

### 3.3 CENTRAL REGION, ST. FRANCIS BAY TO AMBROSE BAY

Table 5 shows the catch composition for the shelf and the slope by main groups. The mean catch rates for hake are similar to those obtained in the October-November 1991 survey. There are increased rates for monk, squid rates are largely unchanged and horse mackerel are reduced to less than half.

The depth distribution of the two hake species is shown in Table 6. These are largely unchanged from the previous survey with the high rates on the juvenile Cape hake in shallow waters.

	100-250m	250-350m	350-450m	450-550m
<b>Cape hake</b>				
Density	36.5	14.6	8.5	1.7
Catch rate	1 100	440	255	50
<b>Deep w. hake</b>				
Density		1.3	6.8	1.6
Catch rate		40	200	50
No. of hauls	29	17	12	1

Figure 8 shows the distribution of Cape hake over this region. This has the same features as that of the last survey. The belts of high density towards the coast represent the new recruitclass identified in the last survey and assumed to derive from the 1990 spawning. This group has now a modal length of 25cm, about 4cm higher than in October-November. The size composition of pooled samples from fishing stations weighted by the catch rates are shown by depth ranges and for the total region in Figure 10. The high numerical abundance of the recruit class causes a juvenile dominance of the composition for the region.

The biomass estimate of Cape hake for this region based on the post stratification shown in Figure 8 is 261 000 tonnes of which 184 000 tonnes inside the 250m depth line and 77 000 tonnes outside. The fishable part of the biomass defined as fish of 36cm and larger can be estimated from the biomass by depth ranges and the corresponding size compositions and is 13 000 tonnes inside 250m and 72 000 tonnes outside, a total of 85 000 tonnes.

The deep-water hake was found in a narrow belt along the slope at 350-450m of depth, see Figure 9. The size composition is as shown in Figure 11 similar to that found in the southern region. Of the 15 000 tonnes biomass 96% was of fishable size.

Table 5. Central Region. Catch rates by main groups by bottom trawl for the shelf and slope. Kg/hour.

## SHELF 100-259

ST.NO.	DEP.	Hakes	Monk	Dentex	Horse mck.	Squid	Other
1118	255	445.2					31.2
1119	207	1411.2					11.2
1125	184	1265.2			663.2	39.8	31.8
1126	141	66.0					600.0
1127	183	1058.0			6.0	1.0	137.0
1128	226	325.9	1.4		2.1	13.0	59.9
1133	255	479.0	25.4				198.0
1134	201	357.0	1.8				70.8
1135	171	1237.2	1.2		1.2	1.2	121.2
1136	140	761.2					267.4
1137	149	1262.3					76.5
1138	154	1495.0			13.0		78.0
1139	205	61.0	2.6		0.4		9.2
1141	122	15.7					1384.6
1142	133	1425.6					19.2
1143	140	710.1			1.0	0.2	37.8
1144	158	1900.0			570.0		1.6
1151	141	2023.8			976.2		
1152	129	136.9					44.2
1153	126	1697.3				6.8	20.3
1154	126	254.0					16.0
1155	150	659.1	2.6		54.6		26.0
1156	227	736.4			5.6		59.1
1157	249	681.6	23.8		54.0	0.7	75.1
1162	225	817.2	8.4	0.8	36.0		74.0
1163	154	553.0	1.0		4.0	0.4	54.0
1164	134	193.2					132.0
1165	180	4555.6			393.2		51.2
1171	232	435.0	3.4	0.8	106.4		9.0
1172	175	4906.8			636.8		56.2
1173	139	107.7					31.2
1174	178	2718.8		8.4	8.4		166.6
1175	250	446.3		18.9	45.2	2.6	6.3
MEAN		1066.6	2.2	0.9	108.4	2.0	119.9

## SLOPE 260-600

ST.NO.	DEP.	Hakes	Monk	Dentex	Horse mck.	Squid	Other
1120	294	330.0	10.8		2.8	4.4	109.0
1121	389	344.6	3.2			16.6	122.8
1122	368	1516.0				17.4	56.6
1123	320	389.4				9.8	101.6
1124	266	708.4	52.2				279.2
1129	265	334.0			9.3	0.9	86.5
1130	349	1121.0	10.4			15.2	140.2
1131	449	13.2	0.6			4.4	91.8
1132	351	870.7	13.5			4.5	133.7
1140	355	643.0				42.6	137.5
1145	306	168.6	3.6		5.2	14.8	73.4
1146	352	360.7			0.4		83.2
1147	403	424.0	22.5			35.0	121.0
1148	350	134.9				8.1	133.6
1149	301	774.4	3.8		3.8	11.4	128.0
1150	281	623.2	12.4		4.0	11.8	141.2
1158	327	268.0	4.0		2.6	14.0	63.4
1159	421	91.2	4.0			42.0	202.4
1160	350	282.2	1.2			13.0	80.5
1161	300	389.0	5.0		7.0	18.6	105.6
1166	269	1051.2		6.0	294.6	4.3	108.1
1167	331	562.6			1.2	1.2	128.1
1168	504	97.6				14.0	216.6
1169	351	512.8				14.6	106.0
1170	301	179.6	8.4	3.6	21.6	1.8	70.2
1176	320	360.0			25.6	1.4	22.9
1177	374	554.6	4.6			1.8	118.1
MEAN		485.4	5.9	0.4	14.0	12.0	117.1

