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Distribution, abundance, and feeding habits of hake (*Merluccius polli*) in Angolan waters.

By

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Abstract

This paper studies the distribution, stock abundance and feeding habits of hake (*Merluccius polli*) by season (cold and warm seasons), using data from trawl surveys carried out by the "Dr. Fridtjof Nansen" research vessel during 1995. The time-series from the 1985-1997 surveys was also used for analysis of biomass trends. The results show that hake is distributed along all the Angolan coast between 100 and 800 m of depth. The densest concentrations were observed at 300-400 m during both seasons. There was an overall shift of the hake distribution towards shallower depth during the cold season. The length groups 20-29 and 30 - 40 cm were dominant during both seasons in numbers and biomass. A significant decrease of biomass was observed from 1994 to 1996. This species feeds mainly on fish (45.5 % and 40.4 % during the warm and the cold season respectively) , shrimps (47.1 % and 32.2 %) and cephalopods (7.4 % and 27.4 %). Myctophidae was the single food item most consumed during both seasons.

Key words: Abundance, biomass, distribution, feeding, hake and habits.

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## INTRODUCTION

*Merluccius polli* (hake) is the most important demersal species in the by-catch of the Angolan commercial fishery for deepwater shrimps (Vaz Velho, 1995). This species is also caught with sparids, sciaenids and other demersal fish species, and catches are predominantly represented by medium-size fish (Anon., 1995).

Despite some preliminary studies carried out on its biology and behaviour (Anon., 1980), very little is known about this species.

The purpose of this paper is to contribute to the knowledge of distribution, abundance and feeding habits of this species in the Angolan coast, and its seasonal variations, using detailed data collected during the Nansen surveys in 1995. Biomass estimates from 1986 to 1997 were discussed in order to appreciate the biomass trends.

## MATERIALS AND METHODS

Data were collected during the surveys carried out by the R/V "Fridtjof Nansen" during the warm and cold season of 1994 and 1995. Data obtained from 1985 to 1997 were also considered for the analysis of the trends of biomass. The study area covered the Angolan coast, with emphasis on the area of commercial fishing activities (Cabinda-Benguela). Geographical distribution maps were drawn using mean catches rates in order to define the areas of highest concentrations of hake.

Abundance was estimated using the swept area method (Gunderson, 1993). Data were stratified by season, depth range and geographical area. The sampling gear was a "Gisund super bottom trawl", with a headline of 31 m, footrope 47 m and 20 mm meshsize in the codend with an innernet of 10 mm meshsize (Anon., 1995). The coefficient of trawl catchability in relation to hake was assumed to be 1 for all the size groups. For the analysis of the vertical distribution of hake, mean catch rates were grouped in 6 depth strata of 100 m each, except for stratum 600-800 m due to relatively low sampling fraction.

Data on feeding habits were collected during two surveys in the warm and cold seasons of 1995. 1138 stomachs were analysed separately by period and depth strata, and grouped in 5 10-cm length groups. Data for food consumption were grouped in two strata (0-399 and 400-800 m), because of low variability in food item along depth. For evacuation time the values proposed by Payne *et al.*, (1987) for *Merluccius capensis* studies were used (i.e., Fish 3 days, crustaceans 1 day and cephalopods 1.5 days). The hake stock's food consumption was estimated using the method of calculation proposed by Mehl and Westgard (1983).

## RESULTS AND DISCUSSION

### DISTRIBUTION

During this study hake (*M. polli*) was found distributed along all the Angolan coast. According to Bianchi and Fisher, (1981) this species overlaps with the South African

hake (*M. capensis*) in the area between Cunene river and Namibe. Its highest concentrations coincided with the areas of commercial fishing activities, varying with the period of the year (Fig. Ia, Ib and Ic). During the warm season, the highest concentrations (> 200 kg/h) were observed in the areas between Benguela and Ponta do morro, Luanda and N'zeto, and the south of Cabinda. During the cold season, the highest concentration were observed between the south of Cabeça de baleia and Cabo de São Braz, and the rest of the coast was dominated by concentrations less than 50 kg/h.

Table I shows the distribution of hake by season and strata. The analysis of the depth strata indicates that Benguela hake was distributed from 100 m to 800 m. Its highest concentrations were observed between 300 and 400 m during both seasons. But there was an overall shift of the distribution towards shallower depth during the cold season. This fact is in agreement with the observation of vertical migration of hake in relation to the period of the year, described by anon., (1994).

### SIZE COMPOSITION

Figures IIa, IIb and IIIa, IIIb, IIIc and IIId show the vertical distribution and size composition of *M. polli* by season and sex. The catches were represented by individuals with length between 12 and 60 cm during the warm season, and between 20-54 during the cold season. The size distribution of females had a large mode than that of males, and covered also width size-range. This effect was observed in both seasons, but in both sexes fish caught during the cold season tended to be smaller than those captured in the warm season.

### ABUNDANCE AND BIOMASS

For the assessment of the stock, the number of individuals and the biomass were calculated during both seasons of 1995. Data were distributed in 5 10-cm size groups, and varying from 10 to 59 cm (Figs. IIIa, IIIb, IVa and IVb).

