CHAPTER 4 CONSIDERATIONS ON THE SURVEY RESULTS

The present survey is the 8th 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 14 shows the effort that has been spent in these hake investigations. The mid-water behaviour of the hake caused a problem of biomass estimate in survey 3/1990. Improved acoustic instrumentation reduced that problem in the subsequent surveys, but in survey 1/1993 and in the present survey this behaviour is again thought to have caused some underestimate of biomass, especially in the northern region.

Table 14 Effort in Namibian hake surveys 1990-1993. Number of swept area fishing stations, number of samples (mostly by sex) and number of length measurements in thousands.

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
2/1992					
20/10-1/12	No. stations	64	78	50	192
	" samples	188	169	143	500
	" measured	13.1	13.4	7.8	34.3
1/1993					
20/1-25/2	No. stations	72	56	56	184
	" samples	197	162	118	477
	" measured	12.7	11.9	7.6	32.2
2/1993					
22/4-25/5	No. stations	61	78	69	208
	" samples	173	202	163	538
	" measured	10.8	13.9	10.2	34.9

The trends in the findings for the deep water hake seem 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 can be observed and described.

A summary of the estimates of the mean density of the hakes by depth strata is shown in Table 15. The difference in depth distribution between the two species is clearly demonstrated. 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 normally restricted to a depth range of about 130 to 200-250m. In the central region densities were high in this range in survey 2/1992, but with a marked reduction in the last two surveys, and the densities are now as in survey 1/92 in the central region and well below in the northern.

Table 15 Depth distribution of the hake species. Mean densities in tonnes/nm².

	100-250m	250-350m	350-450m	450-550m
SOUTHERN REGION				
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	
2/92	11.6	12.2	1.1	0.2
1/93	14.2	25.7	7.2	0.3
2/93	11.0	18.2	4.7	
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
2/92	1.7	7.9	23.8	14.2
1/93	0.2	44.2	26.3	10.3
2/93	0.1	5.1	31.5	12.1
CENTRAL REGION				
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
2/92	53.6	20.1	10.5	0.8
1/93	34.1	9.5	8.9	0.3
2/93	34.4	23.8	4.6	0.6
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
2/92		0.3	3.1	4.1
1/93		0.3	2.8	4.3
2/93		0.6	4.6	6.0
NORTHERN REGION				
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	
2/92	29.6	18.6	17.6	
1/93	13.7	23.2	14.7	2.8
2/93	9.3	16.5	12.8	2.3

Table 16 shows the biomass estimates for the two stocks by regions and the corresponding data for the seven previous surveys. The most remarkable finding of the two last surveys is the decline of the total biomass of the Central Region from the Oct-Nov 1992 results of 540 000 tonnnes to 280 000 tonnes. As discussed above this consists mainly in a reduced abundance of recruit fish below 36 cm of length from a level of 370 000 tonnes in the survey 2/92 through 130 000 tonnes in the last survey and 118 000 at present. Some survey variability may be involved, but the charts of biomass distribution from the three last surveys show clearly that the extended inshore high density area of juveniles of the Oct-Nov 1992 survey is now greatly reduced and that there has been a seaward movement of the 'gravity point' of the fish distribution. Extensive nearshore areas, previously densely populated are now practically free from hake recruits. The reduction by number is about 2000 million fish, or a reduction of 40% of its previous level in three months. No increase in the abundance of juveniles has been observed in the other regions. This would support the idea that the shelf region off Walvis Bay may be periodically subject to marked seasonal fluctuations in environmental conditions which could be responsible for mass mortalities of fish. Periodical mass mortalities of fish have been reported from the Walvis Bay area since the first half of the nineteenth century and most of these occur in the period December-January. Intrusion of upwelled oxygen deficient water onto the shallow shelf and sudden outburst of sulphur gas from the sediments have been suggested as causes, but the processes are not well understood. It is also the experience from the Nansen surveys that trawling in the mud belt off Walvis Bay at times gives large amounts of fish bones in the trawl, supporting the idea that this area could be an environmental trap.