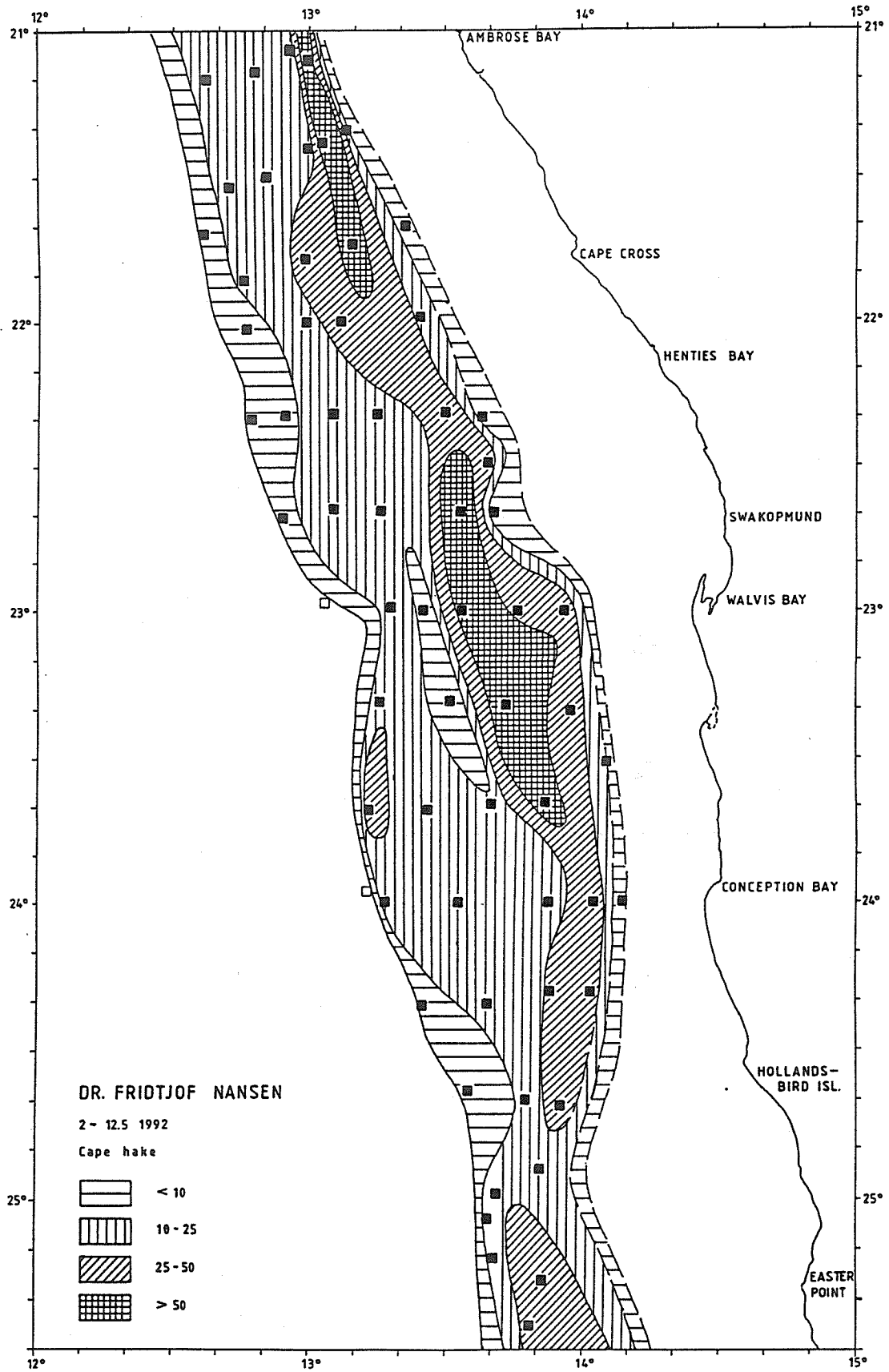


Figure 8. Central Region. Distribution of Cape hake.