The estimated total abundance of hake was 79,6 million individuals during the warm season, and 21.63 millions during the cold season. The lower estimated abundance during the cold season may be related to the presence of high number of big hake in the catches, or to the possible shift to mid-water during this period. By depth strata (fig. IIIa, IIIb), the highest number of individuals was recorded for length group II (41.1 millions) in the stratum 0-399 m, and for length group II and III between 400-800 m during the warm season. During the cold season, individuals of length groups III and IV were more represented between 0-300 m of depth, and length group III between 400-800 m. The higher number of individuals of length group III in the stratum 0-399 m estimated for the cold season is related to the intense vertical migration of hake to shallower waters generally observed during the cold season (Anon., 1994).

Figures IVa and IVb show the estimated biomass of hake by strata, length groups and season. The highest biomass estimated was observed during the warm season (12000 tons), 7000 tons between 0-399 m and 4300 between 400-800 m. During the cold season, the biomass was estimated at 6600 tons, with 4800 tons between 0-399 m of depth, and 1798 tons between 400-800 m. The individuals of length group II were more

represented between 0-399 m, while length group III was more abundant between 400 and 800 m. According to Macpherson and Roel (1988), fish migrate from shallow to deeper areas as they grow. The results from this work support this idea.

Figure V shows the trends of biomass (tons) from 1986 to 1997. The highest biomass was observed during 1986, while a significant decrease was observed between 1994 and 1996, recovering during 1997. This decrease may be related to the increase of fishing effort during this period, or to the possible change in the gear.

It is important to underline that the individuals of smaller (10-19 cm) and bigger size (50-59 cm) are likely to be underestimated during the computation of abundance, taking into account its low incidence during both periods of the year (cold and warm seasons). This fact may be related to the low coefficient of catchability of these length groups, due to the gear avoidance (Dolgov, 1997). The marked reduction in the estimated biomass observed during the cold season is considered to be connected to the possible shift of hake to the water column during this period.

## FOOD AND FEEDING HABITS

Hake (*M. polli*) feeds mainly on fish, crustaceans and cephalopods (Table II). During the study carried out by Kilongo and Mehl (1997), it was estimated that 47.1% of total consumption of hake was fish, while 45.5% and 7.4% for shrimps and cephalopods respectively during the warm season 1995. However, during the cold season 40.4% of total consumption was fish, while shrimps and cephalopods were estimated to represent 32.2 % and 27.4 % respectively of this consumption. The increase of fish consumption during the cold season may be due to the increase of the availability of Myctophidae and the observed decrease of shrimp biomass during this period (Anon, 1995).

In the 0-399 m stratum (Table III) hake consumed mostly Myctophidae and *Synagrops microlepis*, both fish, and *Parapenaeus longirostris* and *Aristeus varidens*, both shrimps. At 400-800 m Myctophidae was the most important food item. During the cold season, Myctophidae, *A. varidens* and *S. microlepis* were more consumed between 0-300 m, and Myctophidae and *Gonostoma denudatum* between 400-800 m. Independently of the omnivorous behaviour of hake, Myctophidae is estimated to be the most important prey consumed by this predator, probably due to its wide distribution and availability along the Angolan coast.

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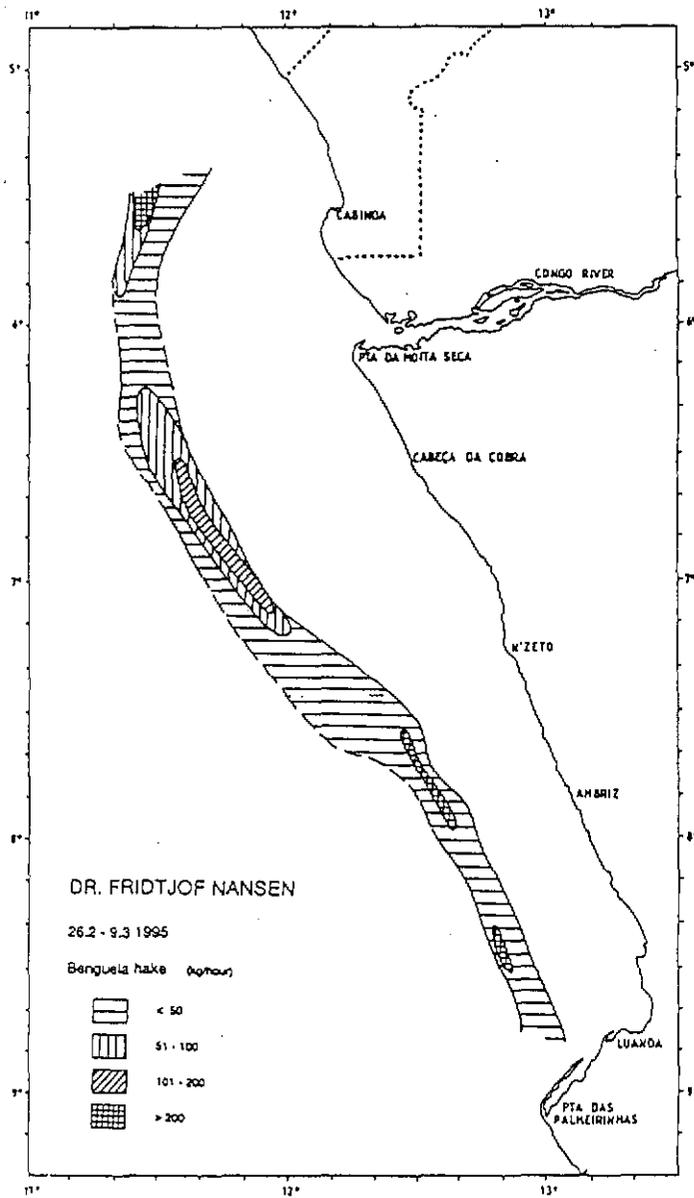


