CHAPTER 5 BIOLOGICAL SAMPLING

5. 1 Sardinella maderensis

Figure 12 (a and b) shows the results of the sampling for determining the maturity stages of this species, for the northern and central region, respectively.

In the region Luanda-Cabinda 289 specimens were sampled, with a size range of 26 to 34 cm. Almost all sardinella above 29 cm was either spawning or ready to spawn. This surprisingly was the case also for the sardinella found well offshore (over depths of 600 m or more), which was in a clear spawning stage i.e. running. It is probable that eggs, spawned in surface waters and the resulting pelagic larvae are transported by currents and possible eddies to the nursery areas closer inshore. Anon. (1980) shows for *Sardinella aurita* off Southern Gabon a spawning area over the deeper part of the shelf and upper slope.

In the region Luanda-Benguela 263 specimens were sampled, with a size range of 21 to 36 cm. The situation appeared similar to the one found in the northern area, i.e. with most individuals above 29 cm either spawning or ready to spawn. In specimens below 28 cm, the gonads appeared to be totally inactive.

No study was attempted for *S. aurita* because it was caught more seldom and the catches consisted of a few specimens only.

5.2 Trachurus trecae

Figure 13 (a and b) shows the relative frequency of the observed maturity stages for the northern and the central region respectively.

The sampled specimens in the northern region were 119, from 31 to 45 cm. They were all ripe or under spawning. In the central region (85 individuals sampled) also small sizes were available. The range was 23 to 26 cm seemed to be critical. While up to the size of 23 cm all specimens were inactive, above 26 cm they were all ripe or under spawning. No specimen within those sizes was available in the samples.

