PART I

SURVEYS OF THE HAKE STOCKS

23 April - 22 May 1992

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PART I

CHAPTER 1 INTRODUCTION

1.1 GENERAL OBJECTIVES

Following an offer from NORAD extended through FAO and UNDP, an agreement was reached in Windhoek in January 1990 between the UNDP Resident Representative and Namibian authorities for the execution of a programme of surveys of the fish resources of the Namibian shelf with the R/V "DR. FRIDTJOF NANSEN".

The purpose of the programme was agreed as follows:

> The main objectives are descriptions of the distribution, composition and abundance of the most important resources of fish. The small pelagic fish horse mackerel, pilchard and anchovy will be investigated by the acoustic integration method combined with sampling with mid-water and bottom trawls. A swept area trawl survey programme will be used for the demersal stocks. All catches will be sampled to species by weight and numbers and biological sampling will be made of the commercially important stocks.
>
> Environmental studies will include recording of surface temperature on a continuous basis and occupation of hydrographic stations in a series of fixed profiles.
>
> Possible taxonomic problems will be studied by sampling and examination by experts in cooperation with FAO's Fisheries Department.

1.2 SPECIFIC OBJECTIVES OF PART 1

During the first part, 23 April to 22 May the main objective is investigations of hakes and associated species covering the whole shelf. The acoustic system will be used to observe possible mid water occurrence of the hakes. The survey design for the swept area trawl programme will be based on a semi-random distribution of hauls intended to cover the depth ranges of the two hake species and with a density of stations adapted to the expected fish densities. Biomass estimates of Cape hake will be based on post stratification by density areas. If time permits trawl selectivity experiments of hake will be made with a metal frame fish separator installed in the trawl.

1.3 PARTICIPATION

The scientific staff from Namibia up to 7 May were:

Hashali Hamukuaya, Helen Boyer, Filimon Dausab, Malakia Shimanda and Victor Hashoongo.

From 8 to 22 May:

Willem Nauiseb, Bennie Ushona, Kosmas Nikackmus, Joryt Traut, Chris Bartholomas and Jonny Gamataham.

The scientific staff from the Institute of Marine Research up to 22 May were:

G. Saetersdal, O. Alvheim, T. Haugland, R. Johannesen and A. Valentine (from 7 May).

K. Carpenter from FAO participated up to 6 May.

1.4 NARRATIVE

Figures 1 a-c show the course tracks with the positions of the fishing and hydrographic stations.

After departure from Walvis Bay on 23 April work started near Lüderitz on 24 April with some trawl hauls in order to make use of daylight. The southernmost line of trawl stations covering the shelf was started near the Orange River on 25 April and the programme largely followed the course tracks and station grids used in the three previous surveys. The hydrographic section off Panther Head was worked on 28 April. The shelf up to St Francis Bay including the hydrographic profile to Hottentot Point was completed by 3 May with a total of 56 successful swept area hauls. The weather conditions were generally unfavourable in this southern area with several periods of wind force 7.

The profile off Conception Bay was worked on 5 May and the swept area trawling programme continued northwards with lines of stations about every 20 nm taking care to locate both the inner and the outer limits of the distribution of the hakes. A call was made on Walvis Bay on 7 May in order to change participating scientific staff.

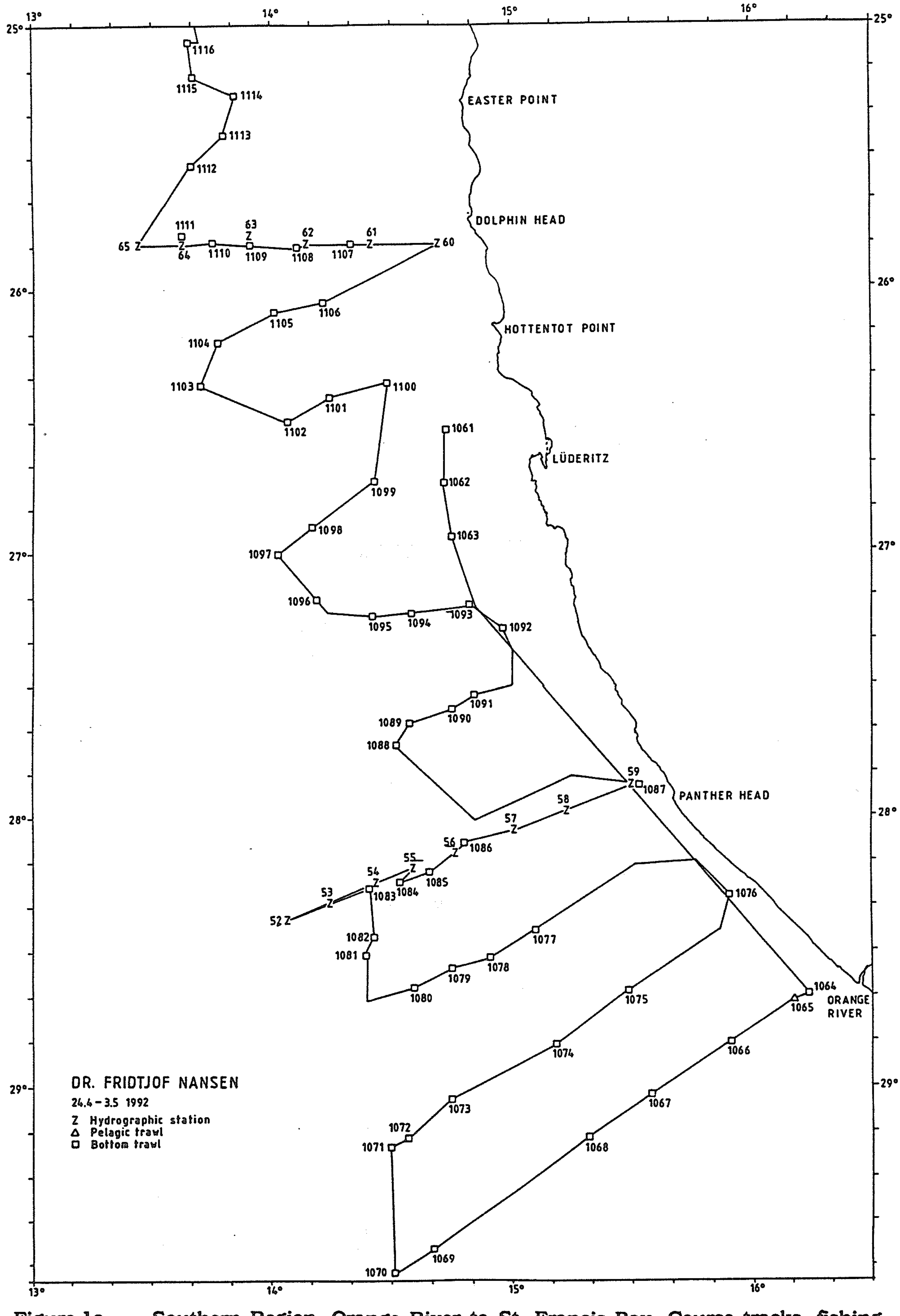

Figure 1a. Southern Region, Orange River to St. Francis Bay. Course tracks, fishing stations and hydrographic profiles.