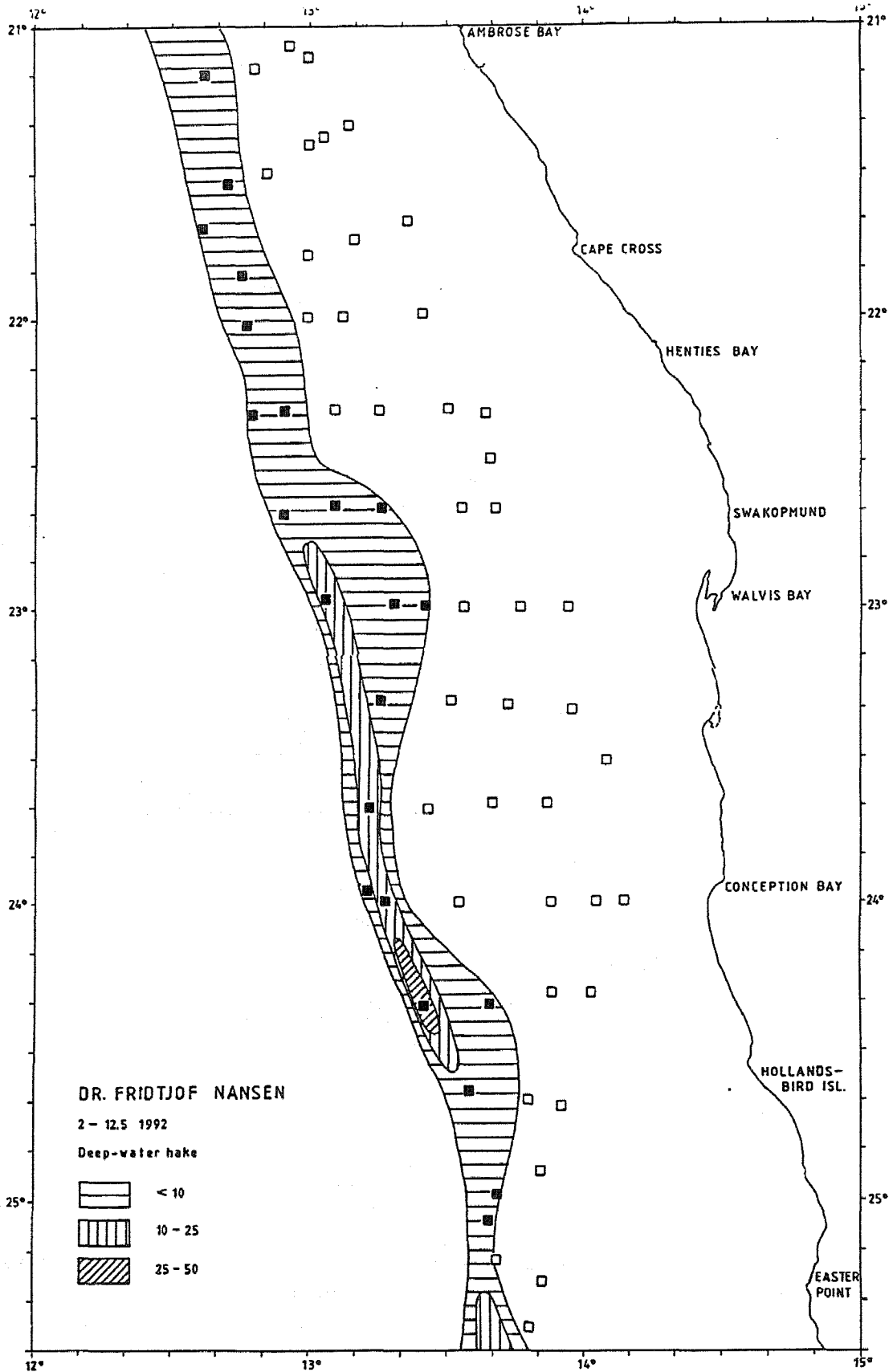
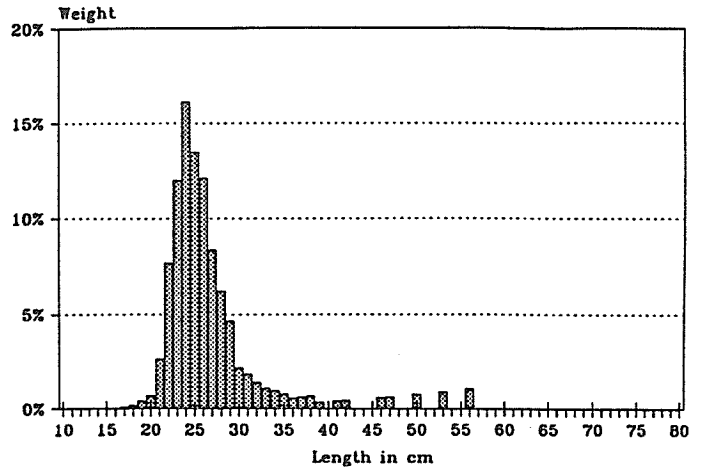
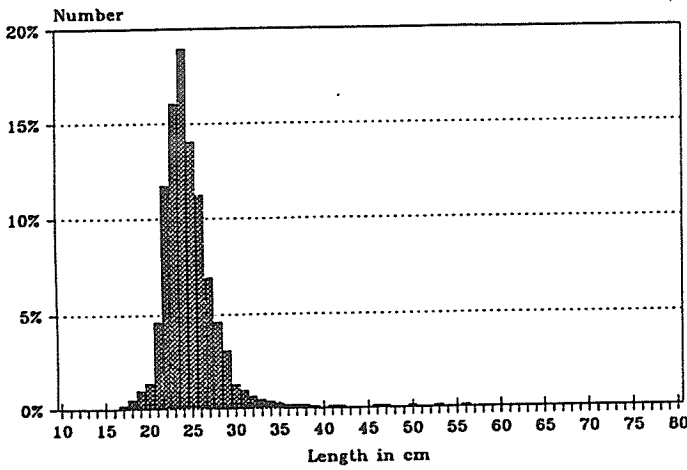


Figure 9. Central Region. Distribution of deep water hake.

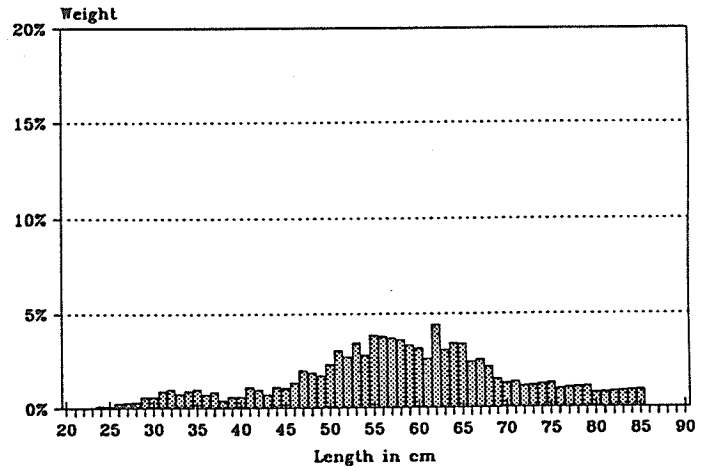
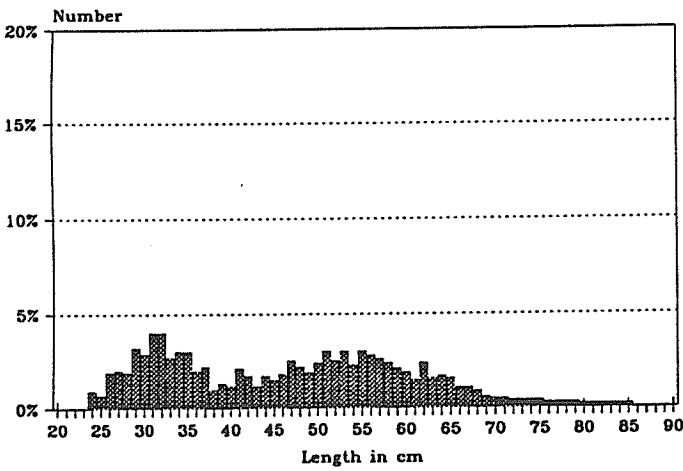
Cape hake, central  
50-250m