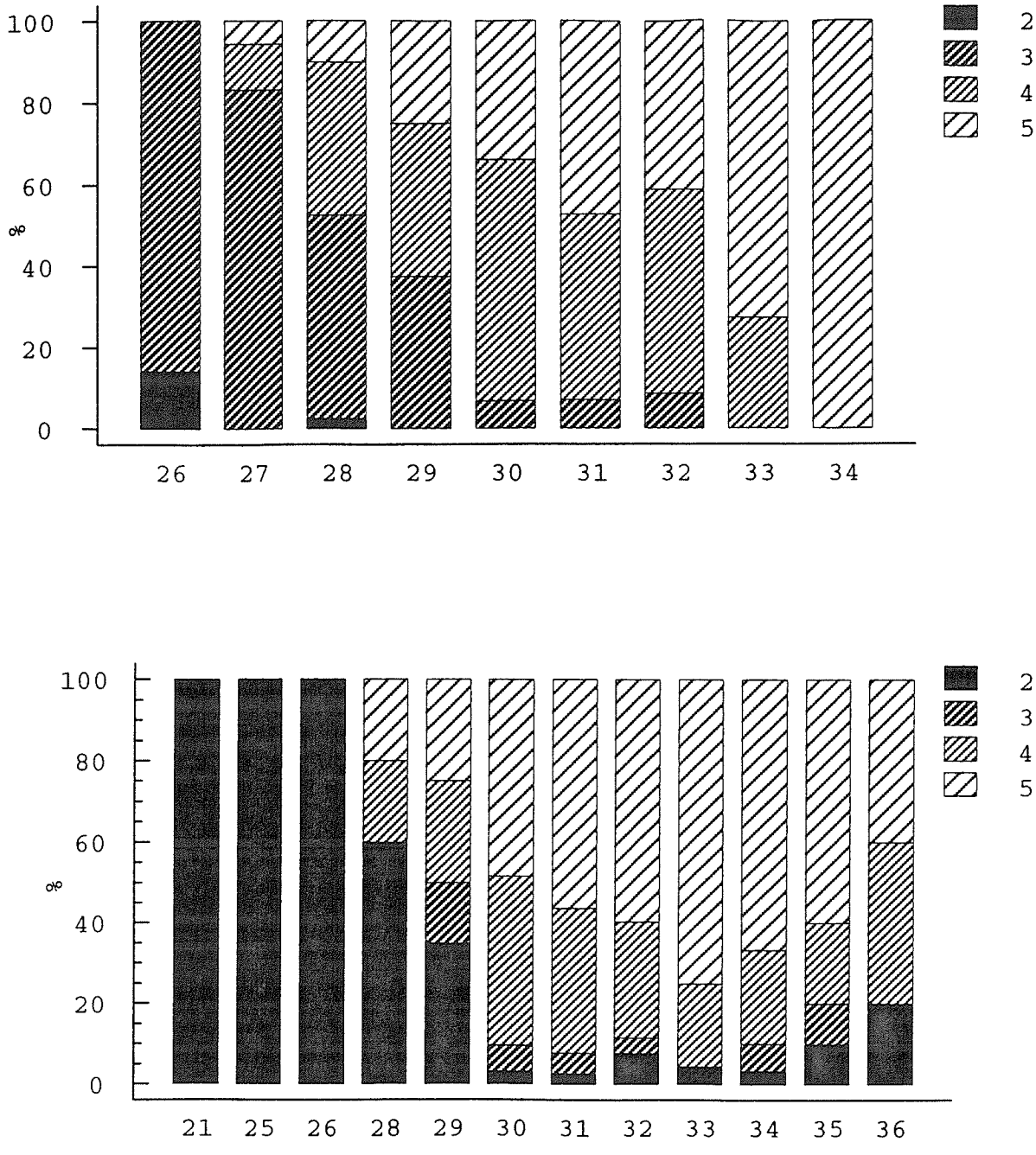


Figure 12. Maturity stages of *Sardinella maderensis* a: Cabinda-Luanda; b: Luanda-Benguela.