Fig. 1a. Distribution of hake (*Merluccius polli*) Cabinda-Luanda (warm season)

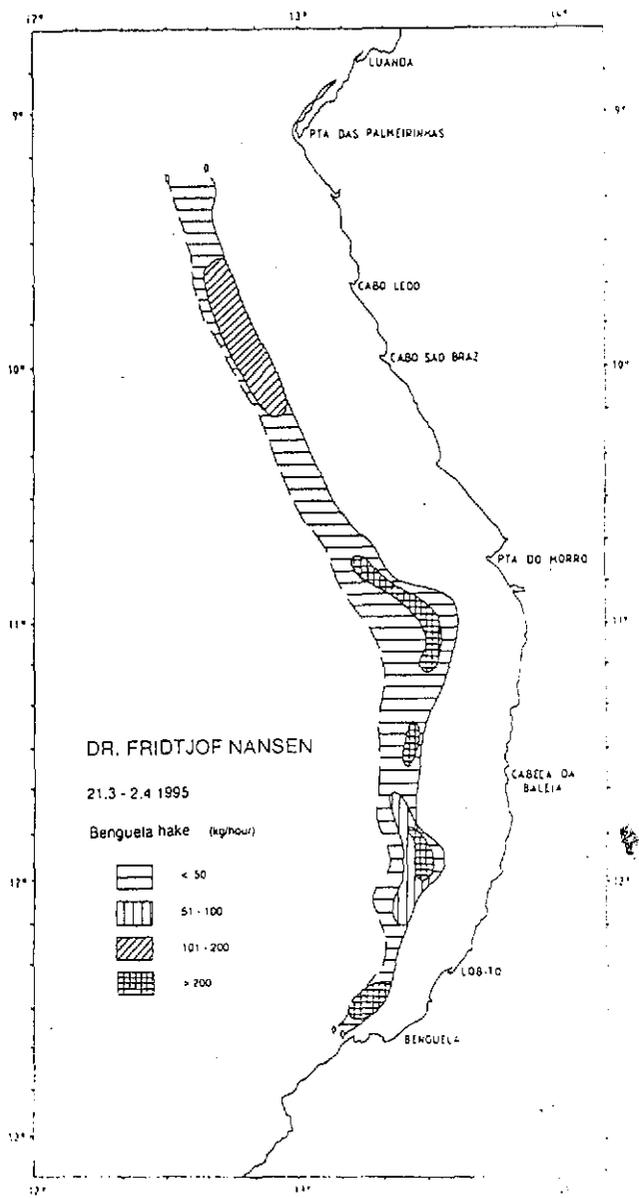


Fig. 1a. Distribution of hake (*M. polli*) Luanda-Benguela (cold season)