Cape hake, central  
50-250m



Cape hake, central  
251-600m

Cape hake, central  
251-600m



Cape hake, central  
Total

Cape hake, central  
Total

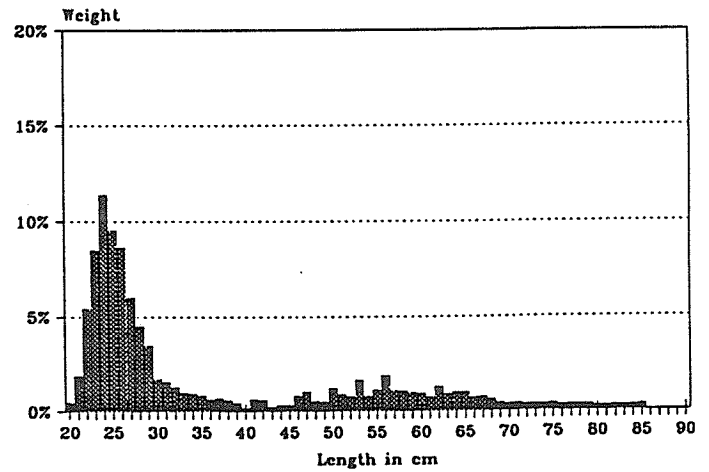
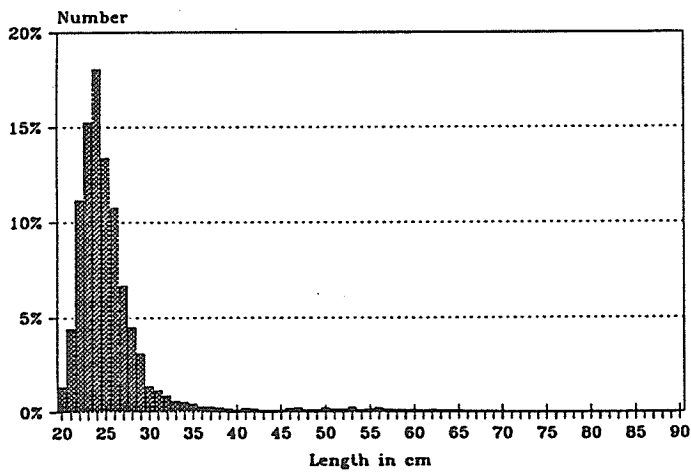


Figure 10. Central Region. Size compositions of Cape hake by depth ranges. Pooled samples weighted by catch rates. Distributions by numbers and biomass.

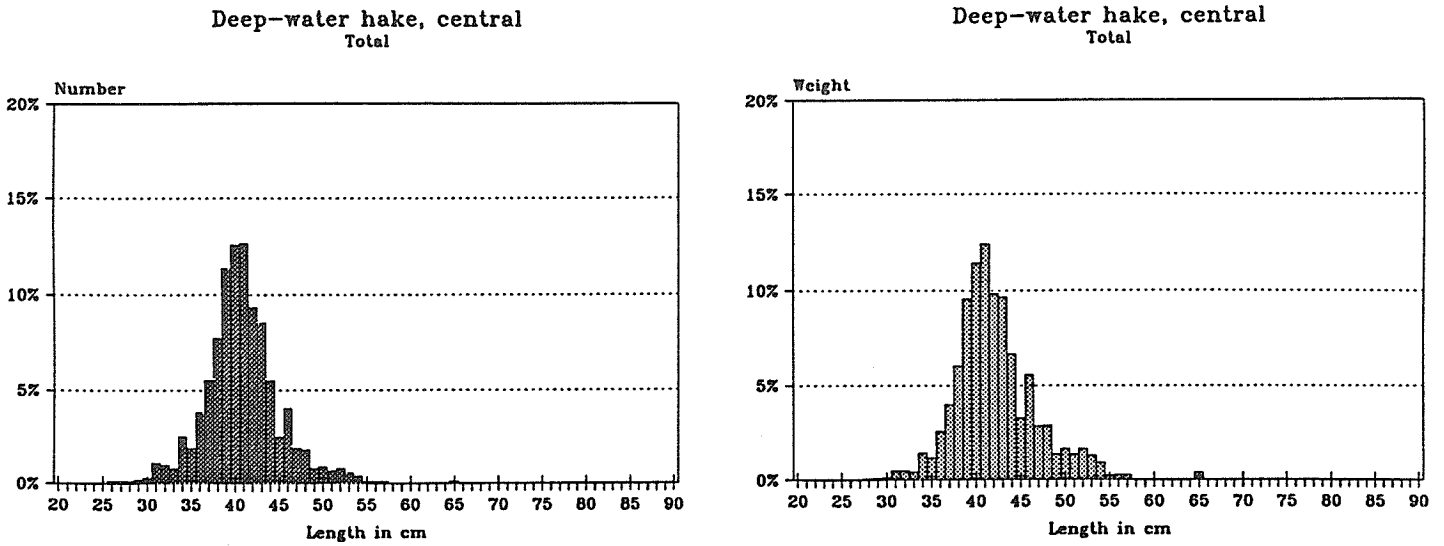


Figure 11. Central Region. Size compositions of deep water hake. Pooled samples weighted by catch rates. Distributions by numbers and biomass.

Table 7 shows the biomass estimates for this region by surveys. It seems probable that the decline from 302 000 tonnes of Cape hake in survey 2/91 to 261 000 tonnes in survey 1/92 results mainly from a migration of adult fish to the southern region where this component has increased significantly.

Table 7. Central Region. St. Francis Bay to Ambrose Bay. Estimates of total biomass by surveys, 1 000 tonnes.		
	Cape hake	Deep water hake
1/90	180	4
3/90	219	6
1/91	150	6
2/91	302	13
1/92	261	15

Maturity sampling of female fish of Cape hake of 30-70cm of length (st nos 1145, 1150, 1161; N=228) showed the following state:

Maturity stage:	2	3	4	5	6
%	64	29			7

This indicate that the adult fish in the Central Region is about to start a new spawning cycle with about 30% showing active gonad development. The spawning season is farther off than in the south. Sampling of the 2 year old fish, 25-35cm showed that a majority of both females and males had advanced gonad development. This confirms previous similar observations of this size group. The significance of the spawning of these fish for the stock propagation is uncertain.