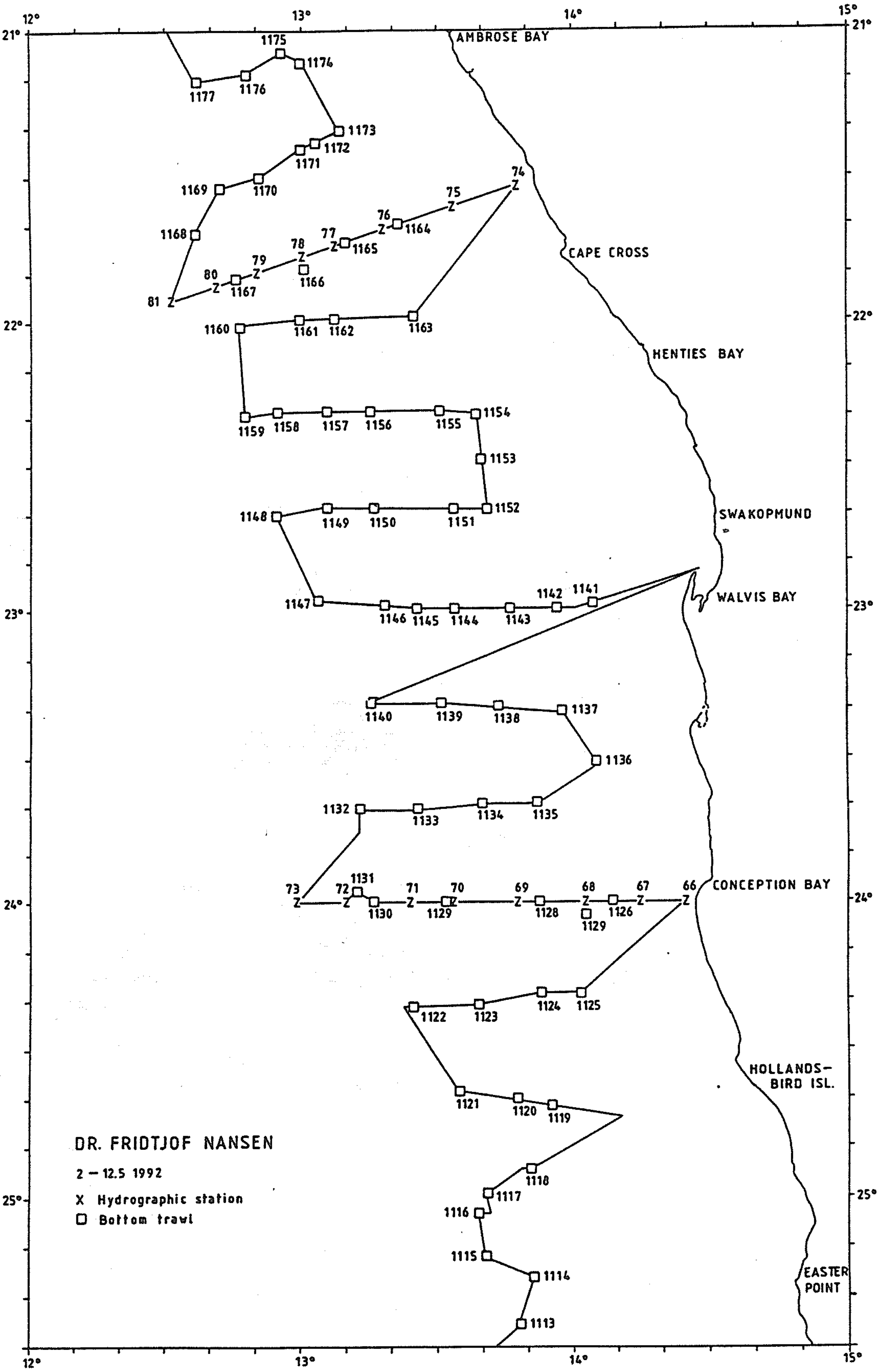

Figure 1b. Central Region, St. Francis Bay to Ambrose Bay. Course tracks, fishing stations and hydrographic profiles.

