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THE BLACK HAKE FISHERY IN THE MAURITANIAN EEZ: ANALYSIS
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ABSTRACT

The fishery of black hake *Merluccius* spp. in the Mauritanian EEZ mainly comprises a Spanish trawler fleet, as well as some longliners. The highly specialised trawling fishery has diminished its effort, while its annual landings have remained stable, not surpassing 12 000 t. In the total annual catch, individuals measuring less than 30 cm do not represent more than 10% (with the exceptions of 1992 and 1993, when the highest recruitment was recorded), although this percentage is higher during the cold season. The evolution of both the yields and the average sizes of the landed hakes, which have increased since 1991, do not indicate an overexploited resource, especially if we take into account that the potential for hake exploitation off Mauritania has been estimated at 133 000 tons annually.

The implementation of a minimum legal length of 30 cm for *Merluccius* spp., which is contemplated in Mauritanian fishing regulations, would contradict the conditions of the present fishing agreement, which imposes a 60 mm mesh size and prohibits fishing within an offshore limit of 18 nautical miles. Due to mesh selectivity, to black hakes' size-segregation with depth, and to the biological characteristics of these species, which are small and highly migratory, Spanish trawlers will continue to catch individuals under 30 cm. Therefore, regulation by means of minimum size would not be an adequate conservation measure for black hakes in the Mauritanian EEZ.

Key words: Trawling fishery, regulation, minimum size, *Merluccius* spp., Mauritania.

RESUMEN

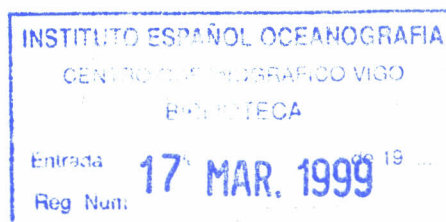
La pesquería de merluzas negras en la ZEE mauritana: análisis sobre la posible aplicación de la talla mínima de 30 cm

La pesquería de merluzas negras *Merluccius* spp. es ejercida en la ZEE mauritana por una flota española de arrastreros y por algunos palangreros. La pesquería de arrastre, altamente especializada, ha disminuido su esfuerzo, mientras sus capturas se han mantenido, no superando las 12 000 toneladas anuales. Aunque con valores mensuales más elevados durante la estación fría, los ejemplares menores de 30 cm sólo han representado más del 10% del total anual en 1992 y 1993, años de fuerte reclutamiento. La evolución de los rendimientos y de las tallas medias de las merluzas desembarcadas, que han aumentado desde 1991, no muestran una sobrexplotación del recurso, sobre todo si tenemos en cuenta que su potencial extraíble ha sido estimado en aguas mauritanas en 133 000 toneladas anuales.

La aplicación de la talla mínima de 30 cm contemplada por la legislación mauritana a *Merluccius* spp. entraría en contradicción con las condiciones del acuerdo de pesca vigente, que impone la malla de 60 mm y autoriza la pesca fuera de las 18 millas marinas. Debido a la selectividad de la malla, a la segregación de tallas con la profundidad que presentan las merluzas negras y a las características biológicas de estas especies, de pequeño tamaño y altamente migratorias, los arrastreros españoles seguirán capturando ejemplares menores de 30 cm. La regulación mediante la talla mínima no será, por consiguiente, una medida de conservación para las merluzas negras en la ZEE mauritana.

Palabras clave: Pesquería de arrastre, regulación, talla mínima, *Merluccius* spp., Mauritania.

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1. INTRODUCTION

The fishery of black hake *Merluccius senegalensis* Cadenat, 1950 and *Merluccius polli* Doutre, 1950 in waters of the Mauritanian Islamic Republic mainly comprises a Spanish trawler fleet, as well as some longliners. Besides these fresh or freezer fleets, between 1993 and 1996 black hake were exploited on a smaller scale by another fleet, under a demersal trawl-fishing license.

Although until the mid-1970s, Eastern European fleets registered major landings of these species in Mauritanian waters, they have since vanished. At present, Spanish trawlers and a few longliners are the only vessels targeting black hake in the area. The trawlers, known as *bous*, tend to work under a license for the Mauritanian exclusive economic zone (EEZ), which they combine with others for Morocco or Senegal.

Since the 30s, the *bous* fleet has frequented the Mauritanian fishing zone, first freely, and since 1964 under different private or bilateral co-operation agreements. The first, more restrictive European Union agreement came into force in 1987, followed by others signed in 1990, 1993 and 1996.