### 3.4 NORTHERN REGION, AMBROSE BAY TO CUNENE RIVER.

Table 8 shows the catch rates by main groups for the shelf and slope separately. The mean rates for hake are somewhat higher than in the previous surveys. Catches of monk shows an increase also in this region both in incidence and rates. There is a sharp increase for dentex in shallow water.

Table 8. Northern Region. Catch rates by main groups by bottom trawl for the shelf and slope. Kg/hour.

#### SHELF 50-259

ST.NO.	DEP.	Hakes	Monk	Dentex	Horse mck.	Squid	Other
1181	174	805.6	3.4	106.4	7.6		33.4
1182	182	684.2		52.8	591.8	8.8	16.5
1183	259	235.0		2.8	397.6	2.8	68.6
1189	235	553.4		207.5	494.1	2.8	24.2
1190	160	251.2		229.6	616.0		14.8
1191	141	863.2			306.6		94.2
1192	196	241.4	3.0	146.4	30.0		64.8
1193	254	78.2	2.8	32.6	17.6	4.6	9.0
1200	233	338.8	5.4	200.0	74.0	1.0	229.0
1201	154	716.8	3.2	1462.4	278.4		398.4
1202	141	1185.0					
1203	190	405.6		84.0	114.0		20.6
1204	249	685.5	30.8	83.4	22.5		48.0
1211	228	903.9	3.8	97.4	121.9		106.1
1212	162	1335.5		480.2	4456.8		127.5
1213	136	86.8		1590.0	340.0		120.0
1214	223	667.8		75.6	27.0		50.0
1215	249	4134.0		333.1	185.0		351.3
1219	201	378.0		194.4	403.2		504.0
1222	203	656.0		200.0	772.8	1.6	448.8
MEAN		787.9	2.6	302.3	496.0	1.2	173.9

#### SLOPE 259-600

ST.NO.	DEP.	Hakes	Monk	Dentex	Horse mck.	Squid	Other
1178	394	1291.8				15.8	177.0
1179	337	524.2	10.4			6.2	109.6
1180	281	697.6	1.2	47.6	140.0	7.4	50.2
1183	259	235.0		2.8	397.6	2.8	68.6
1184	296	609.6	16.8		5.6	5.2	56.2
1185	356	1003.8	11.4			3.0	163.9
1186	402	179.8				24.0	361.6
1187	300	395.8	14.2				51.7
1188	275	705.0	3.8	12.0	12.5	8.2	12.6
1194	303	244.4	2.4	0.6		2.2	12.0
1195	362	479.7	27.8			0.8	64.5
1196	410	145.6				2.2	184.3
1197	371	396.0	4.2			3.2	218.6
1198	337	339.2	12.0			2.2	134.8
1199	294	844.4	9.0	32.0	8.0		48.0
1205	299	954.0	3.0	1.8	10.1	1.9	86.6
1206	349	1568.0					305.0
1207	412	152.6				9.6	290.6
1208	356	845.4	15.0		6.2	1.8	89.6
1209	275	1452.8	3.0	25.8	39.2		304.8
1210	302	609.8	2.8	15.8	4.6	1.6	125.2
1216	360	514.0				12.6	147.6
1217	355	637.0	16.0		11.8	25.6	168.0
1220	302	1888.7			8.1		159.3
1221	303	1306.8	5.7				254.4
1223	406	608.8	5.4			21.6	712.8
1224	299	1441.0		52.9	80.5		125.6
MEAN		743.4	6.1	7.1	26.8	5.9	166.0

Table 9 shows the depth distribution of the hakes. There is an increased rate for Cape hake in the shallow range. From Figure 13 which gives the weighted size compositions of the samples of Cape hake it is evident that the main component in this shallow range is small sized fish with a mode close to 30cm. This must be 2 year old fish of the 1990 cohort that have migrated up from the Central Region since the last survey. The size composition in the deep range shows as in the previous survey mainly large sized fish that now has a mode around 50cm slightly higher than in November.

	100-250m	250-350m	350-450m
Cape hake			
Density	25.4	26.1	15.5
Catch rate	760	780	460
Deep w. hake			
Density			1.7
Benguela hake			1.4
No of hauls	19	17	11

Figure 12 shows the distribution of Cape hake in the northern region by levels of density calculated from the catch rates and with adjustments for fish in mid water. The pattern of distribution is similar to that found previously in this region with bands of high density in deeper waters extending right up to Cunene. The addition of the juvenile fish in shallower waters is demonstrated.

Biomass estimates give a total of 185 000 tonnes, see Table 10 with 70 000 tonnes inside and 115 000 tonnes outside 250m of depth, with fishable parts (36cm and larger) of 30 000 tonnes and 113 000 tonnes respectively. The estimate of total fishable stock in this region, 143 000 tonnes is close to the estimate of 134 000 tonnes obtained in November.

	Cape hake	Deep sea hake
1/90	180	
3/90	105+ midw.	
1/91	200	
2/91	140	2
1/92	185	4

Maturity sampling of female fish of Cape hake of 30-70cm of length (st nos 1183, 1205, 1224; N = 335) showed the following state:

Maturity stage:	2	3	4	5	6
%	92	7	0.3		0.3



This indicate that the adult fish in the Northern region was in a resting stage at this time. The few fish that had started a new gonad development were from the southernmost stations. Similar observations from the October-November 1991 survey ( 1514 fish from 36 stations at depths of 210-460m, maturity scale 1 - 4 ) showed 1% running and 32% postspawning.