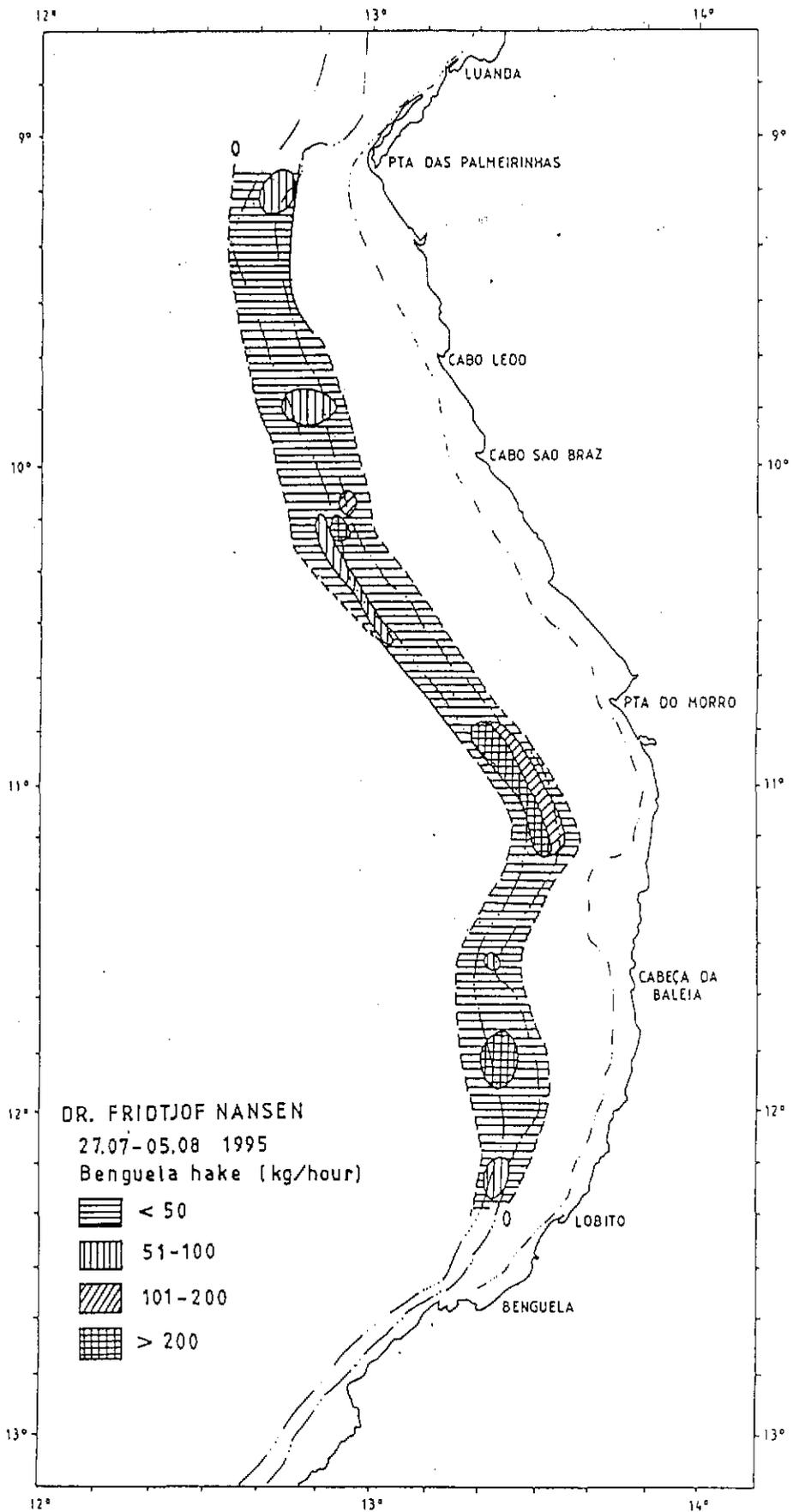


Fig.1c. Distribution of hake (*Merluccius polli*) Luanda-Benguela (cold season)

Table I. Mean catch rates (Kg/hour) of hake by season and depth range during 1995.

Area / depth	Period of investigation			
	Warm season (March 95)		Cold season (Septemb.95)	
Cabinda-Luanda	No of trawls	Mean C./kg	No of trawls	Not Covered
100-200 m	6	2		
200-300 m	11	9		
300-400 m	8	194		
400-500 m	6	86		
500-600 m	6	6		
600-800 m	7	10		
Mean		47		
Luanda-Benguela	No of trawls	Mean C./kg	No of trawls	Mean C./kg
100-200 m	7	3	6	39
200-300 m	9	23	11	51
300-400 m	11	196	7	197
400-500 m	9	80	9	121
500-600 m	7	27	8	8
600-800 m	7	30	4	3
Mean		61		74

Table II. Estimated consumption (%) of the major prey groups of hake by season (1995).

	Warm season	Cold season
	%	%
Fish	45.5	40.4
Shrimps	47.1	32.2
Cephalopods	7.4	27.4

Table III. Estimated distribution of total hake consumption by main prey species by season and depth (1995).

	Warm season	Cold season
	%	%
0-399 m		
<i>Merluccius polli</i>	1.0	11.0
<i>Gonostoma denudatum</i>	8.4	
Myctophidae	27.8	26.8
<i>Synagrops microlepis</i>	12.4	15.5
<i>Nematocarcinus africanus</i>	3.4	4.3
<i>Parapenaeus longirostris</i>	29.1	13.3
<i>Aristeus varidens</i>	17.9	29.0
400-800 m		
<i>Merluccius polli</i>	1.4	
<i>Gonostoma denudatum</i>	26.2	29.6
Myctophidae	39.7	51.9
<i>Synagrops microlepis</i>		
<i>Nematocarcinus africanus</i>	3.1	9.8
<i>Parapenaeus longirostris</i>	12.4	8
<i>Aristeus varidens</i>	17.2	

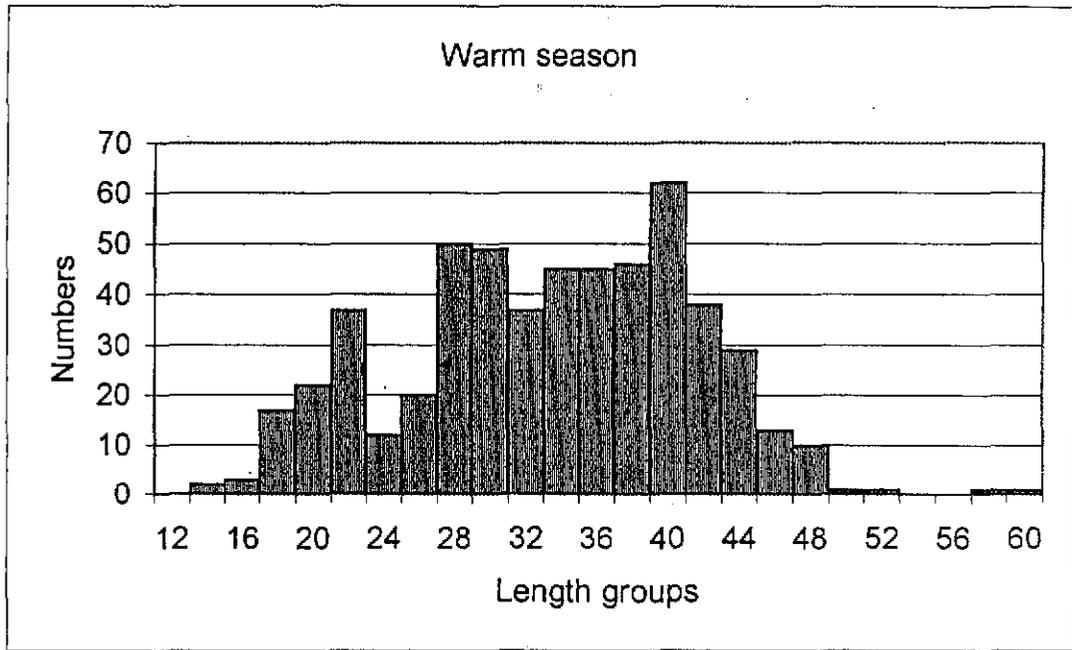


Fig. IIIa. Length distribution of hake during the warm season (1995).