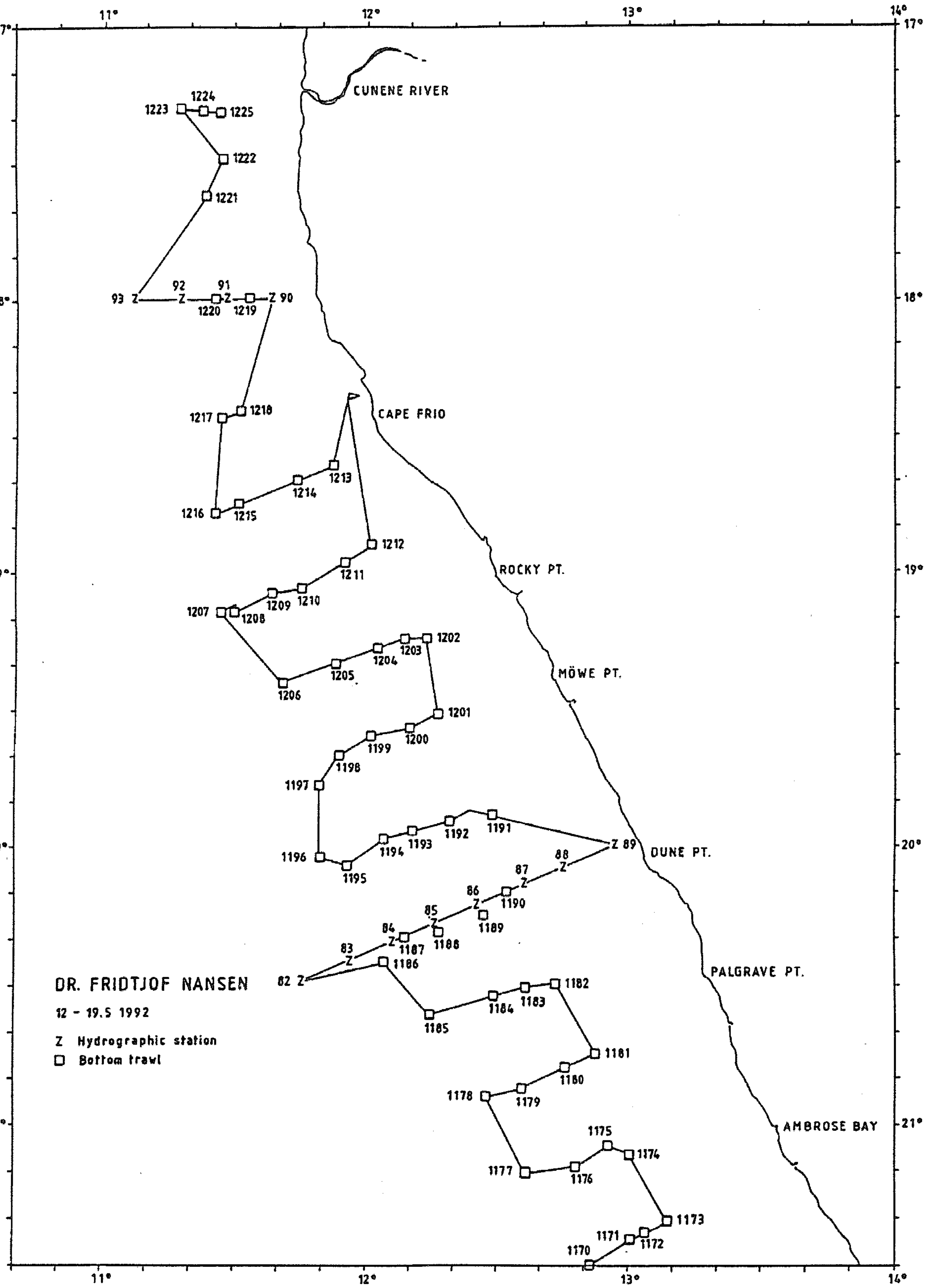

Figure 1c. Northern Region, Ambrose Bay to Cunene River. Course tracks, fishing stations and hydrographic profiles.

In the continued survey starting from Walvis Bay on 8 May northwards both the shallow water distribution of the 2 year old hake from 130 to 180m of depth and that of the large sized hake from 250-350m were covered and some test hauls were made at 400-450m for the deep water species. The weather conditions were favourable and by 12 May the central region up to Ambrose Bay had been completed with a total of 59 swept area hauls.

Small sized 2 year old hake was also found in spots of high density in the northern region and both the shallower and deeper parts of this area was covered with a total of 47 swept area hauls. The survey ended at Cunene on 19 May and Walvis Bay was reached on 21 May.

CHAPTER 2 HYDROGRAPHY

Figures 2 a-c show the sea temperature at 4m of depth as observed with the ships thermograph and Figures 3 a-b show the distribution of temperature, salinity and oxygen in the five hydrographic transects worked. The findings indicate lively upwelling particularly in the southern region.

CHAPTER 3 RESULTS OF THE ACOUSTIC AND TRAWL SURVEY

3.1 DISCUSSION OF METHODS

A description of the fishing gear and the acoustic instruments and their state is shown in Annex I.

In the trawl survey programme all catches were sampled for composition in weight and numbers by species. The bottom trawl has a headline of 31m (float line), footrope 47m, estimated headline hight 6 m and distance between wings during towing about 18m. Observations on the geometry of this type of trawl were made during Survey 2/90 and are described in the corresponding report. For conversion of catch rates to fish densities the area between the wings is assumed to be the effective fishing area i.e. q is equal to 1.

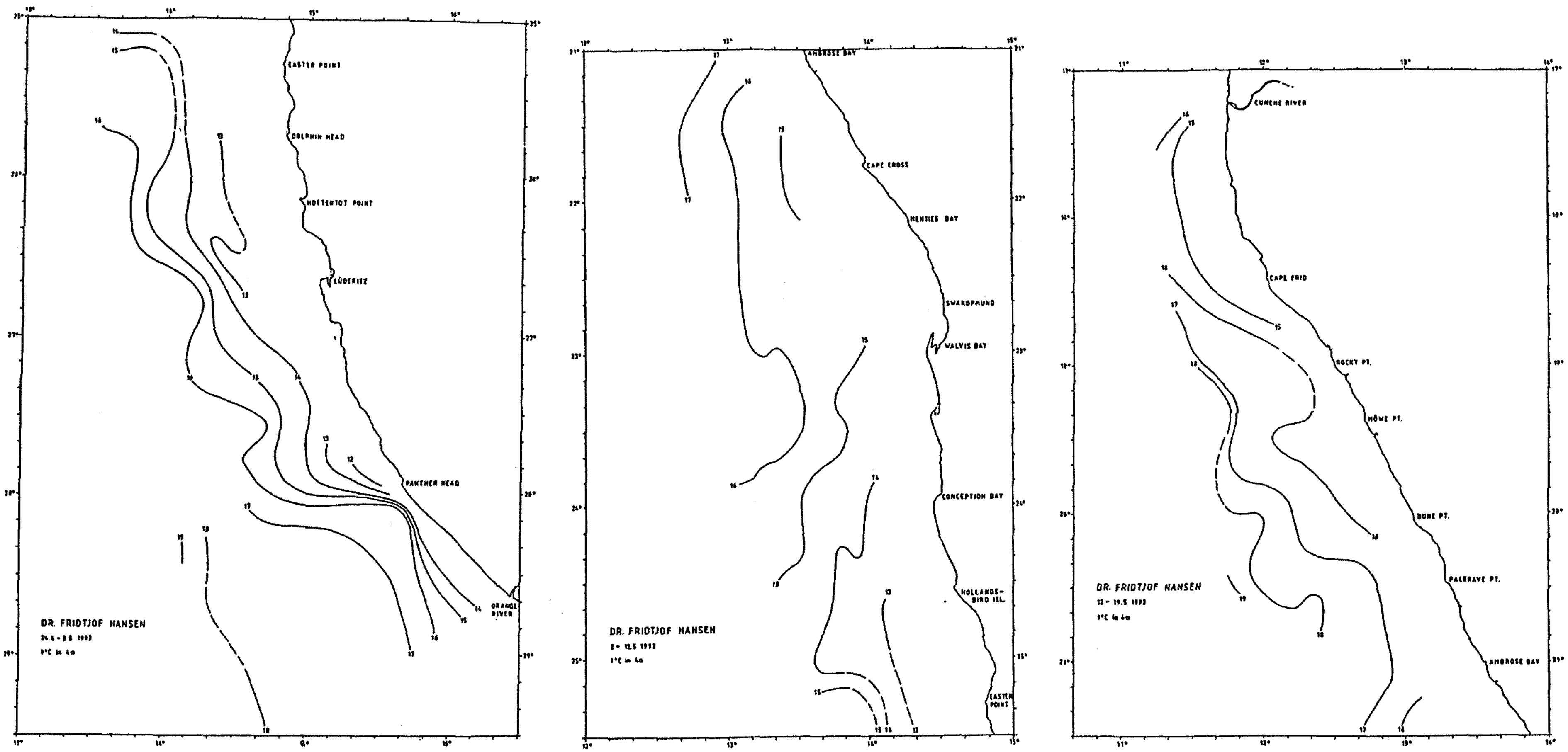

Figure 2 a-c. Distribution of temperature at 4m of depth based on observations from the ships thermograph.