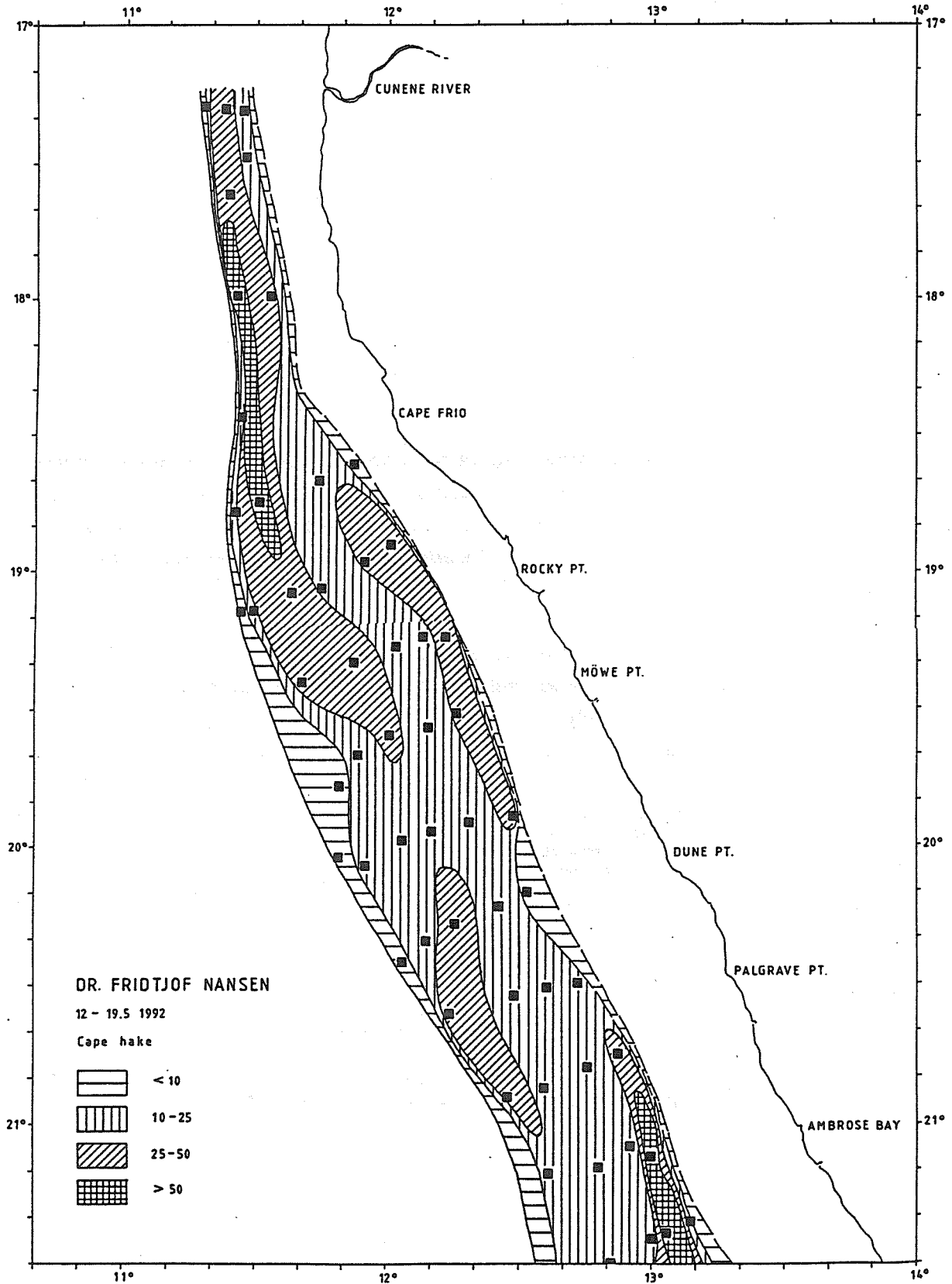
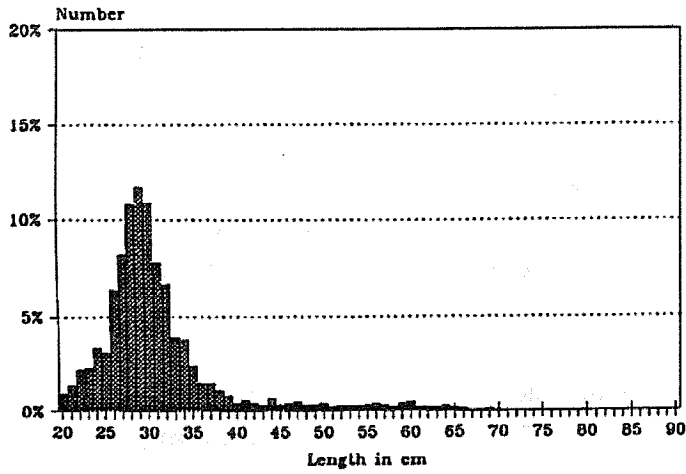
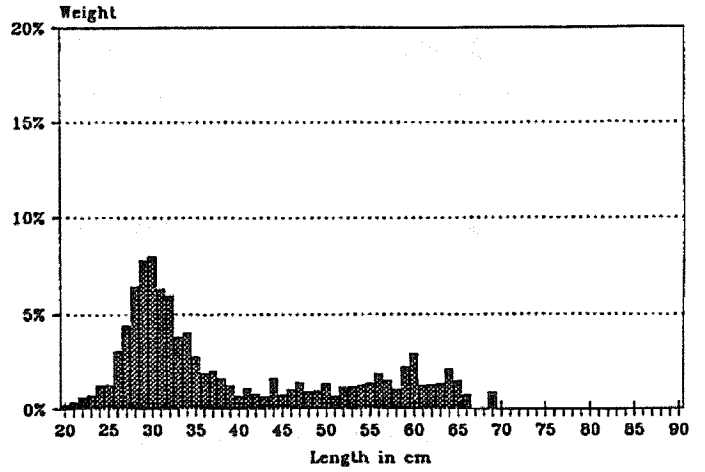


Figure 12. Northern Region. Distribution of Cape hake.