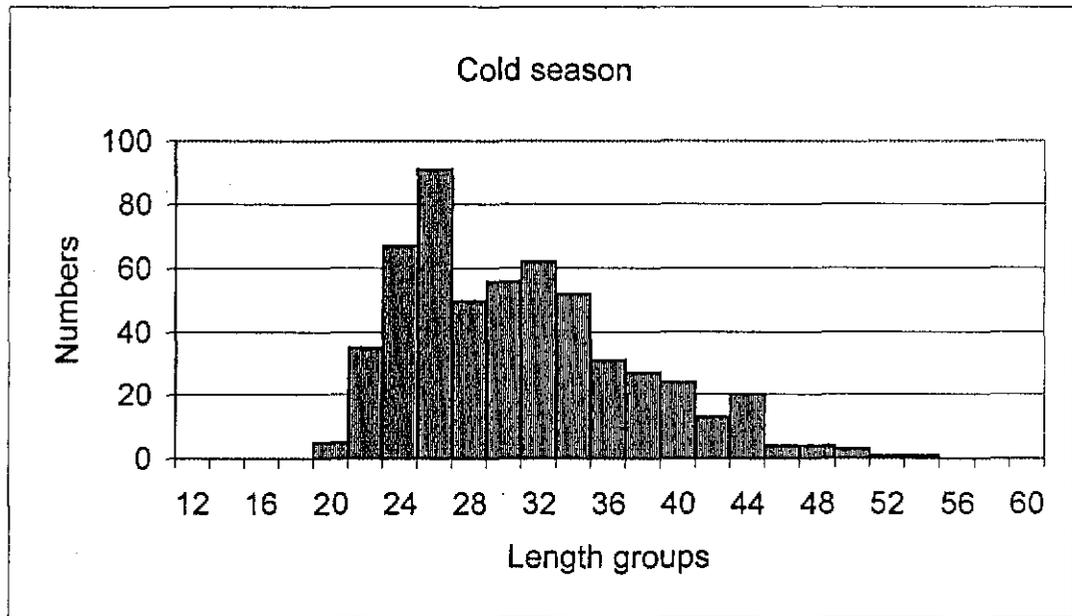


Figure IIb. Length distribution of hake during the cold season (1995).

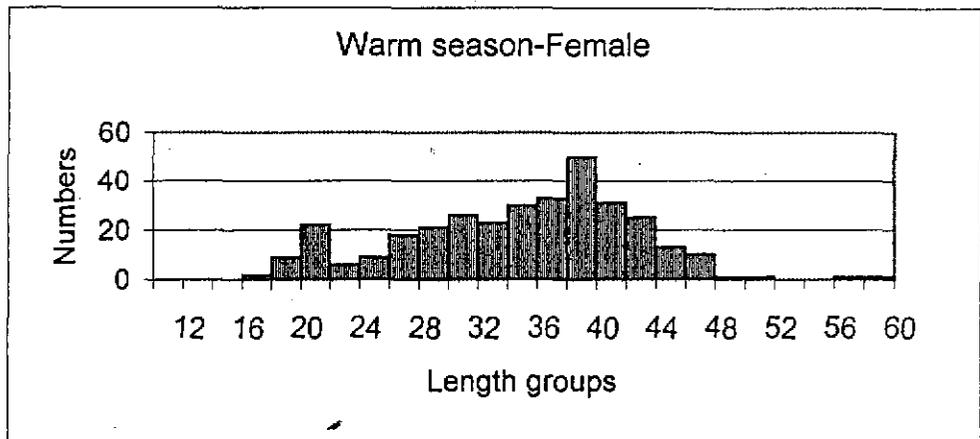


Fig.IIIa.

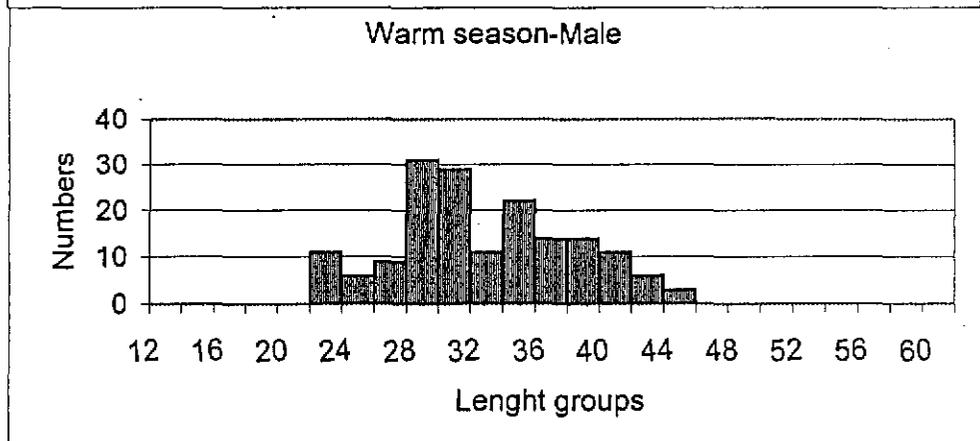


Fig.IIIb.

