3.3 ST. FRANCIS BAY TO AMBROSE BAY

Composition of catches

Table 5 shows the catch rates by main groups for the shelf and the slope separately. The mean catch rates for hake are approximately as in Survey 1/90. The group "other demersal" are mainly monk. Horse mackerel gave high catch rates at shallower depths.

Table 5. St. Francis Bay to Ambrose Bay. Catch rates by main groups in bottom trawl hauls standardized to kg/hour for the shelf and slope.

SHELF 50-259 m

ST.NO.	DEP.	Hakes	Other dem	Horse mck	Squid	Other
546	167	1600.0				16.0
547	226	1702.4				
553	230	330.0				8.4
554	183	351.4		205.0		
555	224	469.2	6.0	216.0		40.8
556	258	261.0				77.4
560	250	147.7	2.8	128.4	5.2	29.6
561	221	278.8		361.6		18.6
562	191	102.4		122.6	1.0	5.8
563	178	194.0		80.0		1.2
564	155	165.0	1.2	1.8		5.6
565	199	119.4		16.0		31.4
566	199	179.4		408.6	9.0	25.8
572	197	105.6		245.0	3.4	24.0
573	150	758.0		5242.0		
574	148	1321.2		177.6		9.4
575	146	1086.8		114.4		60.8
577	249	62.4	3.2	96.0		10.2
578	209	355.4	16.0	732.0		
579	136	307.8	34.0	4064.0		578.0
580	129	798.0		304.8		
581	124	278.4		818.1		3.8
582	132	190.0		176.0		3.8
583	198	343.4	3.0	24.6		13.4
584	195	351.5	1.6	137.8	1.2	10.5
585	237	462.6	5.0	222.0	0.6	9.2
586	247	532.0		372.8	5.0	1.0
590	249	130.6		55.0		5.2
591	193	33.6	0.7	11.7		16.5
592	236	291.2		5.4		31.2
593	201	151.4	0.4	314.4	2.4	20.0
594	150	342.6	3.0	140.2	1.0	5.7
595	124	300.0				6.6
596	113	7.2				149.4
597	121	517.2				42.2
598	113	660.0				1.6
599	125	515.0	4.0	16.5		24.5
600	146	446.4				0.8
601	131	2925.0		20.0		11.0
602	113					
603	124	114.4				2.8
604	114	166.4				
606	97					20.0
607	122	1600.0				
608	142	1.0		30.0		0.5
609	155	93.6		1306.8		4.4
610	200	41.2		754.0		10.4
615	133	120.0		3864.0		3.2
616	181	268.0		37.0		7.6
617	256	138.0		70.0		4.8
621	231	57.0	0.1	15.5		9.6
622	225	116.8	1.6	26.8		32.4
623	152	124.4		254.0		
MEAN		415.3	1.5	399.7	0.5	26.3

Table 5. Continued

SLOPE 260-600 m

ST.NO.	DEP.	Hakes	Other dem	Horse mck	Squid	Other
548	300	215.5	1.0			14.0
549	376	190.5			67.0	29.5
550	401	18.0			13.4	48.3
551	331	244.0	5.0		7.4	40.7
552	278	304.8				1038.0
557	285	450.0	1.4			27.9
558	400	67.8	4.8		22.0	143.0
559	300	756.8			3.2	29.3
567	276	302.8			8.6	67.8
568	333	387.7	17.2		27.4	277.3
569	400	68.8	0.6		16.0	62.8
570	348	47.0	0.6	2.8	9.6	144.0
571	267	172.6	1.8	71.2	6.6	36.6
576	312	92.0	1.6		1.6	22.2
587	282	325.6	2.0	288.0	7.0	9.6
588	359	124.6	4.2	3.0	10.0	39.3
589	300	309.8		1.2	3.4	22.9
611	292	801.2	32.6	307.6	22.0	49.0
612	311	86.2		1.4		16.8
613	328	317.2	5.4		3.6	62.2
614	416	115.2	7.6		9.8	124.4
618	302	91.8		4.2	5.0	122.8
619	349	97.0			6.5	12.1
620	299	140.0	32.2		2.0	34.5
MEAN		238.6	4.9	28.3	10.5	103.1

The hakes

The depth distributions of the two species are shown in Table 6. The density of Cape hake in shallow waters is considerably lower than that found in the two previous surveys. The deep water hake was poorly represented and the trawl survey was not extended beyond the 350-450 m depth range.

Table 6. Depth distribution of the two hake species, St.Francis Bay to Ambrose Bay. Mean densities: t/nm^2 and mean catch rates, kg/hour.

	100-250m	250-350m	350-450m	450-550m
Cape hake				
Density	14.5	9.1	2.2	
Catch rate	435	270	70	
Deep w. hake				
Density	0.2	0.1	0.8	
Catch rate	5	3	20	
No. of hauls	50	20	6	0

Figure 7 shows the distribution of Cape hake over the shelf (acoustic estimates of pelagic hake are included). High density areas were located only in spots whereas in the previous surveys a more or less continuous belt of dense fish was found between 100 and 200 m of depth. This change in distribution pattern may be an effect of the main bulk of fish growing beyond the size where they aggregate in relatively shallow water.