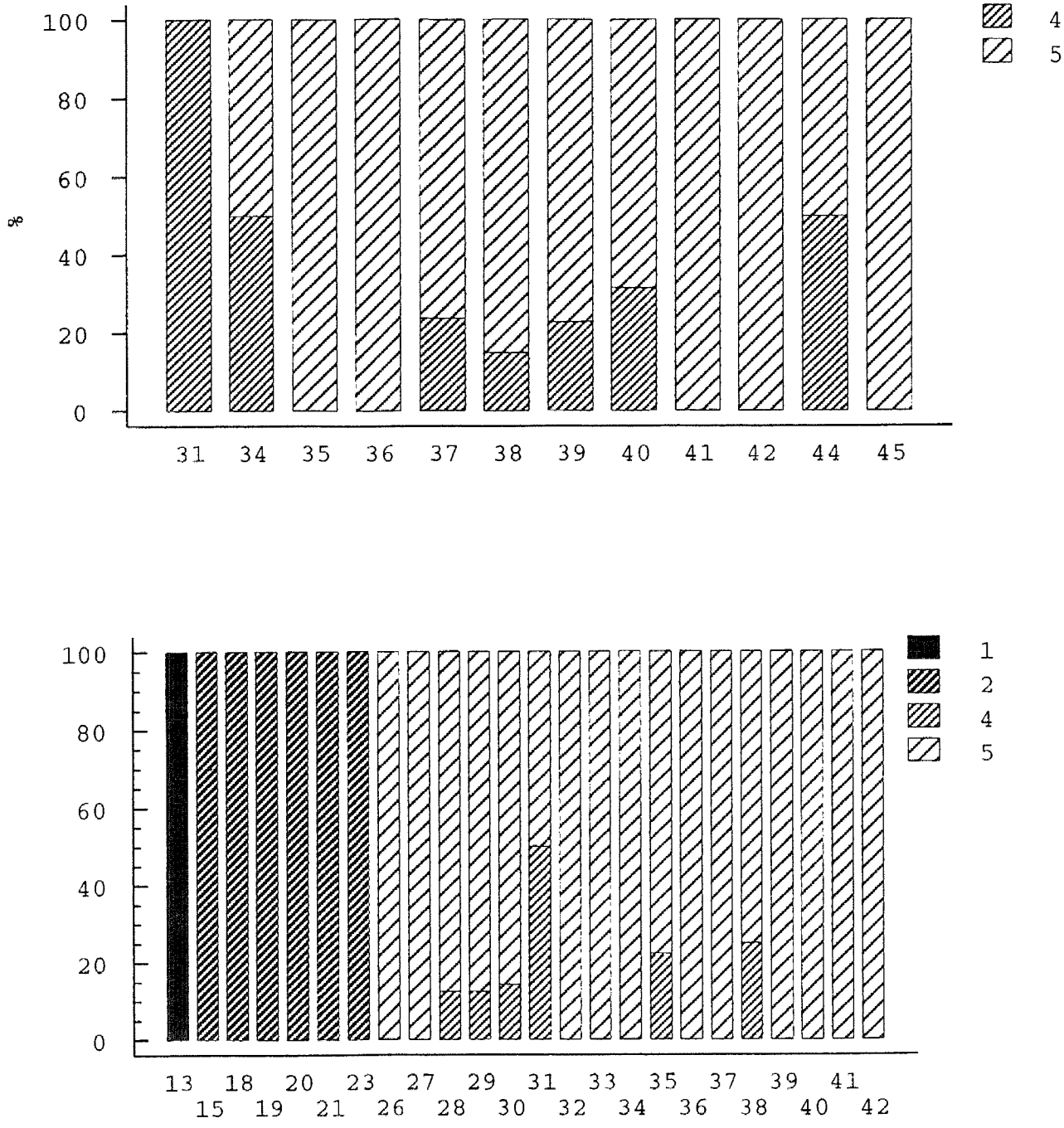


Figure 13. Maturity stages of *Trachurus trecae*: Cabinda-Luanda;
b: Luanda-Benguela

Most of the pelagic species caught appeared to be sexually active indicating that the upwelling season is the most favourable for the survival and growth of the larvae. The environmental dynamics characteristic of this season possibly also ensure the transport of larvae to the nursery areas.

CHAPTER 6 OVERVIEW OF SURVEY RESULTS

The following is an attempt to briefly review the results obtained during this survey and all previous surveys carried out by the RV 'Dr. Fridtjof Nansen' in Angola. The review will only cover sardinella and Cunene horse mackerel.

6.1 Sardinellas

Figure 14 and Table 1 show the biomass estimates from the 'Dr. Fridtjof Nansen' surveys, from 1985 to 1994. Fig. 15 shows the survey estimates averaged for each year and available catch statistics from 1980 to 1990.

Table 1 Estimates of biomass of sardinellas by regions and surveys (1 000 tonnes)

Survey	Cunene-Benguela	Benguela-Luanda	Luanda-Cabinda	Benguela-Cabinda	TOTAL
1/85	25	220	80	300	325
2/85	110	190	180	370	480
3/85	0	70	190	260	260
4/85	0	200	110	310	310
1/86	10	140	110	250	260
2/86	10	130	130	260	270
1/89	40	200	60	260	300
2/89	20	40	130	170	190
3/89	40	100	60	160	200
1/91	+	180	120	300	300
2/91	+	68	154	222	222
1/92	+	119	161	280	280
1/94	*	410	100	510	510
2/94	*	245	290	535	535