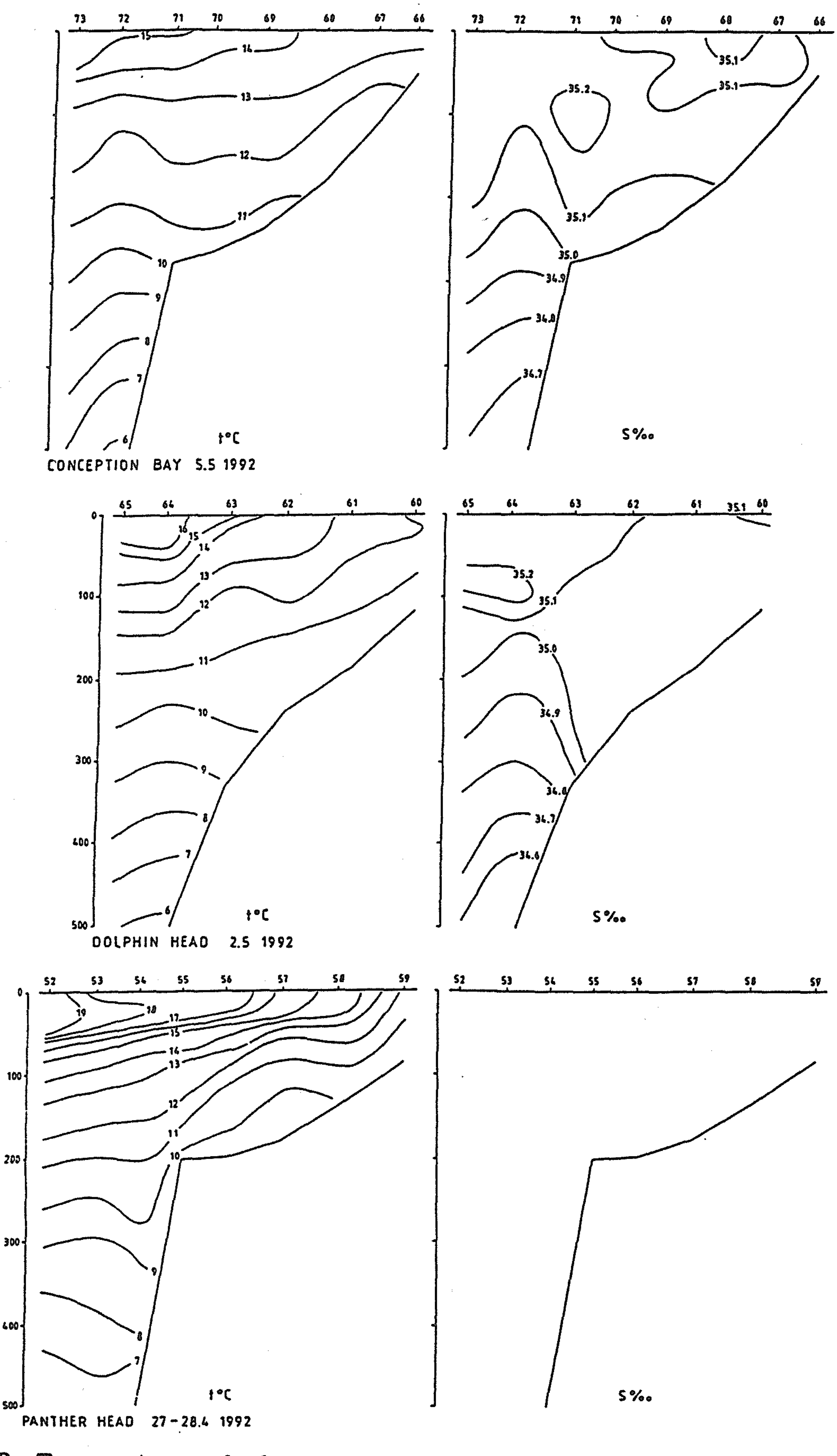

Figure 3a. Temperature and salinity in the profiles worked, Panther Head to Conception Bay.