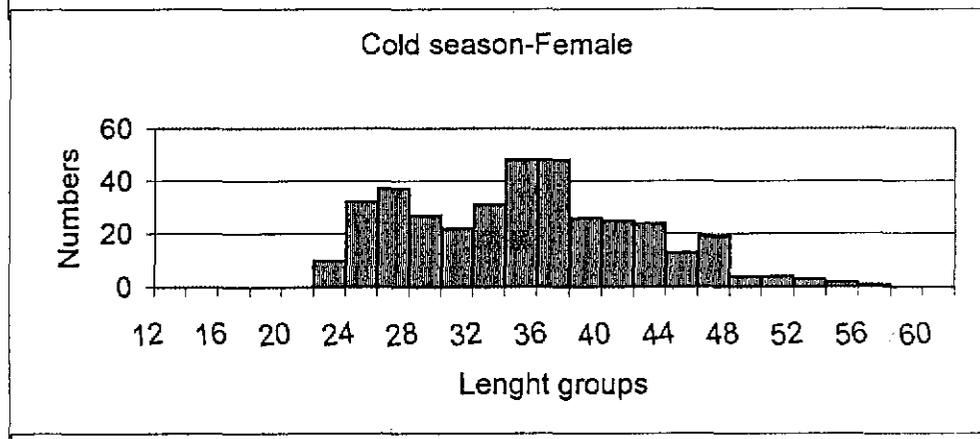


Fig.IIIc.

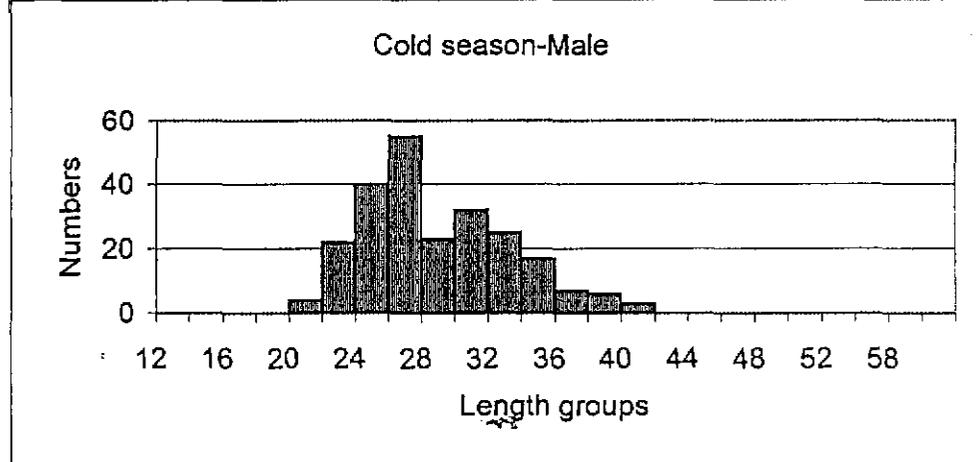


Fig.III d.

Figures IIIa, b, c and d. Length distribution of hake by season and sex (1995).

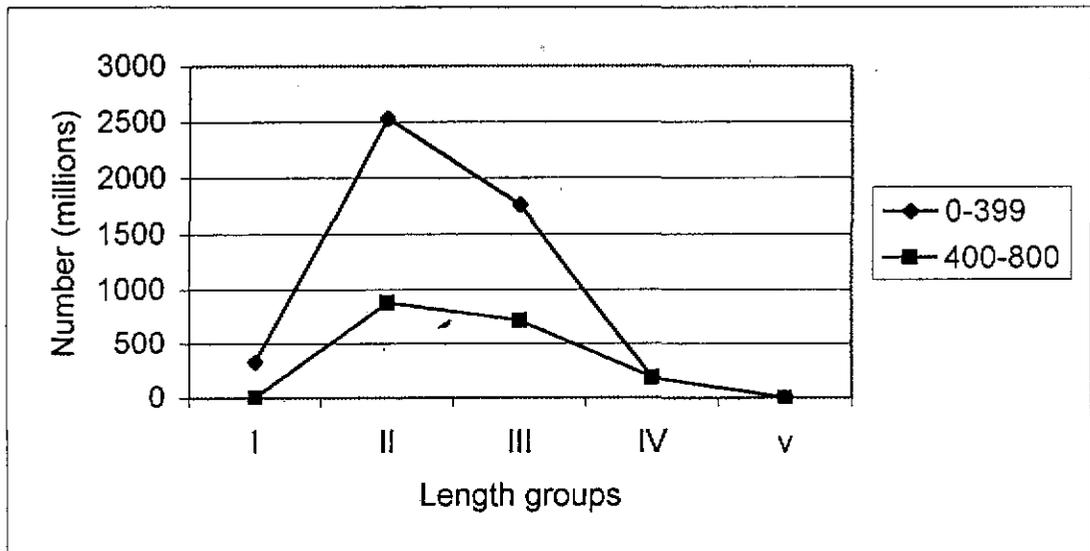


Figure IIIa. Estimated abundance in numbers (warm season 1995)  
 I (10-19 cm), II (20-29 cm), III (30-39 cm), IV (40-49 cm), V (50-59 cm)