* not surveyed

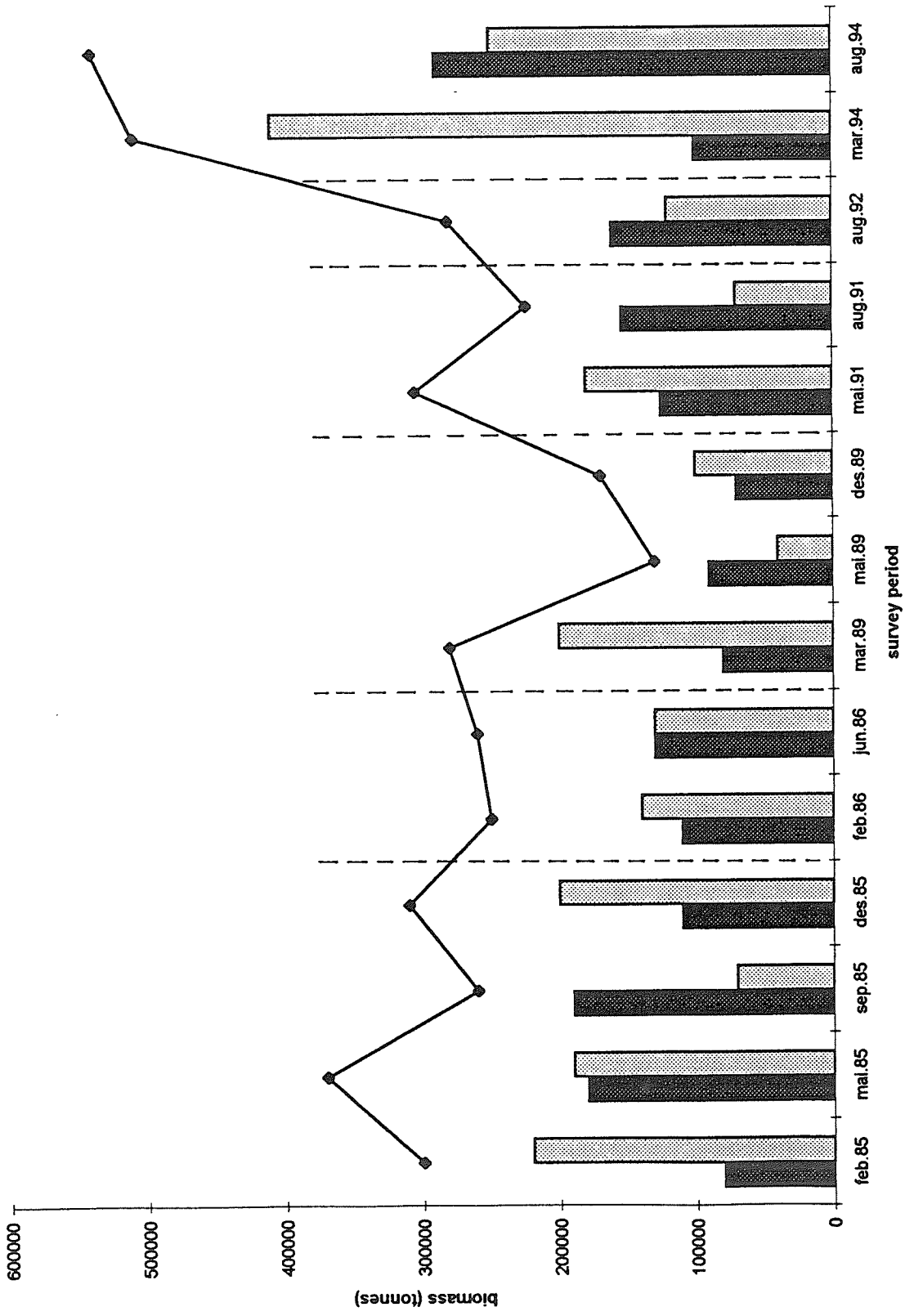


Figure 14. Time series of survey estimates from the 'Dr. Fridtjof Nansen' surveys,*Sardinella* species