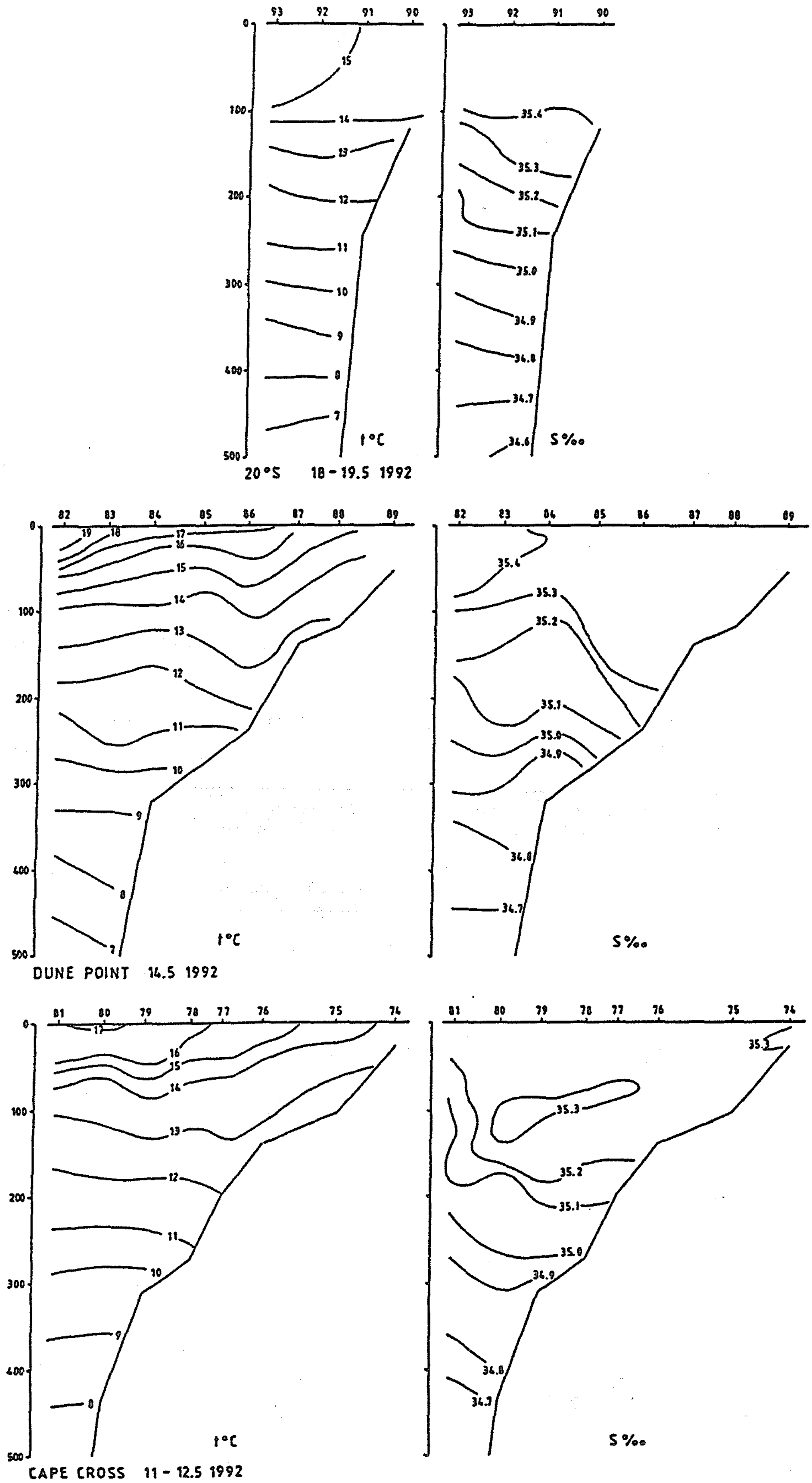

Figure 3b. Temperature and salinity in the profiles worked, Cape Cross to Cape Frio.

The problem of mid-water occurrence of hake and the effect on the swept area assessments were discussed in the report of Survey 1/91. Fish occurring above the headline of the trawl, more than 5m from the bottom must be assumed to cause an under-estimate. The extent of this behaviour seems to have varied between the surveys. Mid-water occurrence during the night has always been observed although with varying frequency. Fishing has, however, been restricted to day time as much as possible, and mid-water occurrence during the day was first found as a problem for the assessment in the northern region during the September-October survey 1990 when abundant echo traces of hake were observed both day and night. Quantification was, however, difficult with the instrumentation then available, but the new SIMRAD EK 500 system which was taken into use in the first 1991 survey provided improved means of observing and measuring the densities of hake in mid-water. A correction for the bias in the swept area estimates was then introduced using the acoustic estimates of fish found more than 5 m from the bottom. The frequent presence of spurious recordings such as of myctophids, gobies, euphaucids and others often complicates the acoustic density estimates of hakes and prevents an ordinary acoustic biomass estimate of mid water hake in the area, but special attempts were made to separate and assess mid-water hake during trawling.

During the January-February 1991 survey mid-water occurrence was common. Of the day time hauls about half was given an acoustic correction in the southern and central regions and about 2/3 in the northern region. In the October-November 1991 survey mid water occurrence was less common, there was hardly any need for adjustment of daylight hauls in the southern and central regions while about half the hauls in the northern region were given an acoustic correction. Table 1 shows the observations and measurements of density

Table 1. Hakes. Frequency of observations of hake in mid-water during trawling. No of trawl stations with swept area densities and no. of stations with observations of hake above 5 m from bottom with acoustic density estimate. Density tonnes/nm².

	DAY	NIGHT
ORANGE RIVER - ST. FRANCIS BAY		
Trawl		
No. stations	43	14
Mean density	30.0	20.0
Acoustic obs.		
No. stations	5	6
Mean density	11.5	9.7
ST. FRANCIS BAY - AMBROSE BAY		
Trawl		
No. stations	44	15
Mean density	28.8	17.0
Acoustic obs.		
No. stations	4	14
Mean density	6.3	6.5
AMBROSE BAY - CUNENE RIVER		
Trawl		
No. stations	36	11
Mean density	22.7	25.5
Acoustic obs.		
No. stations	10	7
Mean density	7.2	7.1

of fish in mid-water during trawling in this survey. Mid-water occurrence during daytime was common in the high density areas in the southern region. In addition to the cases recorded comes a similar number of stations where mid water occurrence was suspected, but could not be clearly demonstrated due to spurious recordings of other organisms at the critical depths. In the central region mid water occurrence during the day was not common and only few of the density estimates by swept area had to be given minor adjustments. In the northern region more of the hake remained above the bottom during the day and about 1/3 of the hauls were adjusted, but the amount of the adjustment represents as for the other regions only a small part of the estimates of total density.

Since estimates of the target strength of Namibian hake are not available a target strength relation used for a similar species, cod in the North Atlantic, TS = 20logl-68 was applied in the calculations of acoustic densities. Where good single fish recordings were obtained some trace counts were made in the channel 5 - 10m above the bottom for comparison with the integrator output in attempts to provide a rough check on the level of target strength. Actual practical examples of the expected relationships are as follows:

For 1.2 kg fish at 300m of depth (55cm fish)
29 fish traces: 1 integrator unit
58 " " : 2 " "

For 1 kg fish at 300m of depth (50cm fish)
32 fish traces: 1 integrator unit
64 " " : 2 " "

For 1 kg fish at 200m of depth (50cm fish)
21 fish traces: 1 integrator unit
42 " " : 2 " "

Only relatively few good recordings of single fish traces were obtained and the counts made are not thought to have a high precision. Ten sets of observations of fish of 1.0-1.2 kg of weight at 275-360m of depth gave a mean fish count about 25% less than that expected. The sources of error are, however, likely to cause an underestimate.

3.2 SOUTHERN REGION, ORANGE RIVER TO ST. FRANCIS BAY

The complete record of the fishing stations are shown in ANNEX II.

Table 2 shows the catch rates standardized to kg/hour by main groups for the shelf and the slope separately. Compared with the previous survey the mean catch rates for hake are more than doubled both on the shelf and in the slope hauls. This will be discussed further below. Some good catches of monk and sole were obtained in intermediate waters and a few high rates of kingklip were unexpectedly made in shallow waters. The higher incidence and rates of monk and kingklip may indicate the start of a recovery of these stocks. Catches of squids remained largely unchanged as did those of horse mackerels.

Table 2. Southern Region. Catch rates by main groups by bottom trawl for the shelf and slope. Kg/hour.