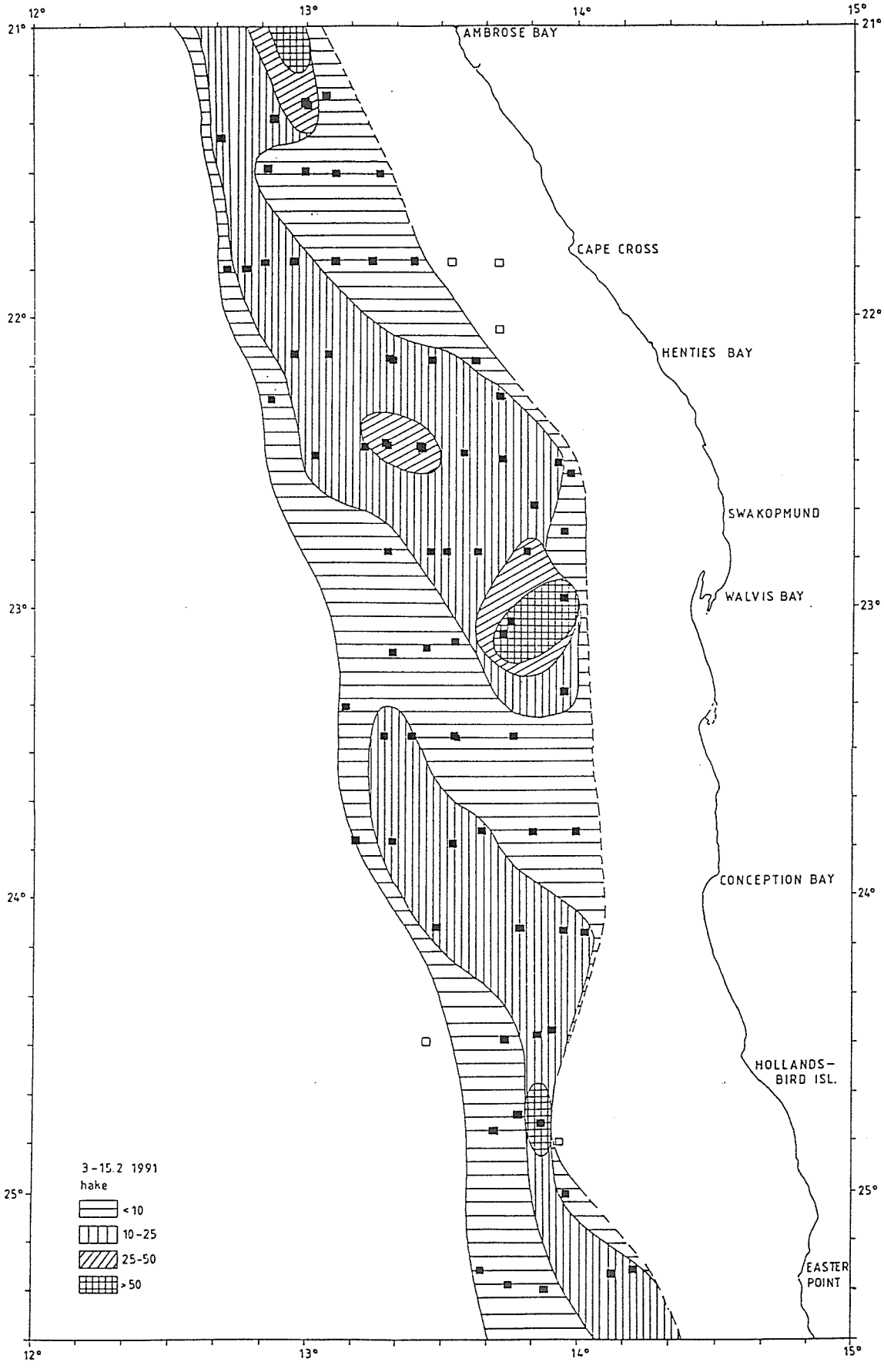


Figure 7. St. Francis Bay to Ambrose Bay. Distribution of Cape hake. Density strata based on catch rates at fishing stations and acoustic density > 5 m from bottom.

The size distributions for this region are shown in Annex 1. The modal group at about 30 cm of fish length found in the southern region was not evident in the shallow water samples here, but 30-35 cm was the dominating fish size at greater depths. The process of size selective depth distribution may thus have affected the size composition in shallow water.

The application of a mesh selection of a 110 mm trawl shows that 17% by numbers and 41% by weight would be available to the commercial fishery in this area, approximately the same proportion as found in the previous surveys.

A biomass estimate of the Cape hake based on post-stratified observations as shown in Figure 7 and adjusted for fish present in mid-water gives a total of 150 000 tonnes for this region. This is significantly lower than the estimates for the two previous surveys, the difference being reduced high density areas of small sized fish in the shallower parts of the shelf.

The full depth range of the deep water hake was not covered in this survey. An estimate of the biomass of this species down to 400 m of depth is 1 500 tonnes.

3.4 AMBROSE BAY TO CUNENE RIVER

Composition of catches

Table 7 shows the catch rates by main groups for the shelf and the slope. Catch rates of hake are considerably higher in deeper waters than in the previous surveys. Large-eye dentex is the main contributor to the group "other demersals". Very high catch rates were obtained for horse mackerel on the shelf.

Table 7. Ambrose Bay to Cunene River. Catch rates by main groups in bottom trawl hauls standardized to kg/hour for the shelf and slope.

SHELF 50-259 m

ST.NO.	DEP.	Hakes	Other dem.	Horse mck.	Squid	Other
624	126					
625	153	20.2				12.6
626	193	4256.0	56.0	84.0		224.0
627	254	1568.0		16.8		28.0
630	259	25.8		2.1		4.8
631	259	35.7	0.4	2.0		13.2
632	179	348.0	46.0	4440.0		30.0
633	152			30000.0		
634	129			785.7		
635	197	416.4		3304.8		
636	252	31.8		170.6		2.2
641	250	102.2		467.2		4.0
642	213	219.0	233.7	1557.0		10.5
643	185	79.8	1435.2	1140.8		27.6
644	128	195.3	615.6	6583.2		482.6
645	178	32.6				0.2
646	234	162.2	15.0	13.6		8.0
654	216	89.5		0.5		10.5
655	149	2.2	12.0			5.6
663	200	54.0	94.2	1.7	4.2	12.6
664	238	903.6	86.8	6.4		27.8
665	179	10.6	10.0			4.0
666	238	3396.2	72.8	1456.0		24.8
671	235	241.5	41.7	1.5	6.9	316.5
674	157			9600.0		
675	257	2188.2				94.6
677	212	791.7	46.2	205.8	5.4	34.8
680	200	11.4		365.2		62.2
681	126			24000.0		
682	182	216.4	72.0	1171.2		230.8
MEAN		513.28	94.5	2845.8	0.5	55.7