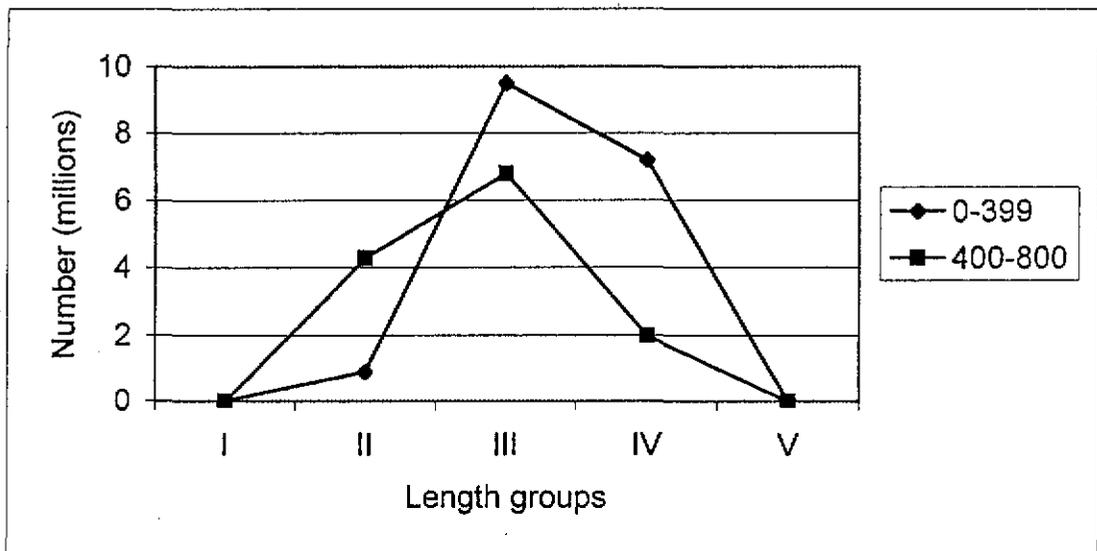


Figure IIIb. Estimated abundance in numbers (cold season 1995).  
 I (10-19 cm), II (20-29 cm), III (30-39 cm), IV (40-49 cm), V (50-59 cm)

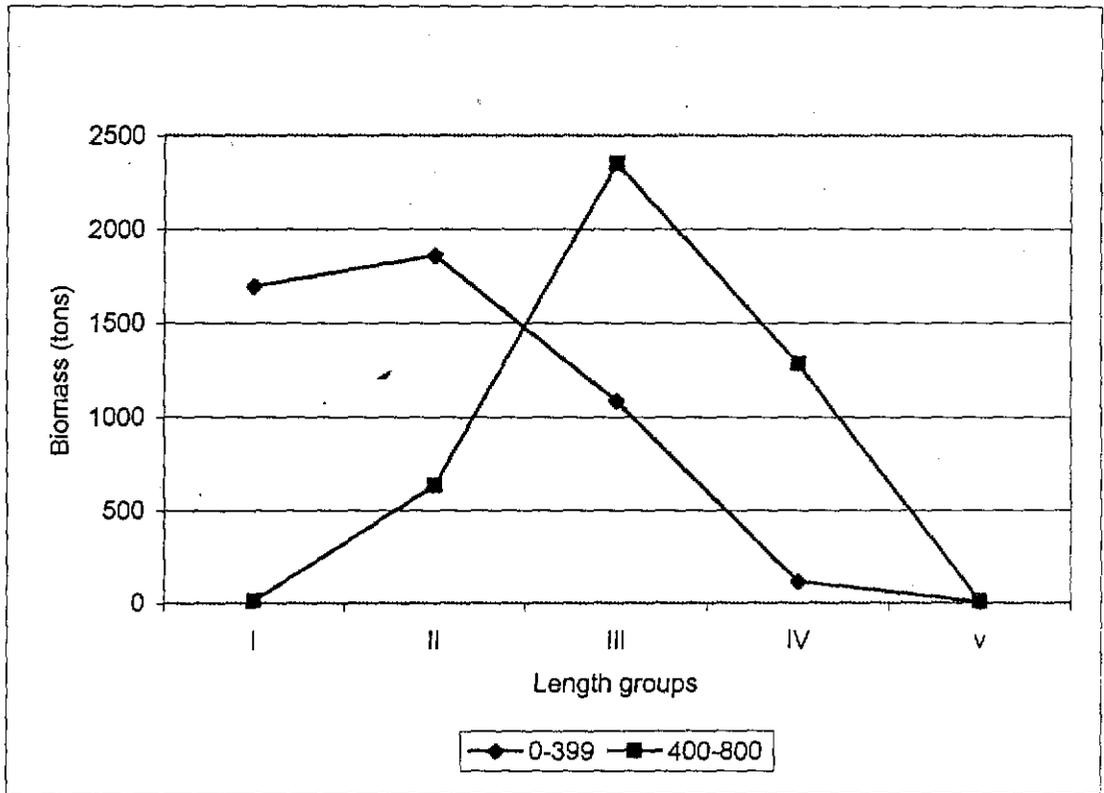


Figure IVa. Estimated biomass in tons ( warm season 1995).  
 I (10-19 cm), II (20-29 cm), III (30-39 cm), IV (40-49 cm), V (50-59 cm)