SHELF 50-259 m

ST.NO.	DEP.	Hakes	Monk	Kingklip	Soles etc.	Squid	Other
1061	167	1.0					540.0
1062	204	2490.0					510.0
1063	210	579.1					
1064	81	350.0		343.8	13.0	62.0	216.6
1065	5						
1066	152	78.2			1.6	6.4	64.0
1067	174	277.6		0.6	3.6	14.4	108.0
1068	176	232.4		67.2	8.1		93.9
1073	219	210.8					2816.4
1074	158	203.1				7.8	111.3
1075	177	220.6		2.6	1.0	98.4	156.0
1076	86	136.8		25.0	1.3	11.7	31.6
1077	168	198.8		1.8	1.8	33.6	108.8
1078	176	122.5			0.5	4.5	259.6
1079	194	176.3	1.6			3.0	143.4
1080	168	529.7				1.0	7700.4
1085	195	573.4				1.4	515.8
1086	194	227.6			1.0		367.2
1087	85	253.0	1.0		1.5	5.2	62.5
1092	179	226.0		7.0		0.8	3.0
1093	250	280.6	0.8	13.8		2.0	17.6
1106	250	1229.4	115.0		110.0		2400.0
1107	207	5.4					2037.4
1108	254	1223.5	83.5		66.0		307.5
1114	247	1179.6	18.0				215.6
MEAN		440.2	8.8	18.5	8.4	10.1	751.5

SLOPE 260-600 m

ST.NO.	DEP.	Hakes	Monk	Kingklip	Soles etc.	Squid	Other
1069	388	409.6				3.2	49.6
1070	550	111.0					48.6
1071	411	348.6		12.0			30.0
1072	304	950.6		52.4	3.0	10.8	349.4
1081	449	205.6		3.6		4.5	46.6
1082	409	530.4		14.0		3.6	13.8
1083	553	22.0					49.3
1084	301	1434.0					103.2
1088	504	55.4				5.8	70.5
1089	395	525.0				26.2	19.2
1090	328	788.8				13.6	131.2
1091	300	1025.0				9.0	13.9
1094	321	831.6	10.8	7.4		2.0	23.2
1095	370	737.3		3.2			45.8
1096	421	412.0		20.0		6.4	93.2
1097	428	119.2				6.4	46.3
1098	379	1837.5		4.0			61.5
1099	318	2012.4		9.8			6.6
1100	284	1149.4		1.6			56.0
1101	328	1259.6				19.2	132.2
1102	378	1666.2				52.7	155.0
1103	421	347.0				20.2	56.0
1104	381	7958.0					42.0
1105	315	601.4		6.5		11.1	82.2
1109	331	3841.2					158.8
1110	381	3950.2		31.4		23.6	30.8
1111	533	313.8				17.6	329.2
1112	404	534.0				24.6	71.4
1113	295	802.8					180.9
1115	357	606.0				44.4	154.3
1116	415	656.4				10.4	44.4
1117	356	828.6					154.2
MEAN		1152.2	0.3	5.2	0.1	9.9	89.0

The depth distribution of the two hake species based on the catch rates converted to densities are shown in Table 3. For both species the densities are higher than in any previous survey while as before the Cape hake shows the highest rates in the 250-350m range and the deep water hake in the 350-450m range.

Table 3. Depth distribution of the two hake species, Orange River to St. Francis Bay. Mean densities tonnes/nm² and mean catch rates kg/hour.

	100-250m	250-350m	350-450m	450-550
Cape hake				
Density	12.6	28.4	4.6	
Catch rate	380	850	140	
Deep w. hake				
Density		8.9	34.8	4.0
Catch rate		270	1040	120
No. of hauls	18	14	17	4

The distribution of the two hake species based on plots of densities by fishing stations are shown in Figures 4 and 5. These include the acoustic estimates of fish present above the 5 m bottom channel during trawling as discussed above. There was a wide high density area of Cape hake offshore from 27° to 25°S which represents a new feature in the distribution of this species compared with previous surveys. The deep water hake shows the same characteristics of distribution as in the October-November 1991 survey, but the densities are now considerably higher.

Biomass estimates based on a poststratification of the estimated densities as shown in Figure 4 and 5 give 200 000 tonnes for the Cape hake and 145 000 tonnes for the deep water hake, see Table 4. These estimates represent significant increases of biomass for both species compared with the findings of the previous surveys.

Table 4 Orange River to St. Francis Bay. Estimates of total biomass by surveys, 1 000 tonnes.

	Cape hake	Deep water hake
1/90	130	22
3/90	130	25
1/91	113	31
2/91	80	82
1/92	200	145

The size compositions of the Cape hake from pooled samples weighted by catch rates are shown by depth ranges and total for the region in Figure 6. There is as usual an increase of size with depth. The dominating cohort with a modal size around 30cm must be identical to that found in this region in the October-November 1991 survey with a mode of 25-27cm. This is assumed to originate from the 1990 spawning. The great increase in biomass now observed can not, however, be explained by the growth of this cohort over 6 months. The bulk of the increased biomass consists, as shown in Figure 6 presenting the distribution of biomass by fish length, of adult fish which must have migrated into the region most likely from the north. The fishable part of the Cape hake in this region defined as fish 36cm and larger is estimated at 37% by numbers and 72% by weight.