Total number of stations : 30

Table 7. Continued

SLOPE 260-500 m

ST.NO.	DEP.	Hakes	Other dem.	Horse mck.	Squid	Other
628	323	247.4	13.6	266.0	5.8	36.9
629	344	164.0		7.0		12.2
637	299	606.8	14.4	6.8		29.4
638	352	267.0	24.0			126.7
639	301	273.0	2.6			40.2
640	302	288.4	5.6	1.2	1.8	62.4
647	272	92.8		1.0		9.6
648	307	119.4	15.1	17.0		42.1
649	403	6.0				0.1
650	351	334.6	8.4	1.6	8.0	61.2
651	376	463.6		10.0	9.4	118.5
652	325	413.8	11.8	4.6	20.0	53.6
653	275	371.6	22.8	1.0	2.3	45.6
656	283	210.0	6.6		1.8	241.2
657	287	343.0	128.0	20.9	12.0	28.3
658	303	457.4	31.0	8.8	20.8	69.0
659	360	267.6			13.0	120.8
660	411	71.4			16.8	153.2
661	374	277.0			25.4	66.8
662	319	936.0			18.0	101.6
667	287	6333.6		82.4		170.8
668	402	729.2		5.6	31.4	82.8
669	351	1382.0			42.8	88.8
670	281	1861.2	34.2	3.6	11.4	57.8
672	411	225.2			22.0	171.6
673	301	1769.4			7.4	279.0
676	356	417.0			67.8	342.9
678	306	555.0			6.9	32.4
679	406	371.4			3.0	69.6
MEAN		684.6	10.9	15.0	11.9	93.6

Total number of stations : 29

The hakes

Minor amounts of Angola hake, Merluccius polli is found in the northern part of this region. Table 8 shows the depth distribution of the Cape and Angola hakes. The Cape hake shows a clear shift towards greater depths as compared with the two previous surveys in which there was hardly any fish below 350 m of depth. This is most probably related to the larger fish size present during this survey.

Table 8. Depth distribution of hake species. Ambrose Bay-Cunene River. Mean densities: t/nm^2 and mean catch rates, kg/hour.

	100-250m	250-350m	350-450m	450-550m
Cape hake				
Density	15.0	27.0	11.5	
Catch rate	450	810	345	
Angola hake				
Density		0.2	1.5	
Catch rate		5	45	
No. of hauls	22	22	12	0

Figure 8 shows destribution of Cape hake in this region. The pattern is similar to that found in the two previous surveys with a high densities in a belt from Palgrave Point northwards to the Cunene River. As mentioned above, a substantial part of the fish was found in mid-water in these high density areas even during the day.

The size compositions are shown in Annex 1. Also in this area there is a demonstration of depth dependent size distribution. The size of the Cape hake in this northern region has in all three surveys been larger than in the southern regions and a consistent increase of size has taken place through Surveys 1/90, 3/90 to 1/91. It seems unlikely that this can be accounted for through the growth of the fish in a possible local stock. It is more probably the effect of size selective migrations of fish from the southern regions northwards. This may fit with the observation that the hake from Ambrose Bay northwards was found to have resting gonads both in Survey 3/90 and Survey 1/91. This indicates a general pattern of a feeding migration towards the north which must be followed by migrations southward for spawning. In general this would fit the Benguela regime with a surface current flowing northward providing transport for egg and larvae.

Applying the selection of a 110 mm trawl mesh to the estimated total size distribution of this northern region shows that most of this fish, 75% by numbers and 85% by weight would be available to commercial fsihing.

A biomass estimate based on the post-stratified data on densities of Cape hake shown in Figure 8 is 200 000 tonnes. A considerable part of this biomass was found in mid-water also during daytime. This adds to the lack of precision of the estimate. This is an increase over the previous surveys when, however, no account was taken of the fish in mid-water.

3.5 JUVENILE CAPE HAKE

From Survey 1/90 juvenile hake was reported to occur in dense aggregations in mid-water in a few locations in the two southernmost regions at depths of 120-150 m. The group appeared only occasionally in the swept area hauls. In Survey 3/90 this group was found in low abundance in some of the catches at depths shallower than 250 m. In Survey 1/91 a new group of juvenile hake appeared in catches over a much wider area than in the previous surveys. Usually they represented only a small part of the catch, but in restricted locations along the coast at depths of 120-150 m very dense patches were found mostly in mid-water which contained only small sized hake. These occurred particularly off Easter Point-Hollandsbird Island and off Walvis Bay-Cape Cross, see Figure 9. The densities in these aggregations were very high. The catch rates in the fishing stations shown in Figure 9 ranged between 1 and 2 tons/hour, but most of fish were distributed in swarms or layers in mid-water extending over several nautical miles. The estimated densities of four such aggregations located in the survey ranged from 40 to about 200 tonnes/nm^2, each observation representing a mean over 5 nm. A rough estimate shows that each aggregation may contain several billion specimens. This indicates that the high density areas may contain significant parts of the total recruitment.