Table 16 Summary of estimates of biomass of the two hake species by surveys and areas. 1 000 tonnes.

	TOTAL BIOMASS							
	Feb-Mar 1990	Sep-Oct 1990	Jan-Feb 1991	Oct-Nov 1991	Apr-May 1992	Oct-Nov 1992	Jan-Feb 1993	Apr-May 1993
SOUTH REGION								
Cape hake	130	130	126	80	200	160	210	180
Deep w.hake	22	25	31	83	145	125	150	115
CENTR.REGION								
Cape hake	180	219	150	302	261	542	280	280
Deep w.hake	4	6	6	13	15	15	12	20
NORTH REGION								
Cape hake	180	105*	200	140	185	190	150	110
Deep w.hake				2	4	8	4	6
TOTAL	516		513	620	810	1040	810	710
TOT.FISHABLE	220		300	370	503	490	520	420

* unadjusted underestimate due to fish off the bottom.

The present estimate for the Cape hake is lower than the one obtained in the previous survey by 100 000 tonnes, 80 000 tonnes of which represent fishable biomass. This is a reduction in the fishable biomass of 21% over 3 months.

This difference could be ascribed to a real reduction in the fishable biomass or to random statistical variability as well as to sampling problems due to the pelagic behaviour of the hake and systematic sampling bias.

The pelagic behaviour is mainly a problem in the northern region and the consistent reduction in the estimates of fishable biomass by 18%, 21% and 25% in the southern, central and northern region respectively, suggests that this is not likely to be the reason of the observed reduction. The hypothesis of the presence of a systematic sampling bias in the last survey should also be excluded as sampling procedures and gear have remained unchanged during the period.

The trend in the estimates of fishable biomass of the two hake species, the recruits (both species combined) and the total are also shown in Figure 8. For the Cape hake there has been an increasing trend in the fishable biomass from early 1990 until end of 1992. The two recent surveys indicate at least stagnation in the rate of increase. It is however recommended to seek confirmation by other data. If the estimated trend signifies a true reduction in the standing stock this should also be reflected in the average CPUE from the commercial fleet. It is therefore strongly advised that an analysis of the development of the catch rates from a few selected fishing boats are analyzed, since at least May 1992, in order to check whether the same declining trend has occurred there.

The development in the fishable biomass of deep water hake (Fig. 8 b) shows a sudden increase during 1991 to a level around 100 000 tonnes in the last two years. The increase has mainly taken place in the southern region and the part of the stock in Namibian waters is only a fraction of the stock with its main distribution point further south. The increase in Namibian waters can be seen as either a northern shift in the distribution of the deep water hake in general or as an effect of a general increase in the stock. Data from recent investigations in South Africa should clarify this and it is recommended to make consultations.

The bulk of the biomass of deep water hake is as previously found in the southern region. The slight reduction in the stock estimate is totally within the survey variability.