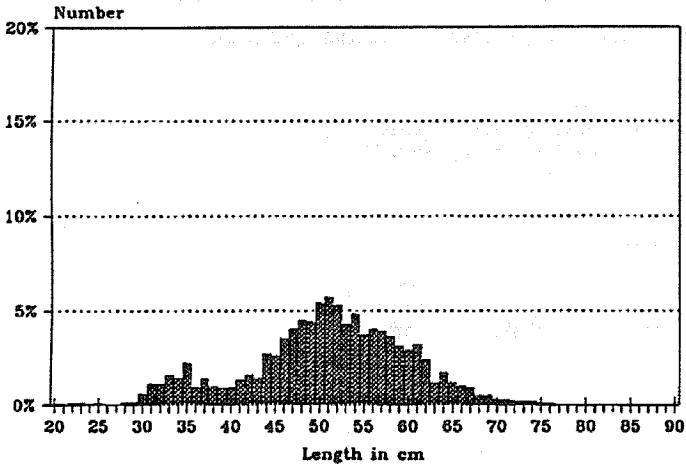
Cape hake, north  
50-250m



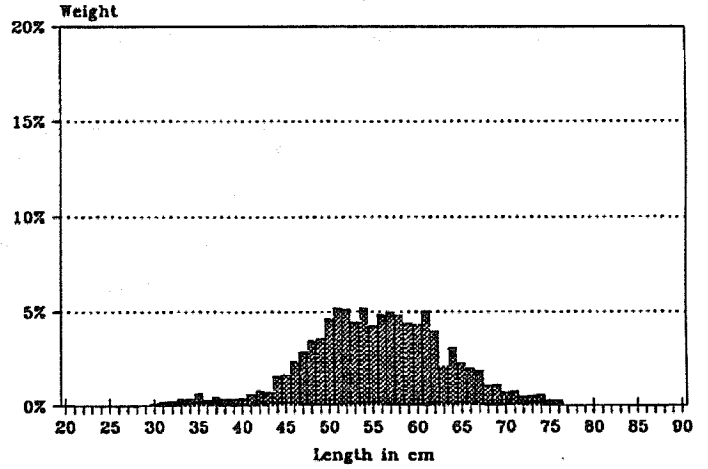
Cape hake, north  
50-250m



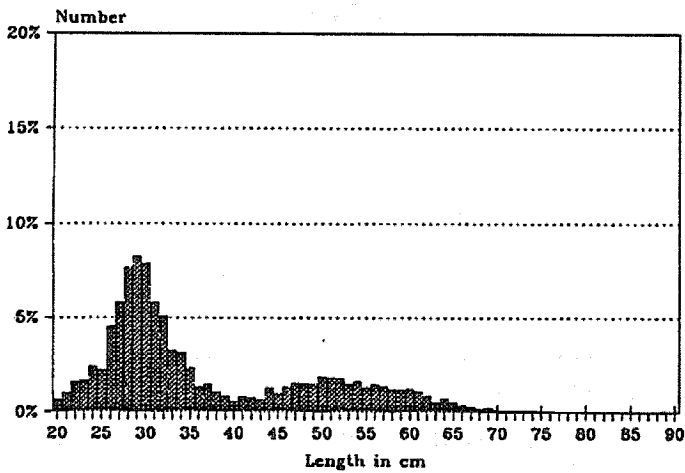
Cape hake, north  
250-600m



Cape hake, north  
250-600m



Cape hake, north  
Total



Cape hake, north  
Total

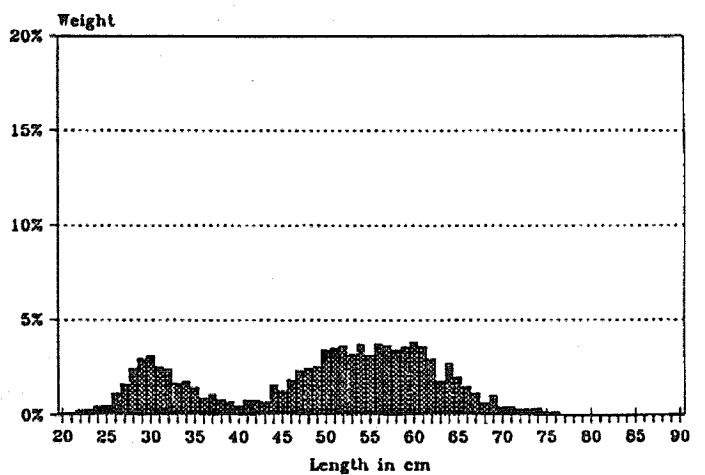


Figure 13. Northern Region. Size compositions of Cape hake by depth ranges. Pooled samples weighted by catch rates. Distributions by numbers and biomass.

## CHAPTER 4 CONSIDERATIONS OF THE SURVEY RESULTS

The present survey is the 5th in a series started in early 1990 and in each of which the distribution of the hake stocks over the whole Namibian shelf has been covered. Table 11 shows the effort that has been spent in these hake investigations. The meaningful and largely consistent results obtained in these investigations with regard to the distribution, size composition and biomass of the hake stocks indicate that the methods used are reliable and that the efforts expended have been at an adequate level. The mid water behaviour of the hake caused a problem of biomass estimate in survey 3/1990, but this was at least partly overcome through the use of new acoustic instrumentation in the following surveys.

The trends in the findings for the deep water hake seems to indicate that this stock has received parts of its recruitment from areas outside the Namibian EEZ. This is evidently not the case for the Cape hake where recruitment cycles have been observed and described.