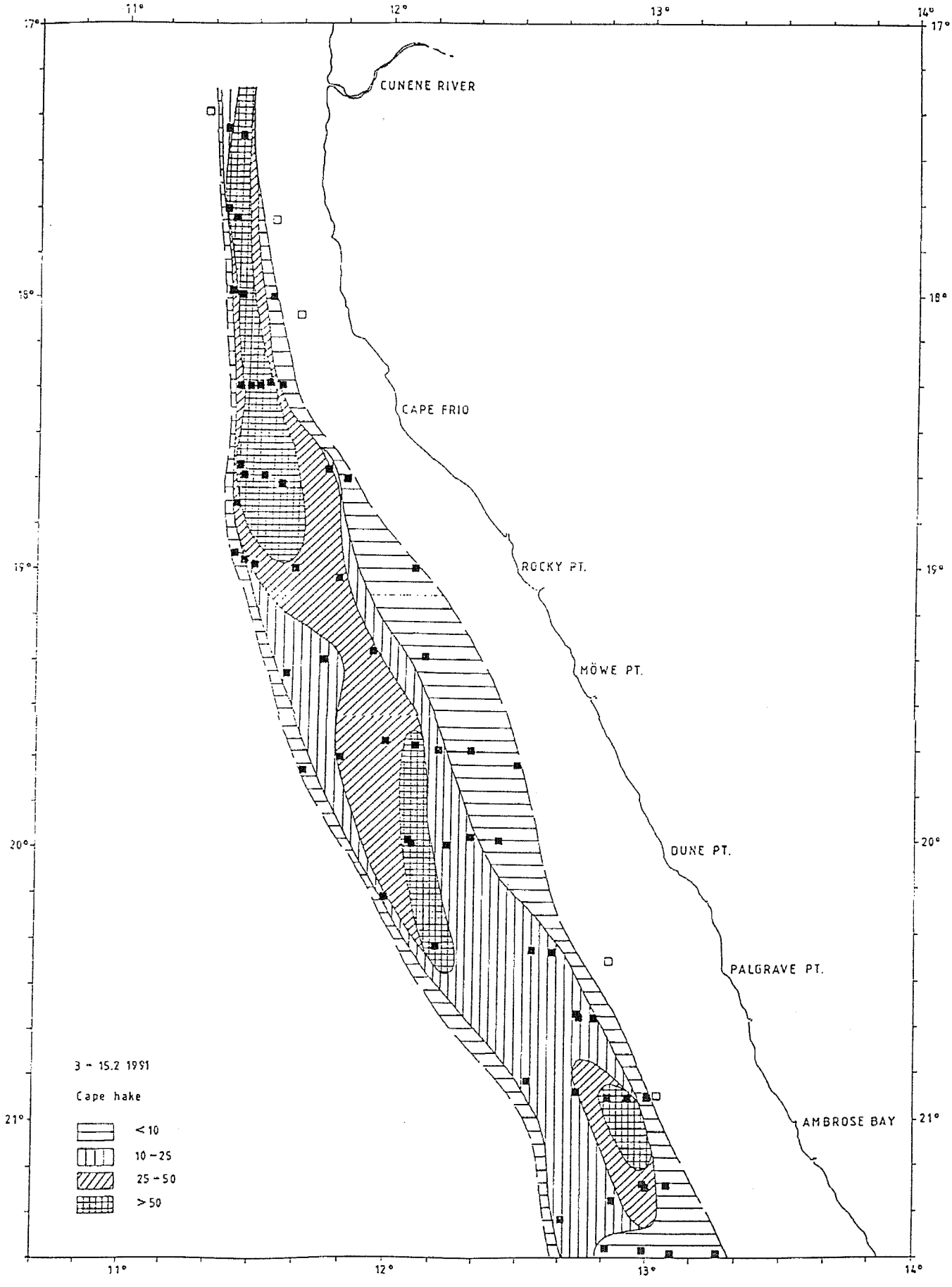


Figure 8. Ambrose Bay to Cunene River. Distribution of Cape hake. Density strata based on catch rates at fishing stations and acoustic density > 5 m from bottom.

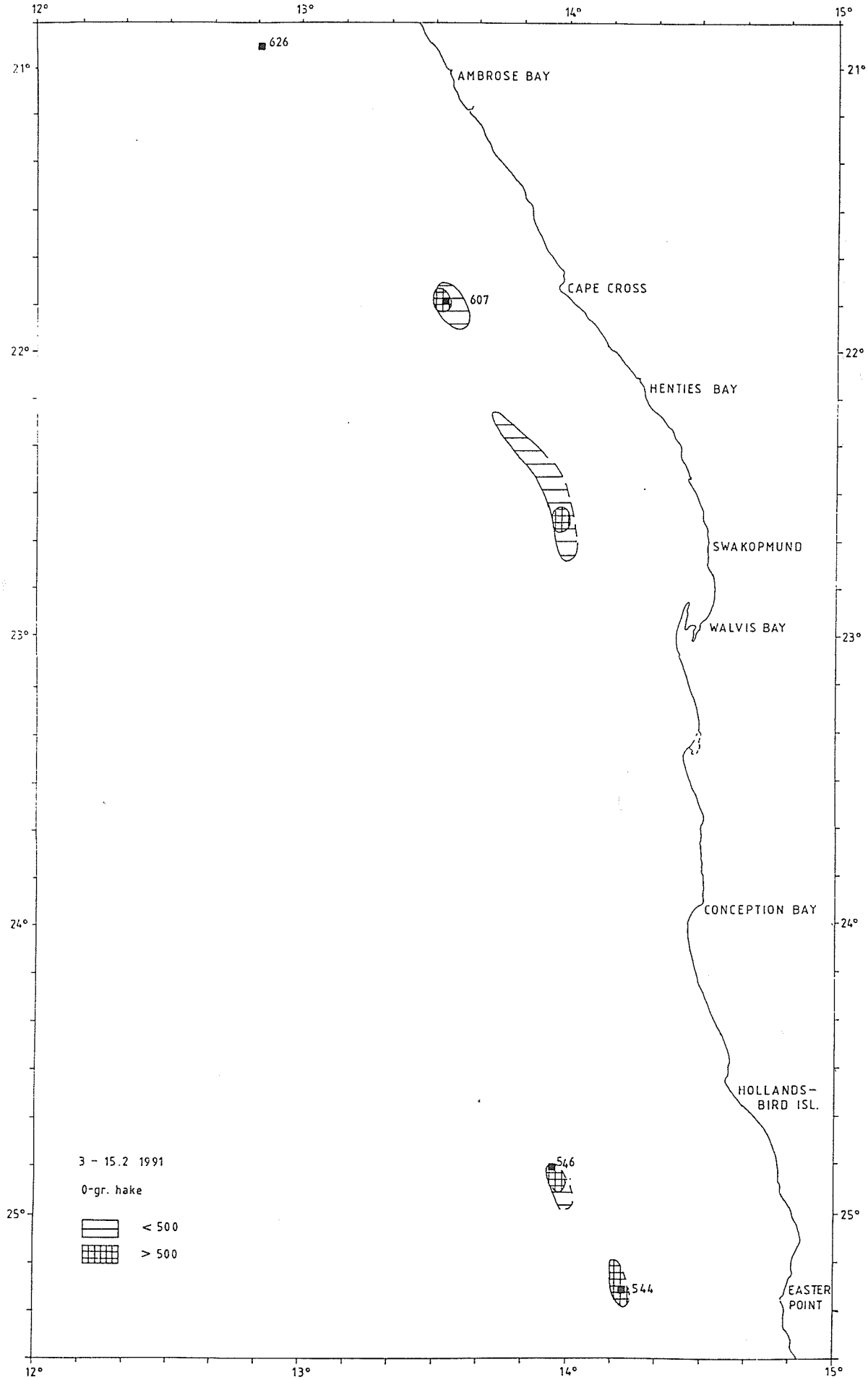


Figure 9. Areas with high acoustic density of juvenile hake and fishing stations with high catch of juveniles.

The size compositions of the juveniles in the three surveys are shown in Figure 10. The group with modal length of 12-13 cm in Survey 1/90 were evidently derived from spawning in 1989 and had grown to a modal size of 16-17 cm in Survey 3/90. The new group at a modal size of 12 cm in Survey 1/91 then represents the 1990 year-class.

The data obtained during this survey on the new recruitment does not permit an estimate of the absolute abundance of the 1990 year-class. There are clear indications, however, that this year-class is considerable stronger than that from 1989 which was observed during survey 1/90. More data on the 1990 year-class may become available from survey efforts later this year and can be expected from next years summer survey when the group will be available to sample trawls in shallow water. In the future special surveys should be directed towards the mid-water occurrence of the juvenile hake with a special further developed detailed acoustic and mid-water sampling programme for assessment of the absolute or at least relative abundance of the O-group fish.

