Engraulis capensis
16°30 - 17°30
Mean length = 13.38
N = 175