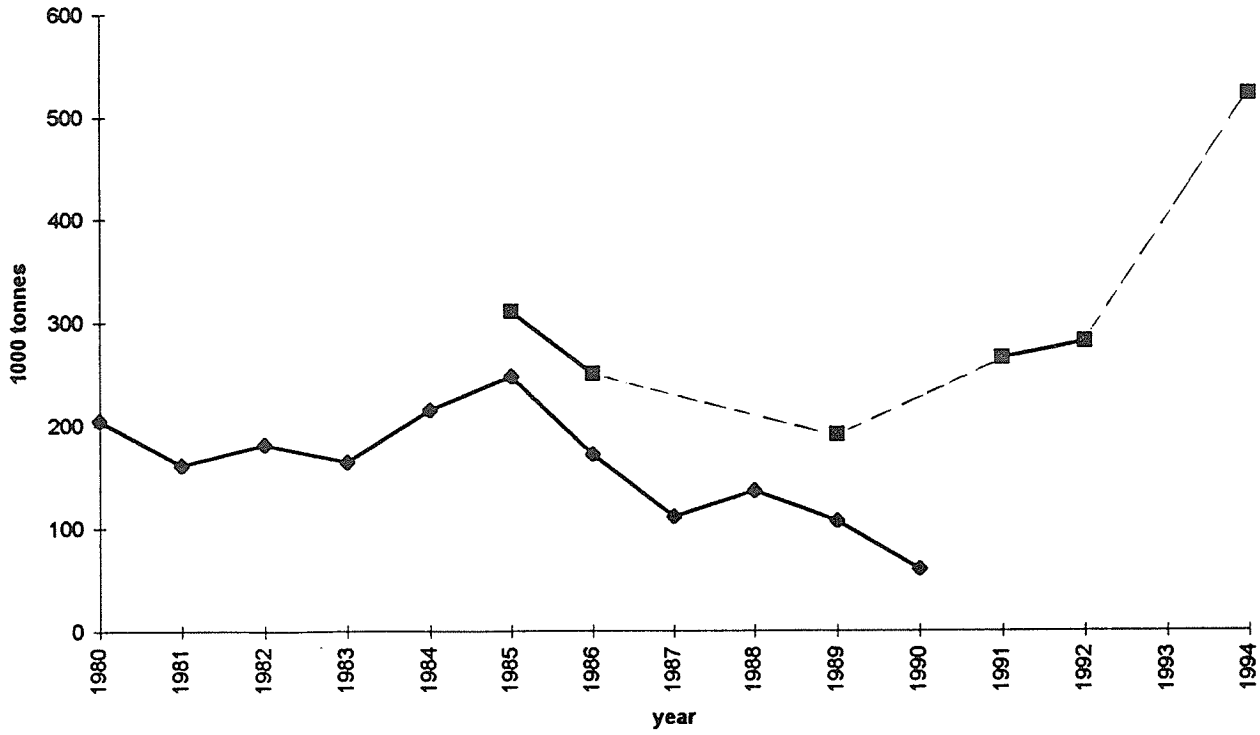
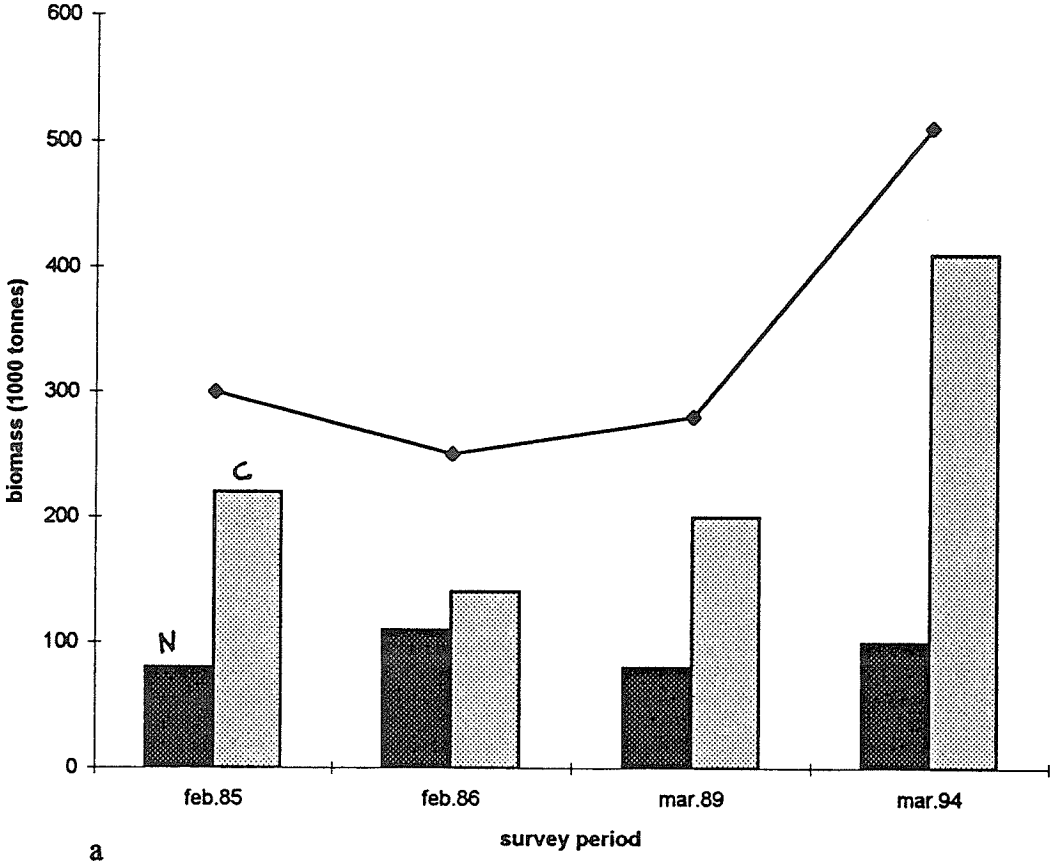


Figure 15. Fishery statistics and biomass estimates by the RV 'Dr.Fridtjof Nansen' for *Sardinella* species in Angola

As already pointed out by Anon. (1991), a clear decline in biomass may be observed in the period 1985 to 1989, from 300 000 to 200 000 tonnes. This was identified as the probable continuation of the stock decline from the early 1980s, when Soviet investigations indicated a stock with a potential annual yield of 230 000 tonnes, corresponding to a standing biomass of 600 000 tonnes. In 1989 a 50% reduction in the TAC was introduced which probably explains the slight recovery in 1991.