CHAPTER 4 CONSIDERATIONS OF THE SURVEY RESULTS

The main objective of the programme, the hake survey, was successfully accomplished with a total of 175 swept area trawl stations. Acoustic observations with the new SIMRAD EK500 system showed the well known pattern of hake lifting off the bottom at night, but also that substantial amounts of fish remained off the bottom during the day, especially in the northern part Ambrose Bay to Cunene. A similar behaviour was observed during Survey 3/90, but the indications are that the pelagic occurrence was more pronounced in the present survey.

The analysis of data from successive surveys may, in addition to data on fish distribution, composition and abundance and biological parameters, also provide information on stock structure and biological history of the hake. Figure 11 shows the estimated size compositions for the total stocks in each of the sub-areas and for each of the three surveys. In the two first surveys the size compositions are dominated by fish of 25-30 cm assumed to derive from high survival from the spawning in 1988. This group is also partly apparent in the compositions from Survey 1/91, but these also reflect the effect of another process than fish growth; viz. a northward shift of larger sized fish. There is in all surveys a tendency for the hake in the Ambrose - Cunene region to be larger sized than further south and this is more pronounced in Survey 1/91. The mid-water occurrence of this fish and their state of resting gonads indicate, as discussed under section 3.4 above, a regime of feeding migrations towards the north of the adult fish. These findings are not consistent with a concept of two separate stocks of Cape hake in Namibian waters, but there is a need for further studies of the structure of the stock.

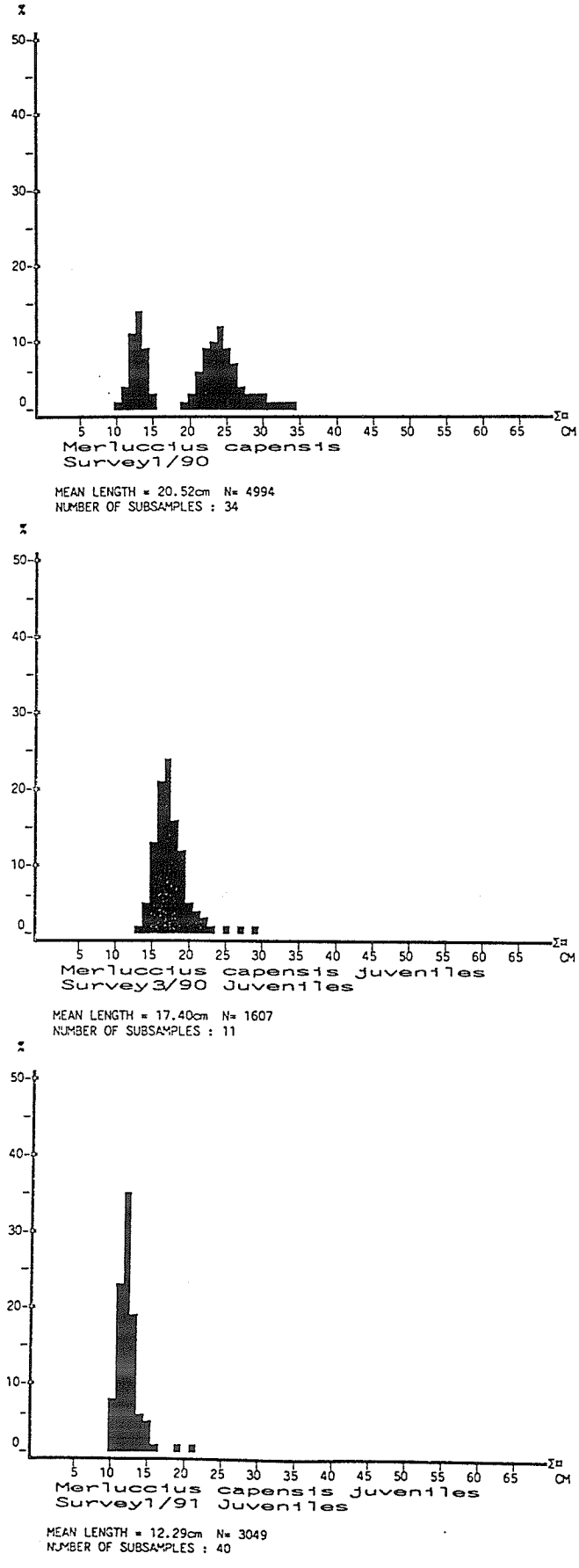


Figure 10. Size composition of samples of juvenile hake in the three surveys.