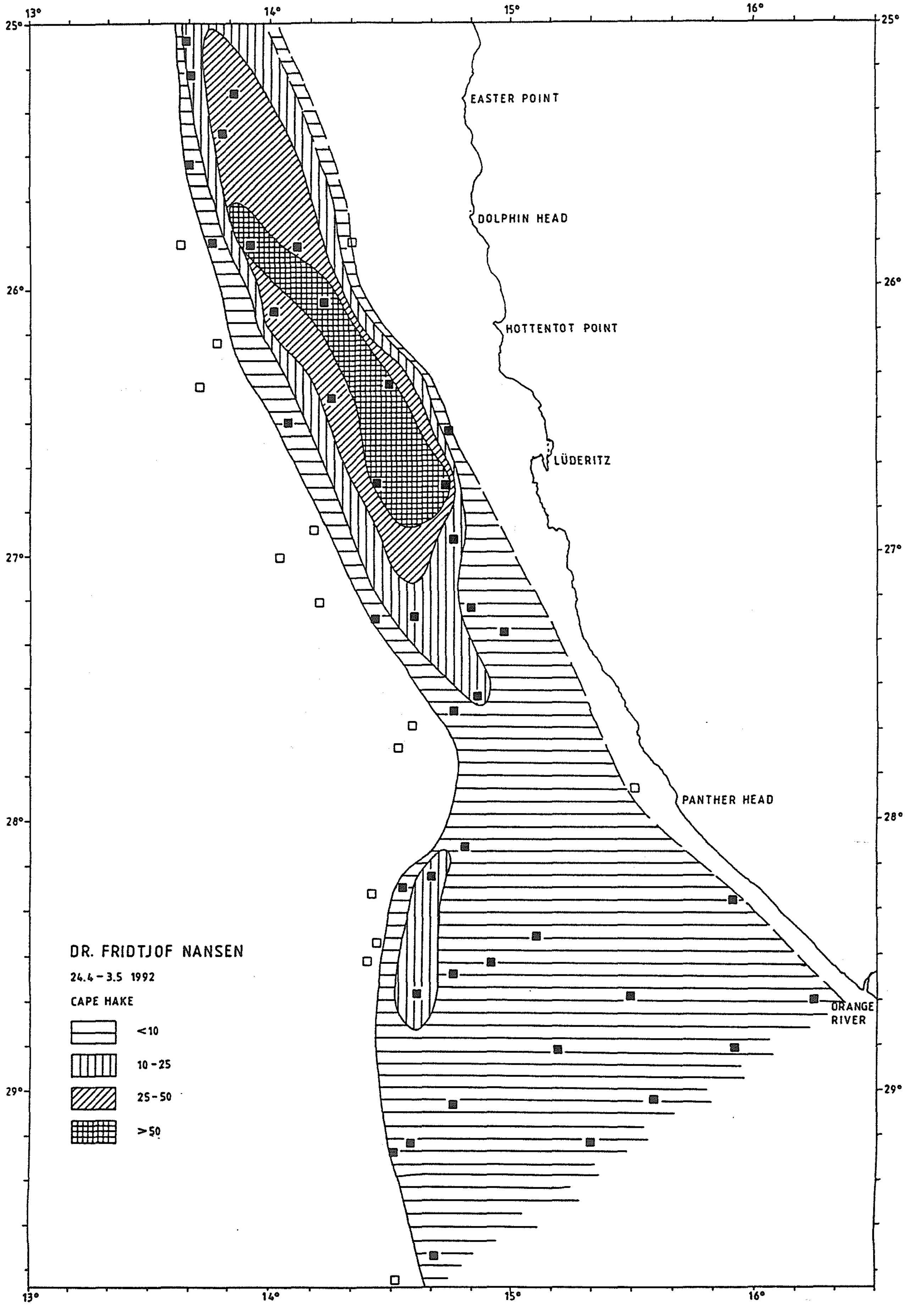

Figure 4. Southern Region. Distribution of Cape hake.

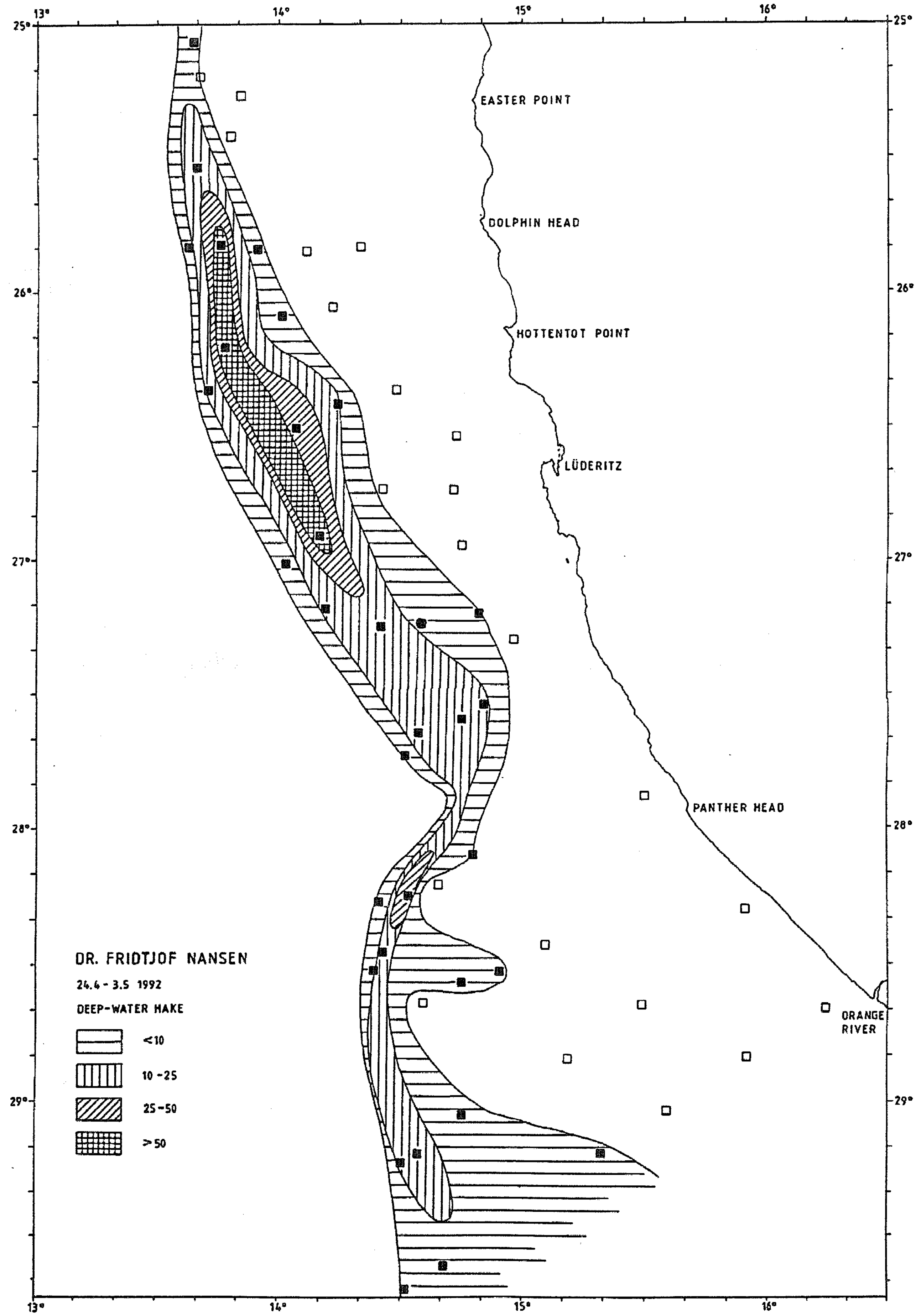

Figure 5. Southern Region. Distribution of deep water hake.