In recent years a consistent and considerable increase in biomass has taken place: to almost 300 000 tonnes in 1992 and over 500 000 tonnes in 1994. This could be due to the lower fishing effort exerted in later years.

Figure 16 (a and b) shows the distribution of sardinella in the summer and winter periods respectively, as observed through the surveys with the RV 'DR. Fridtjof Nansen'. The figures show clearly that in the summer period, characterized by more stratified water masses and higher temperatures in the water column, more than 50% of the biomass is found in the central region. On the contrary, the opposite is true in the winter period, characterized by upwellling and colder surface waters. This pattern is probably due to north-south migrations, that possibly apply to both species.



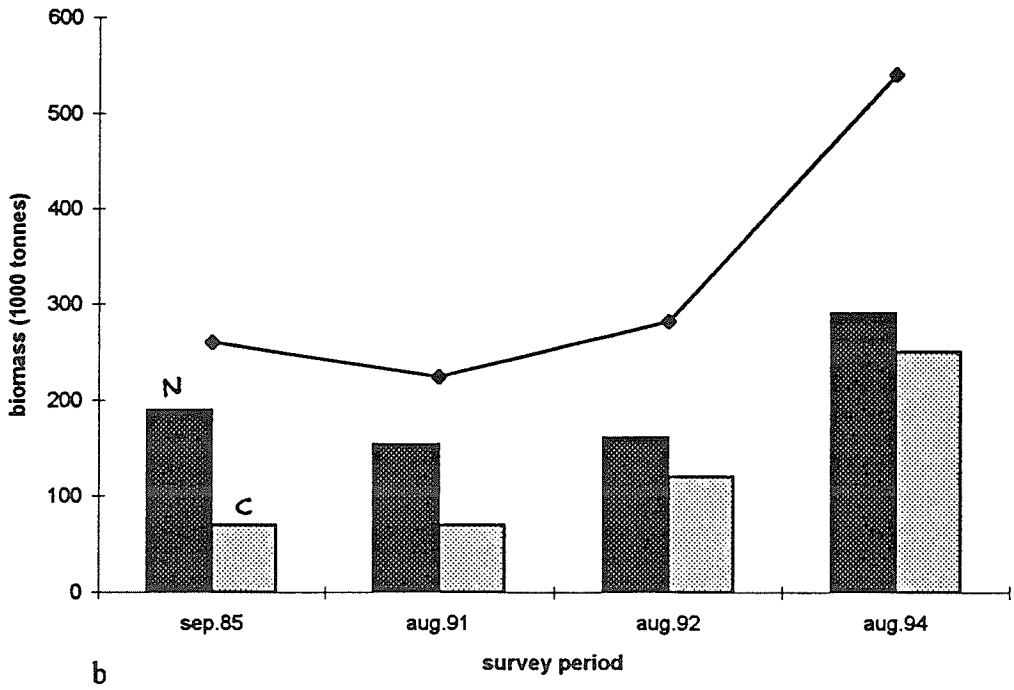


Figure 16. Survey estimates for *Sardinella* species in Central and Northern Angola. a: summer; b: winter.

It is quite remarkable that the substantial increase in biomass regards only *S.maderensis*, while *S.aurita* became more rare in the catches.

Another surprising pattern emerged from the 'Dr. Fridtjof Nansen' surveys is the lack of juveniles in the catches in later years. This had lead Anon.(1991) to be pessimistic about future recruitment. However, this pattern has continued in the 1990s, but the stock has instead increased. It is difficult to understand why the young cohorts are not any longer recorded by our surveys. On the other hand, the 1994 surveys off Congo-Gabon have shown the presence of large concentrations of juveniles in this area, where they actually dominate in numbers and biomass over the adults.

6.2 Cunene horsemackerel

Table 2 shows a summary of the survey results since 1985. In figure 17 these are plotted, including northern and central Angola. The values in figure 18 were obtained by averaging the biomass estimates in different seasons, for the same year. The pattern showed by this figure resembles the one observed for sardinella, i.e. a decrease in the standing biomass from 1985 to the end of the 1980s and a considerable recovery since the beginning of the 1990s. The reasons for this recovery might be the same as for sardinella, i.e. lower fishing pressure.