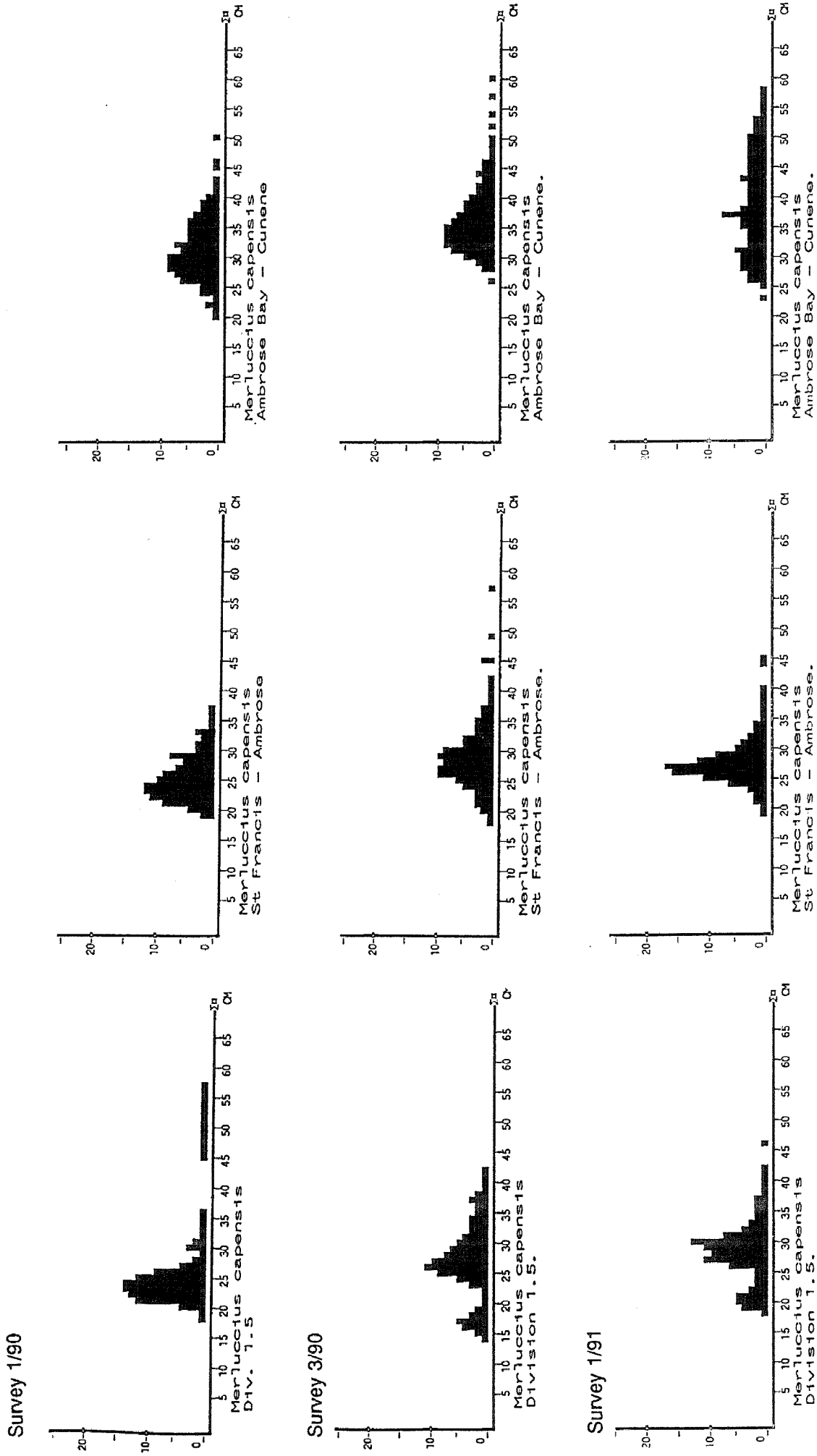


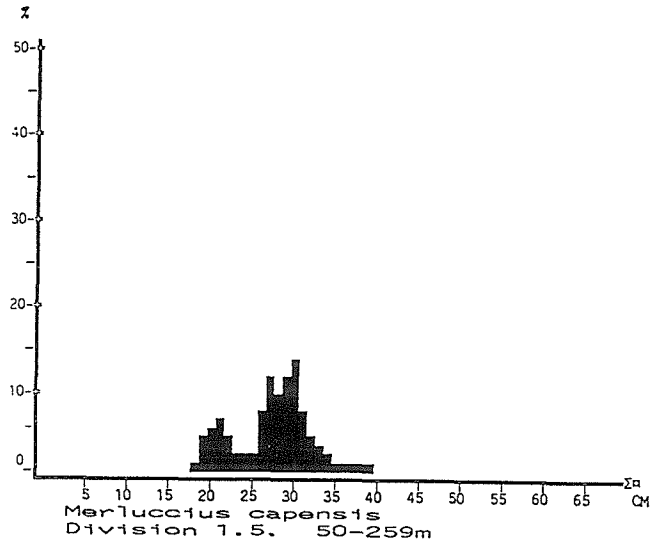
Figure 11. Estimated size compositions for the stocks in each of the sub-areas and for each survey.

Table 9 shows a summary of the biomass estimates from each of the three surveys. The low estimate from Ambrose Bay-Cunene in September-October 1990 does not include the biomass of fish observed to occur in mid-water. One should perhaps have expected an increase of the total stock from 1990 to 1991, but this could be hidden by the relatively low precision of the estimates. Also the removal by the 1990 fishery must be taken into account. This is unknown, but could be around 100 000 tons. One may conclude that the surveys show a biomass level of the Cape hake of 0.5 million tons. There is an increasing availability of larger sized commercial fish and the relatively abundant 1988 year-class is expected to result in a further increase of the fishable stock over 1991-92.

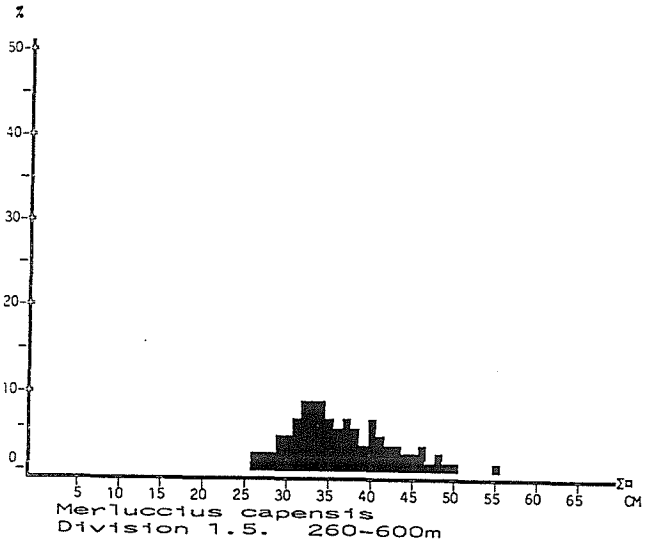
Table 9. Summary of estimates of biomass of the two hake species by survey and area. Tons.

	Total biomass		
	Feb-March 1990	Sep-Oct 1990	Jan Feb 1991
Orange River-St.Francis Bay			
Cape hake	130 000	130 000	113 000
Deep w. hake	22 000	25 000	31 000
St Francis Bay-Ambrose Bay			
Cape hake	180 000	219 000	150 000
Deep w. hake	4 000	6 000	1 500
Ambrose Bay-Cunene River			
Cape hake	180 000	105 000+	200 000