Survey		Orange R.- St. Francis	St. Francis Ambrose	Ambrose- Cunene	Total
1/1990					
25/1-10/3	No. stations	59	73	37	169
	" samples	37	73	25	114
	" measured	6.0	10.7	2.6	18.6
3/1990					
11/9-6/10	No. stations	44	51	34	129
	" samples	68	106	77	251
	" measured	9.3	10.3	5.6	25.2
1/1991					
25/1-28/2	No. stations	41	77	56	174
	" samples	104	170	114	388
	" measured	6.8	13.3	6.9	27.0
2/1991					
23/10-21/11	No. stations	52	69	49	170
	" samples	110	132	110	352
	" measured	7.1	14.3	9.6	31.0
1/1992					
23/4-21/5	No. stations	57	60	47	164
	" samples	136	141	102	379
	" measured	9.0	11.2	8.2	28.4

A summary of the estimates of the mean density of the hakes by depth strata is shown in Table 12. The difference in depth distribution between the two species is clearly demonstrated especially in the southern region where the deep water hake has its highest abundance. There has been a change in density by depth over the survey period with increasing densities at greater depths. This demonstrates an increasing amount of large sized hake in the stocks. For the Cape hake the density in the shallow range, 100-250m is mainly determined by the abundance of the young recruits, fish of less than about 30 cm of length which is restricted to a depth range of between 130 and 200-250m. In the central region

densities were high in this range in the last two surveys and also in the northern region in the last survey.

Table 12 Depth distribution of the hake species. Mean densities in tonnes/nm <sup>2</sup> .				
	100-250m	250-350m	350-450m	450-550m
<b>SOUTHERN REGION</b>				
Cape hake				
1/90	21.9	4.4		
3/90	11.5	6.1	0.1	
1/91	11.3	8.8	0.9	
2/91	6.3	12.5	0.7	0.7
1/92	12.6	28.4	4.6	
Deep water hake				
1/90		1.4	5.0	1.2
3/90	0.1	6.3	1.2	0.4
1/91		4.4	6.0	1.1
2/91	0.3	8.9	14.9	4.9
1/92		8.9	34.8	4.0
<b>CENTRAL REGION</b>				
Cape hake				
1/90	27.1	7.4	0.4	
3/90	38.6	8.3	2.5	
1/91	14.5	9.1	2.2	
2/91	34.2	19.0	7.2	1.0
1/92	36.5	14.6	8.5	1.7
Deep water hake				
1/90			1.6	1.4
3/90	0.2	0.4	0.9	0.9
1/91	0.2	0.1	0.8	
2/91		0.3	5.3	5.6
1/92		1.3	6.8	1.6
<b>NORTHERN REGION</b>				
Cape hake				
1/90	41.3	20.9	1.0	
3/90	25.9	15.1		
1/91	15.0	27.0	11.5	
2/91	13.6	23.5	24.3	4.3
1/92	25.4	26.1	15.5	

Table 13 shows the biomass estimates for the two stocks by regions and the corresponding data for the four previous surveys. The results demonstrate that the stocks are in continued growth with a present level of about 800 000t for all fish larger than about 20cm and about 500 000t for the fishable stock of sizes 36cm and larger. The hakes are now spread more evenly on the regions with high density areas along the whole shelf from off Lüderitz up to Cunene. Adult hake is especially abundant on the deeper part of the shelf from Lüderitz to Easter Point and from Ambrose Bay to Cunene. Juvenile hake is abundant inside 200-250m in the Central and parts of the northern regions.

The bulk of the biomass of deep water hake is as previously found in the southern region. The stock estimate is up from about 100 to about 160 000t since November 1991, an unexpectedly high increase.

The Cape hake figures for the two last surveys show an increase since the last survey from about 520 to about 650 000 tonnes with 315 and 370 000 tonnes for the fishable parts.

About 60% of the increase of the total biomass comes from the juvenile stock and is related to the high abundance of the 1990 cohort.

	TOTAL BIOMASS				
	Feb-Mar 1990	Sept-Oct 1990	Jan-Feb 1991	Oct-Nov 1991	Apr-May 1992
<b>SOUTHERN REGION</b>					
Cape hake	130 000	130 000	126 000	80 000	200 000
Deep w. hake	22 000	25 000	31 000	83 000	145 000
<b>CENTRAL REGION</b>					
Cape hake	180 000	219 000	150 000	302 000	261 000
Deep w. hake	4 000	6 000	6 000	13 000	15 000
<b>NORTHERN REGION</b>					
Cape hake	180 000	105 000 + mid w.	200 000	140 000	185 000
Deep w. hake				2 000	4 000
<b>TOTAL</b>	<b>516 000</b>		<b>513 000</b>	<b>620 000</b>	<b>810 000</b>
<b>TOTAL FISHABLE</b>	<b>220 000</b>		<b>300 000</b>	<b>370 000</b>	<b>503 000</b>

The recruitment to the stock of Cape hake can be estimated from the numerical abundance of the 2 year old fish. The estimates for the 1990 yearclass based on the current survey data are shown in Table 14 together with previous observations. The new estimate which is close to that of the last survey confirms the high abundance of the 1990 yearclass. This fish is now 20 to 35 cm of length and is still distributed inside the 200-250m depth line.

The 1991 yearclass was represented by small numbers of about 15cm fish in some catches in the Central and Southern Regions. This age groups is not yet fully settled on the bottom and its abundance will be better estimated in the next surveys, but the first impression is of a group of low abundance.

Yearclass	1988	1989	1990*	1990**
Region south	980	100	160	300
centre	1 320	170	1 710	1 620
north	10	10	20	240
<b>Total</b>	<b>2 310</b>	<b>280</b>	<b>1 890</b>	<b>2 160</b>

\* From survey 2/91  
 \*\* " " 1/92

Observations on the gonad state of adult female Cape hake are still incomplete, but may support an hypothesis of main spawning in winter (southern) and with the bulk of the spawning restricted to the Southern and Central Regions. The Central Region spawning may take place somewhat later than that in the south, perhaps late winter. This would correspond with the observed difference in the size of the recruit groups between the two regions.