Table 2 Estimates of Cunene horsemackerel by regions and surveys (1 000 tonnes)

Survey	Cunene-Benguela	Benguela-Luanda	Luanda-Cabinda	Benguela-Cabinda	TOTAL
1/85	30	195	40	235	265
3/85	50	90	40	130	180
4/851/86	100	125	20	145	245
1/89	35	55	40	95	130
3/89	170	40	35	75	245
1/91	100	80	20	100	200
2/91	100	70	30	100	200
1/92	98	86	80	166	264
1/94	*	238	1	239	
2/94	*	130	120	250	

* not surveyed

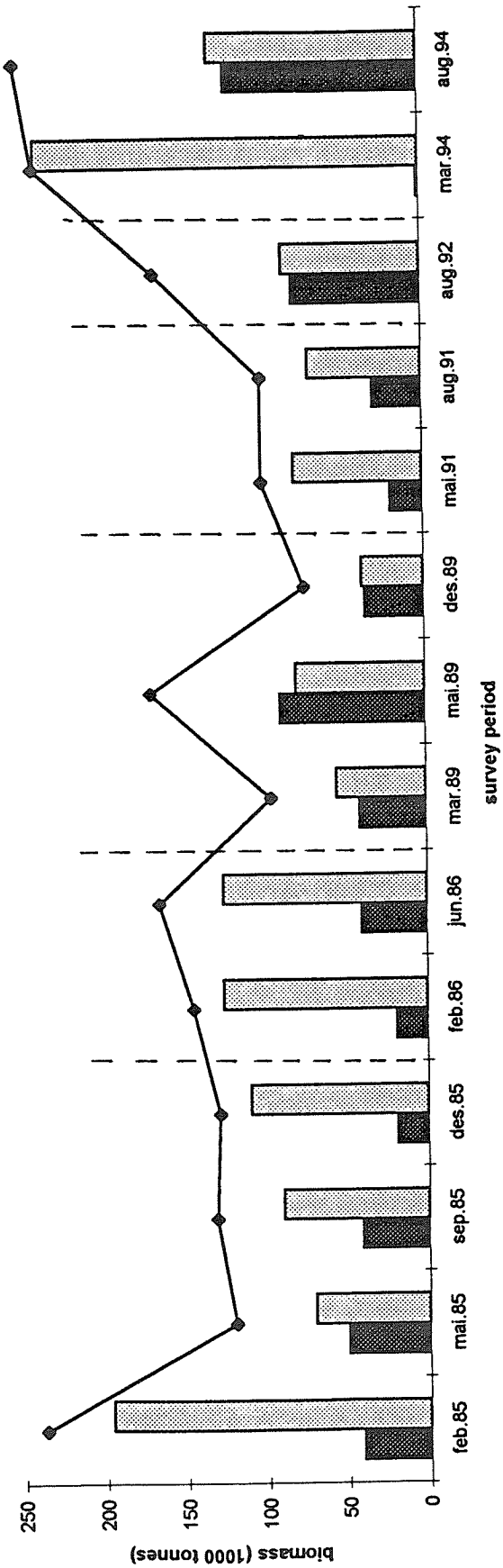


Figure 17. Time series of survey estimates from the 'Dr. Fridtjof Nansen' surveys, *Trachurus trecae*

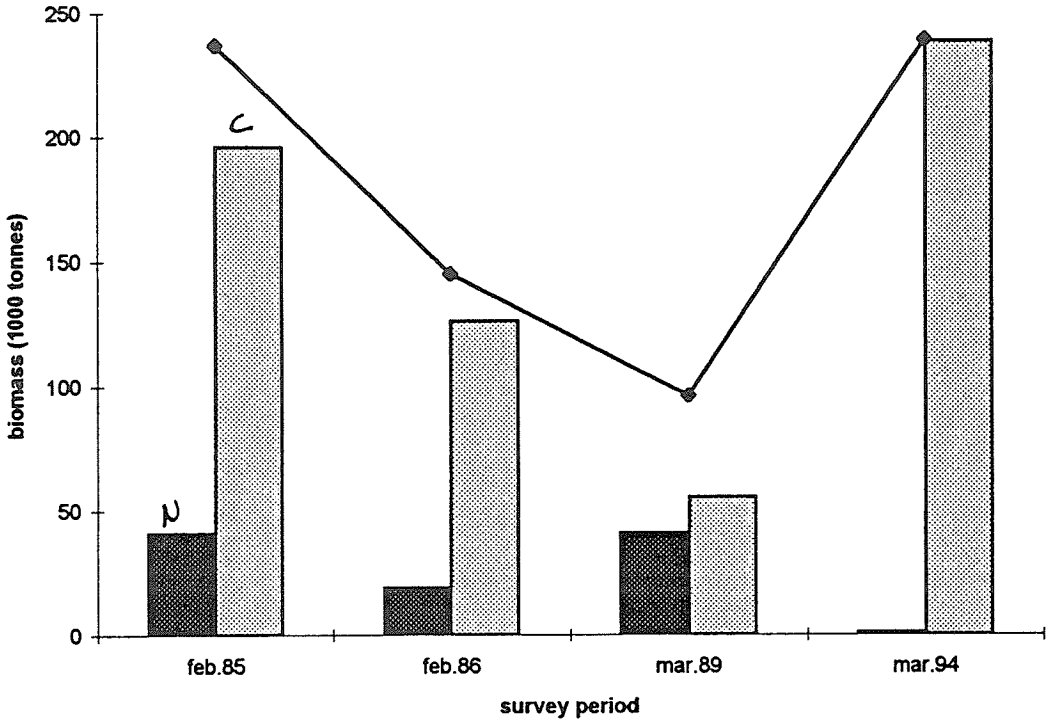
Figure 18. Survey estimates for *Trachurus trecae* (only northern and central regions included)