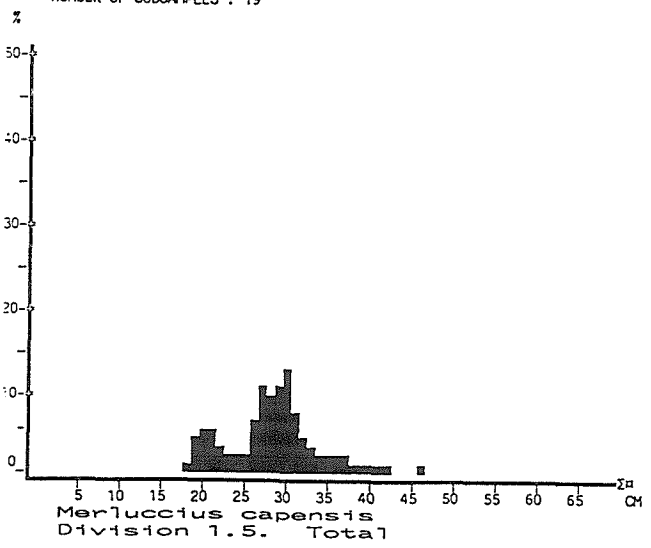
ANNEX I SIZE COMPOSITIONS OF MAIN STOCKS



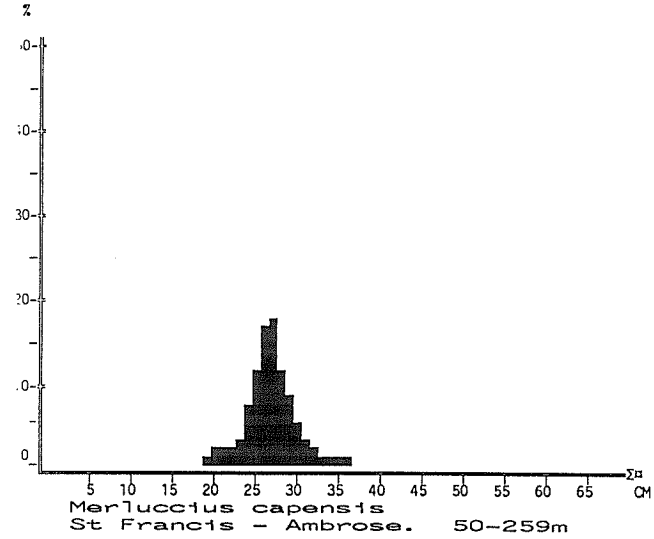
MEAN LENGTH = 27.94cm N= 3512
NUMBER OF SUBSAMPLES : 52



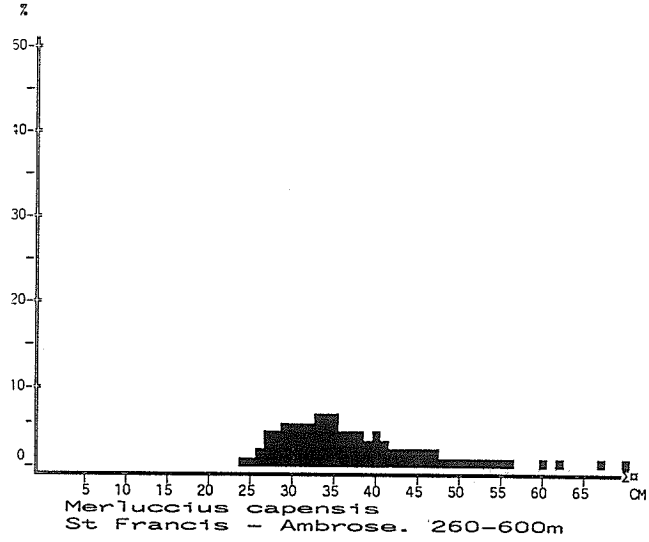
MEAN LENGTH = 36.83cm N= 1025
NUMBER OF SUBSAMPLES : 19



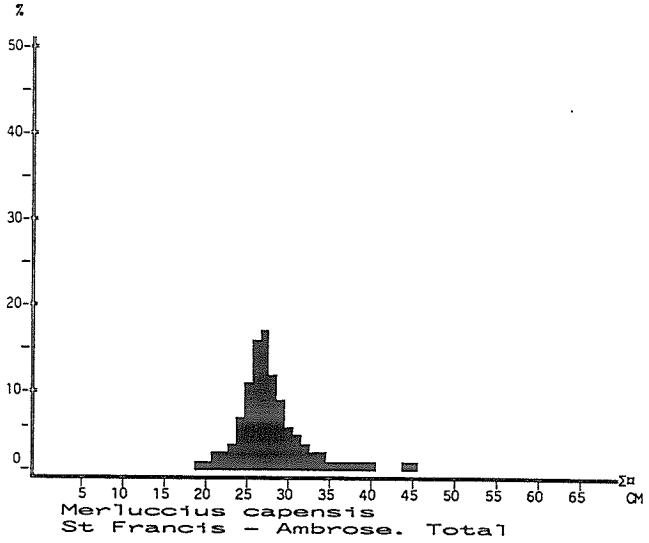
MEAN LENGTH = 28.95cm N= 4537
NUMBER OF SUBSAMPLES : 71



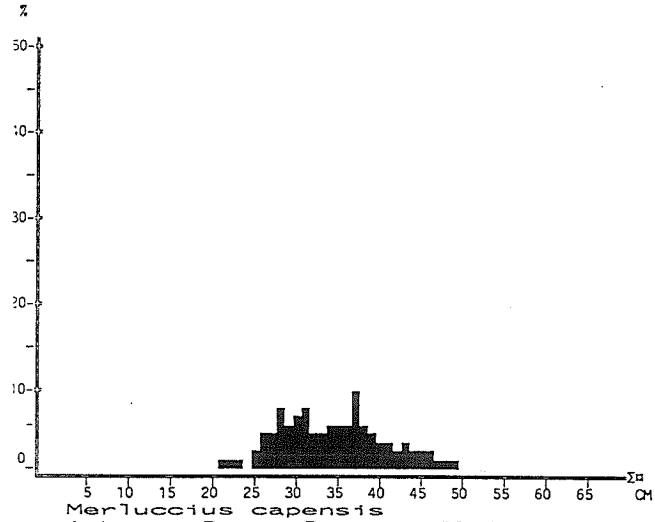
MEAN LENGTH = 27.61cm N= 8719
NUMBER OF SUBSAMPLES : 93