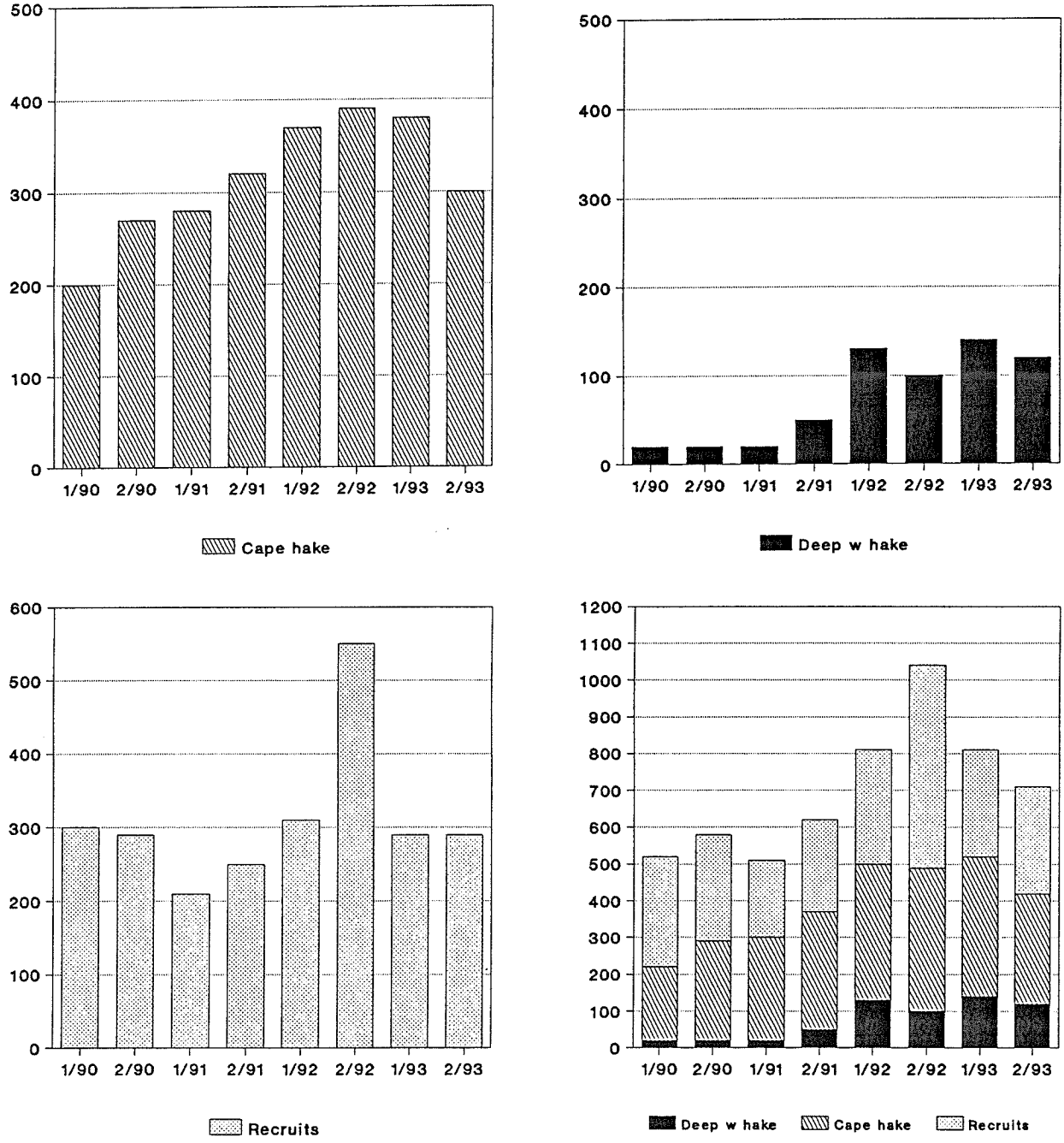

Figure 8 Trends in biomass estimates : a) Cape hake, 'fishable' stock, b) deep water hake, 'fishable' stock, c) recruits ('non-fishable' bimass) and d) total hake in Namibia. Thousand tonnes.

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 1991 yearclass based on the current survey data are shown in Table 17 together with previous observations. In spite of its drastic reduction since November the abundance of the 1991 yearclass is now at a 'normal' level comparable to those of 1988 and 1990.

Table 17 Estimates of strength of recent yearclasses of Cape hake. Cohort population numbers at about two years of age for the groups assumed to have been spawned in 1988, 1989, 1990 and 1991. Millions of fish.

Yearclass	1988	1989	1990	1990	1991	1991	1991
Region south	980	100	160	300	990	670	390
centre	1 320	170	1710	1620	3500	1230	1370
north	10	10	20	240	440	270	130
Total	2 310	280	1890	2160	4930	2170	1890
Survey/Year	1/90	1/91	2/91	1/92	2/92	1/93	2/93

However, a high reduction in the abundance of the hake cohorts between 25 and 35 cm may be a regular and stronger feature of the Namibian stocks in comparison with other hake species . A better understanding of the mechanisms behind this reduction should be given high priority and should involve a team effort from resource surveys, predator-prey relationship studies and biological oceanography.