A similar pattern as for sardinella emerges pointing at a seasonal north-south migration. This is better illustrated in figure 19 (a and b), where the summer and the witer estimates for the northern and central regions are showed. Although more than 50% of the biomass is usually found in the central region, figure 19 shows that in the summer period most of horsemackerel concentrates in the central region, i.e. from Luanda to Benguela.

Literature cited

Anon. (1980). Etude regionale sur la pêche maritime dans le Golfe de Guinée. Annexe N 2: La pêche maritime au Congo. Commission des communautés européennes - Fonds européens de développement

Anon. (1991). The state of Angola's main fish resources 1990-1991. (IIP, Internal document)



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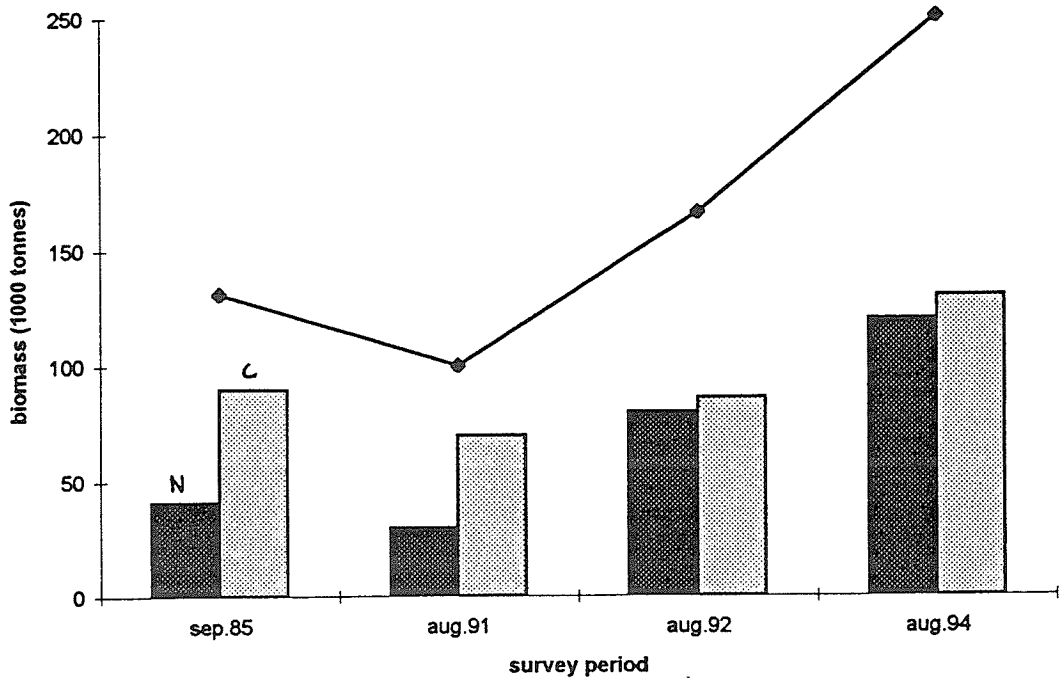

b

Figure 19. Survey estimates for *Trachurus trecae* in Central and Northern Angola. a: summer; b: winter.