MEAN LENGTH = 37.93cm N= 2827
NUMBER OF SUBSAMPLES : 44

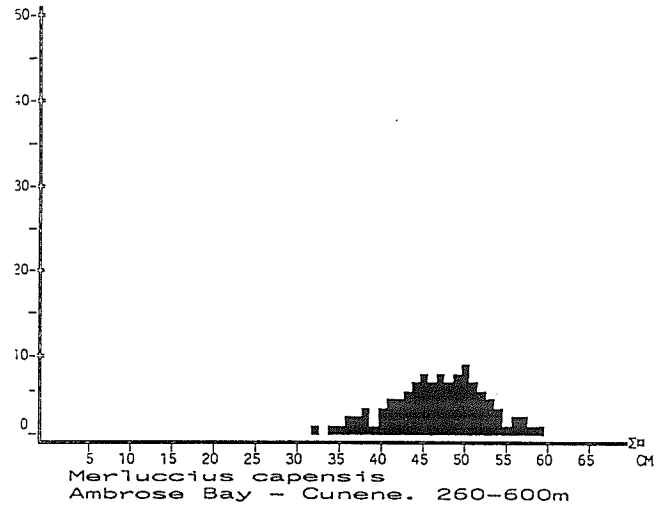


MEAN LENGTH = 28.63cm N=11546
NUMBER OF SUBSAMPLES :137



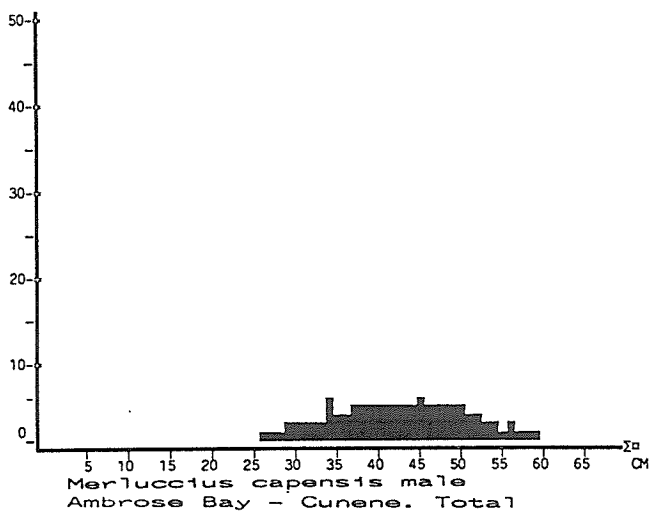
Merluccius capensis
Ambrose Bay – Cunene. 50–259m

MEAN LENGTH = 34.94cm N= 2776
NUMBER OF SUBSAMPLES : 49



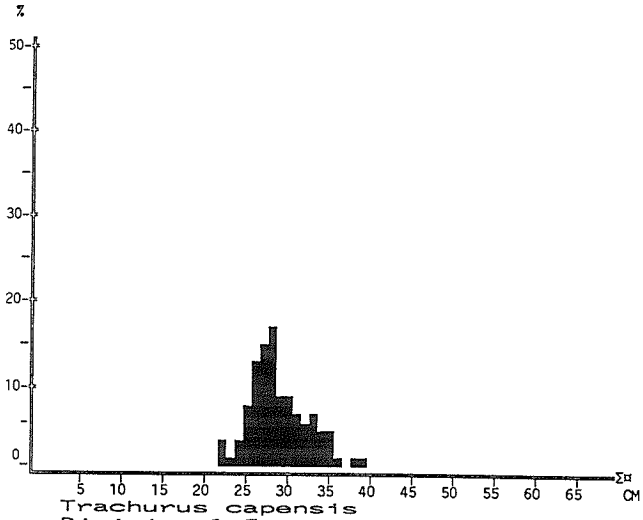
Merluccius capensis
Ambrose Bay – Cunene. 260–600m

MEAN LENGTH = 46.81cm N= 3201
NUMBER OF SUBSAMPLES : 55



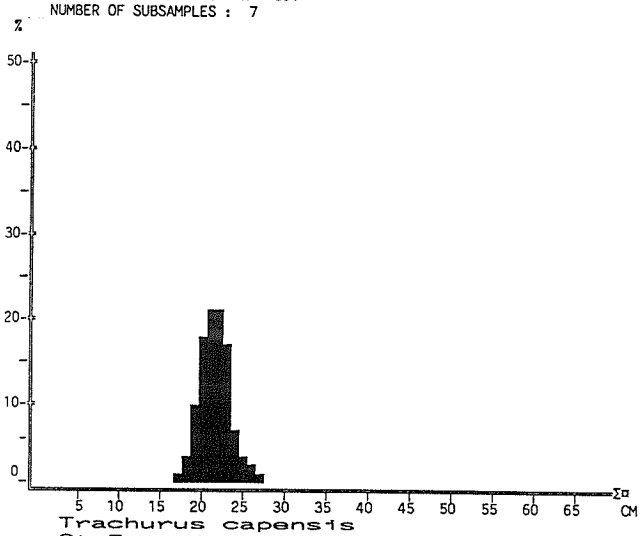
Merluccius capensis male
Ambrose Bay – Cunene. Total

Pooled sample (simple adding)
MEAN LENGTH = 42.46cm N= 371
NUMBER OF SUBSAMPLES : 1



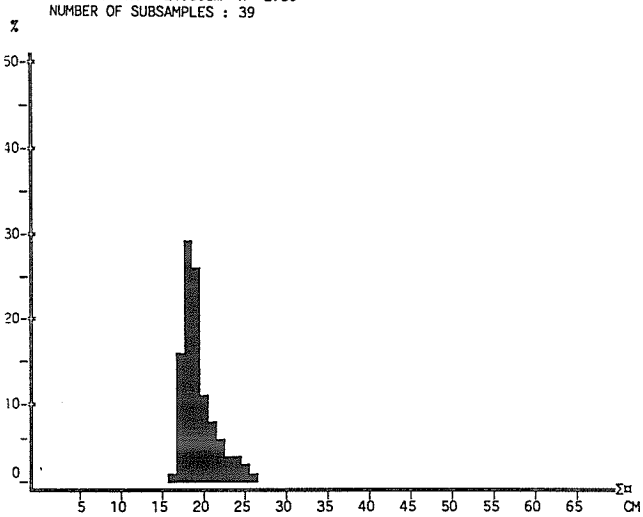
Trachurus capensis
Division 1.5

MEAN LENGTH = 28.69cm N= 391
NUMBER OF SUBSAMPLES : 7



Trachurus capensis
St Francis - Ambrose Bay

MEAN LENGTH = 21.85cm N= 2736
NUMBER OF SUBSAMPLES : 39



Trachurus capensis
Ambrose Bay - Cunene River

MEAN LENGTH = 19.31cm N= 1406
NUMBER OF SUBSAMPLES : 18