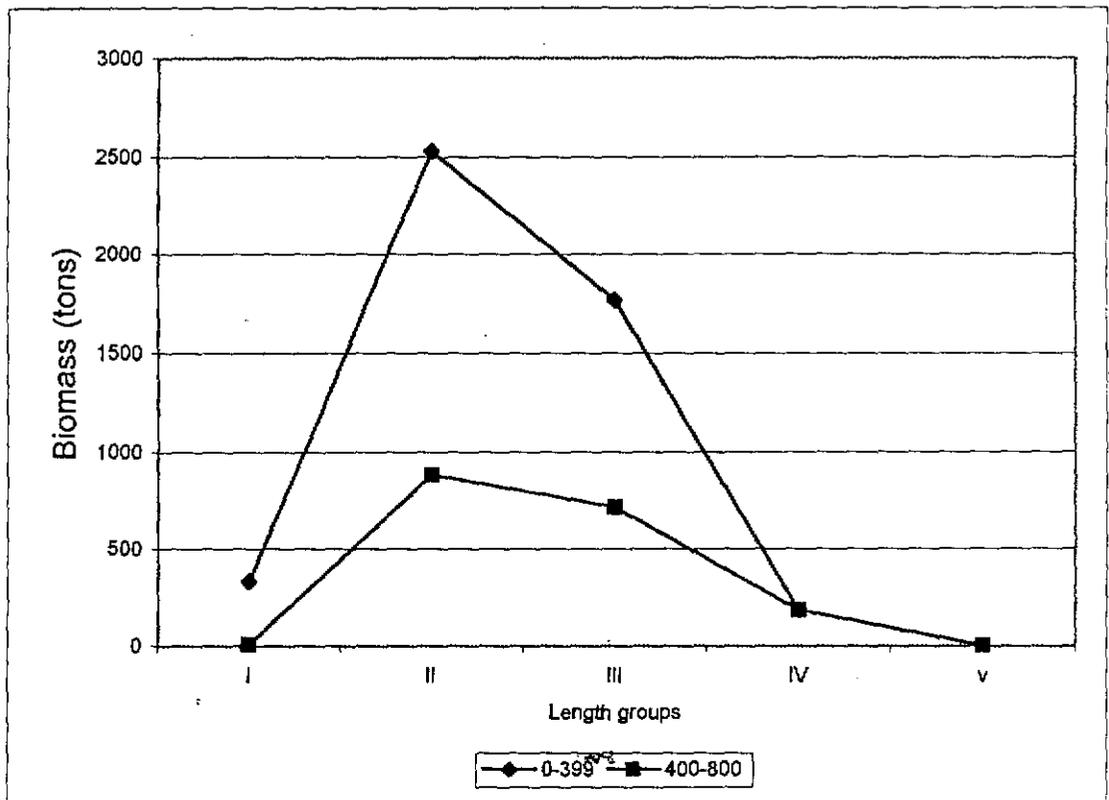


Figure IVb. Estimated biomass in tons ( cold season 1995)  
 I (10-19 cm), II (20-29 cm), III (30-39 cm), IV (40-49 cm), V (50-59 cm)

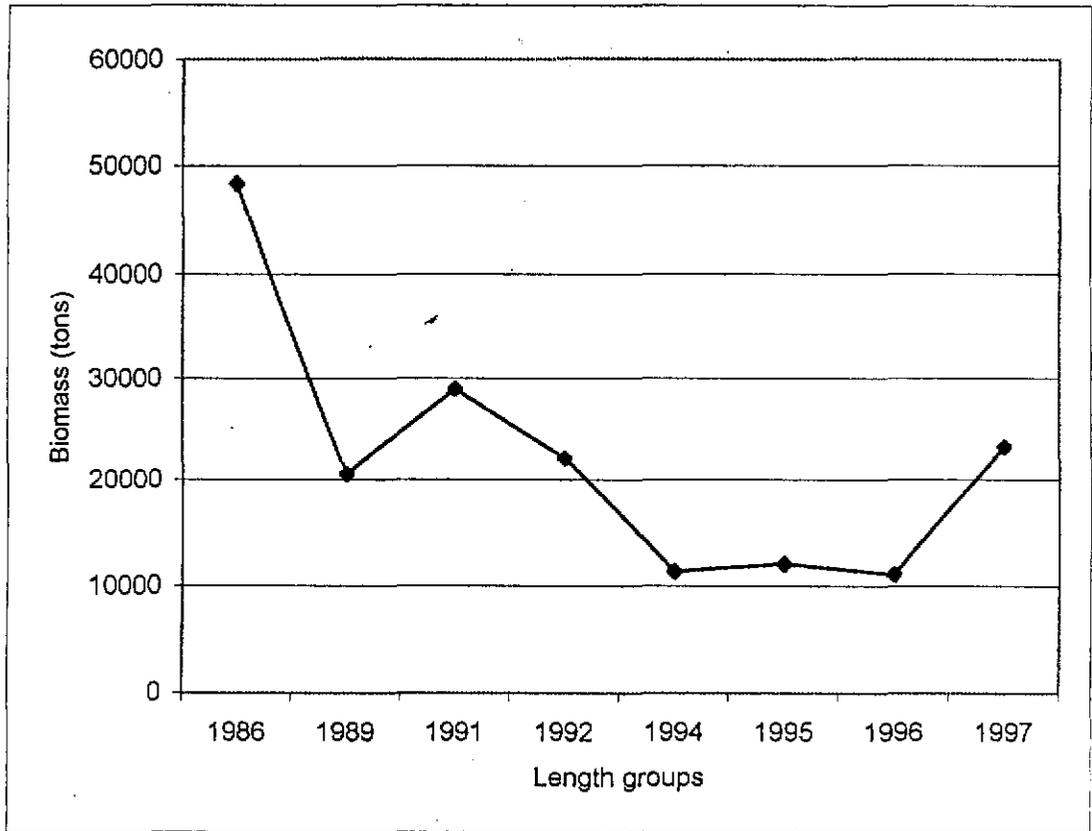


Figure V. Trends of biomass in tons from 1986 to 1997.