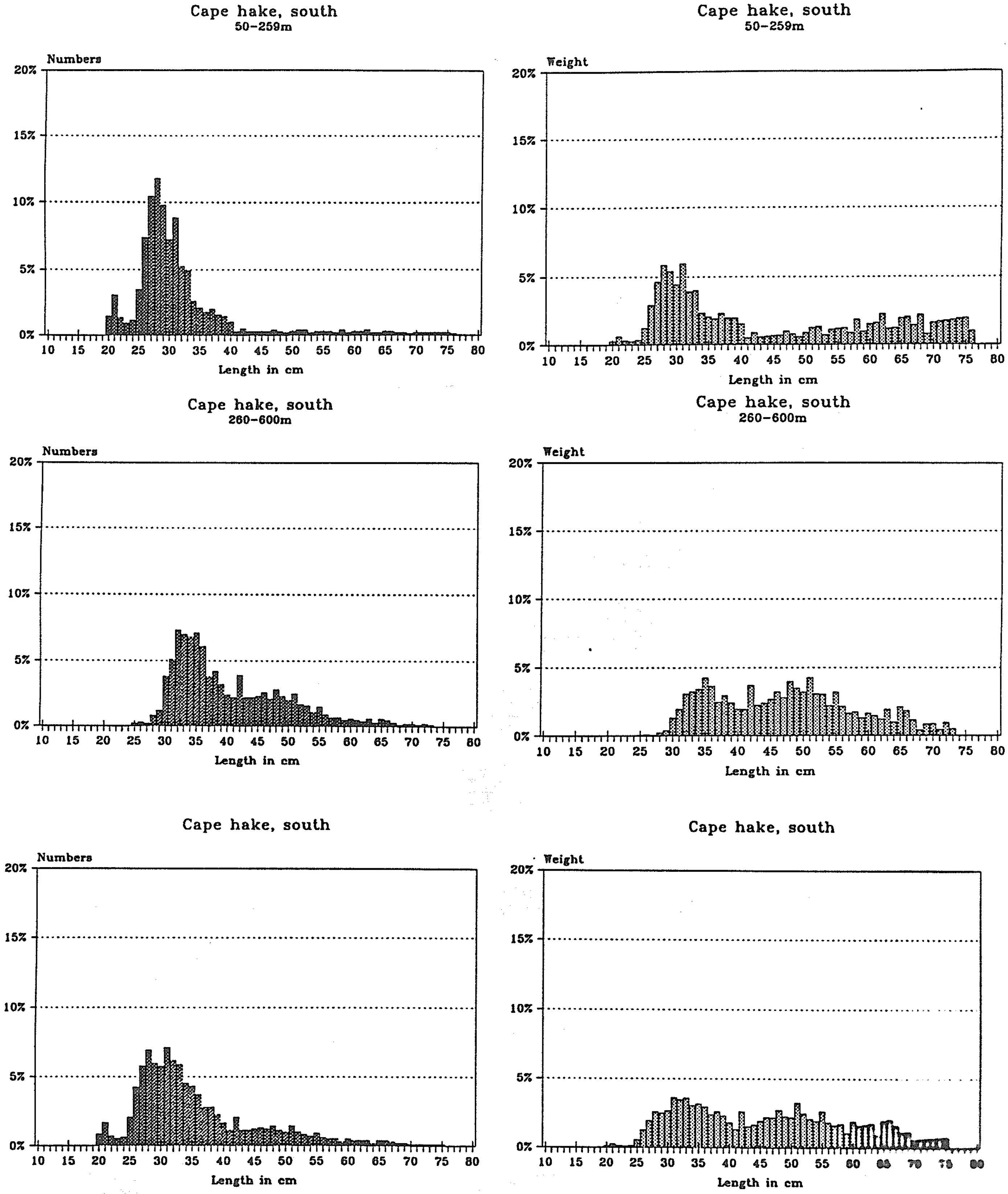

Figure 6. Southern region. Size compositions of Cape hake by depth ranges. Pooled samples weighted by catch rates. Distributions by numbers and biomass.

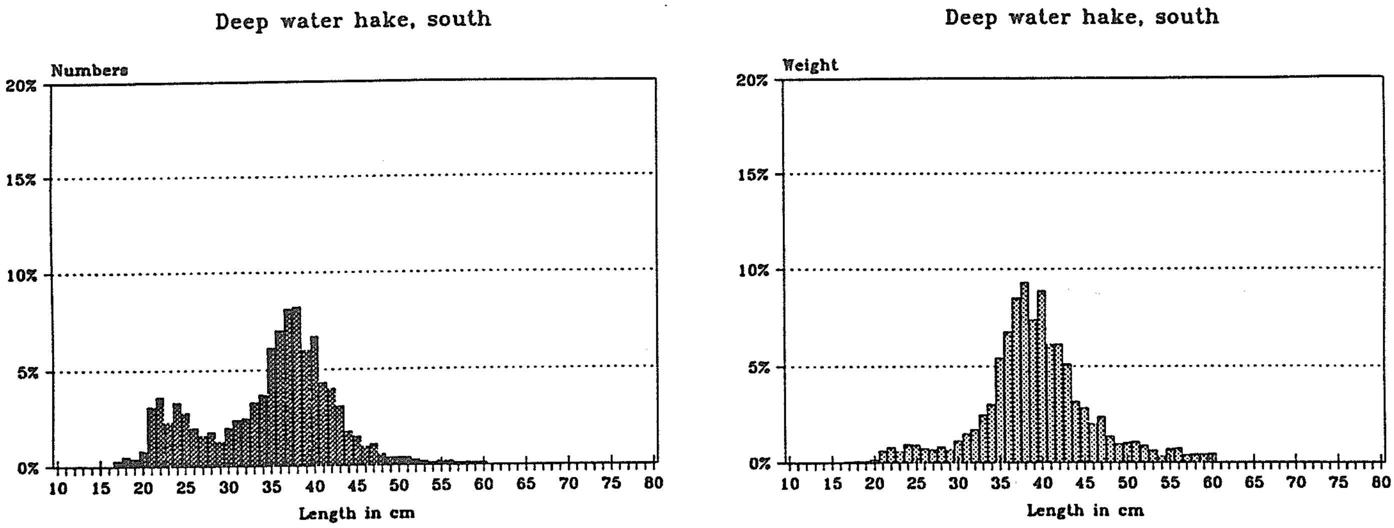

Figure 7. Southern Region. Size composition of deep water hake. Pooled samples weighted by catch rates. Distributions by numbers and biomass.

The size composition of the deep water hake, see Figure 7 shows a dominating group with a modal size of about 38cm. The main group in the October-November 1991 survey, presumably the same cohort, had a mode of about 32cm. The increase of biomass of this stock between the two surveys is greater than that expected from growth of the fish and there is no great addition of small sized recruits. Estimates of the total population number from stock biomass and size composition shows an increase since the last survey from about 370 million to about 430 million fish. This may be the effect of survey variability or perhaps more likely of immigration from outside areas. None of the surveys have shown substantial concentrations of juvenile deep water hake. There may have existed problems of identifying the juvenile stages of this species, but the most likely explanation is that the principal areas of recruitment are found outside the survey coverage.

In the present stock, fish of sizes 36cm and larger represent 56% by numbers and 78% by weight.

Some special sampling was made of the state of maturity of the gonads of female fish. A maturity scale used for blue whiting in the North Atlantic was made use of in a slightly modified form, see Annex 1. Two samples of Cape hake of large sized fish, mainly 40-70cm from deeper waters showed the following state of maturity:

Maturity stage:	2	3	4	5	6
%	38	14	32	4	12

From this it seems that more than 80% of the fish were in a resting or prespawning condition. Some spawning has started, but the main spawning is still ahead.