Mauritanian black hake stocks have been described in the reports of the Committee for the Eastern Central Atlantic Fisheries (CECAF) working groups on resources evaluation in the country's EEZ (Josse and García, 1986; Josse, 1989) and on hake fisheries in the northwest African zone (Anon., 1978, 1986, 1990a). The Spanish trawl fishery targeting black hakes off Mauritania has been described by Ramos and Fernández (1992).

Since 1989, Mauritanian fishing regulations have imposed a minimum size of 30 cm for specimens of *Merluccius* spp. caught in the country's waters. In December 1996, the Mauritanian government declared a year-long moratorium on this measure, later extended for three more months, affecting EU fleets operating in its EEZ. During this time, an Ad Hoc Working Group was to decide, in light of the results, whether or not to apply the 30 cm minimum size regulation.

The present report analyses and discusses the contradictions that, both at the biological and fisheries levels, would ensue from the application of this regulation; one that is, in any case, unusual in the management of the fisheries of other *Merluccius* spp. in fishing-grounds around the world.

2. DESCRIPTION OF BLACK HAKE STOCKS

In Mauritanian waters, from 21° 46' N to 16° 04' N latitudes, two species of black hake are found: the Senegalese hake *M. senegalensis* and the Benguela hake *M. polli*. Both species are easily distinguished

from the European or white hake *Merluccius merluccius* (Linnaeus, 1758) due to their darker colour; therefore, they are known by the generic name of black hake.

In practice, differentiation between the two black hake species is very difficult, because it is based on internal characteristics, e.g. number of vertebrae and gill-rakers or shape of sagittal otolith (Maurin, 1965; Wysokinski, 1986). Therefore, these two species are not usually considered separately in commercial catch statistics (Anon., 1986).

The European hake, whose distribution limit coincides with the northern Mauritanian border (Anon., 1990a), is caught only occasionally in these waters, and in very small numbers.

2.1 Geographic and bathymetric distribution. Seasonal migrations

Senegalese hake are found exclusively on northwest African coasts; the species's distribution area extends between 33° N and 10° N latitudes, in waters off the southern coast of Morocco, Mauritania and Senegal, as it can be seen in figure 1 (Anon., 1990a; Bravo de Laguna, 1985; Wysokinski, 1986).

The distribution area of Benguela hake is wider, stretching from northern Mauritania (20° N) to Angola (18° 30' S). Therefore, at the northernmost point of its distribution zone, the two species' distributions overlap in Mauritanian and Senegalese waters (Inada, 1981).

Both species make seasonal latitudinal and bathymetric migrations, linked to movements of cold water masses. During the summer they almost disappear from Senegal, and their abundance increases in Mauritanian fishing-grounds (Wysokinski, 1986; Caverivière *et al.*, 1986).

Trawling surveys carried out on the Mauritanian shelf in 1982, 1983 and 1985 served to delimit the two species' latitudinal and bathymetric distributions (figure 2); they also showed the Senegalese hake's dominance along the Mauritanian coast (Overko, Boukatine and Ly, 1986; Boukatine, 1986). Senegalese hake have been found in Mauritanian waters at depths of 26-825 m, with the highest concentrations being observed between 200-600 m, mainly in the central and southern zones (figures 3 and 4).

2.2 Size distribution by depth

The size of black hake caught in Mauritanian waters during the research surveys cited above ranged from 21-70 cm. Although juveniles occupied the more coastal waters, the results of these surveys showed that the size-segregation by depth is not total, and there is a great deal of overlapping. Down to 200 m the average size of hake was 29.1 cm,

while from 400-600 m specimens smaller than 30 cm are caught, mainly in the central and southern zones. At these depths the hake sizes ranged, respectively, from 21-43 cm and from 27-63 cm, as shown in figure 5 (Overko, Boukatine and Ly, 1986).

Likewise, during the surveys carried out in Senegal, small individuals were taken during the deepest trawls (Caverivière *et al.*, 1986). Specifically, at depths above 350 m, the average size of *M. polli* specimens was longer than 30 cm (figure 6).

Wysokinski (1986), in a general review of the *Merluccius* genus in the area, confirmed that specimens ranging from 15-65 cm were fished at depths of 130-250 m. The same phenomenon has been reported for European hake in Moroccan waters (Anon., 1986; Turner and El Ouairi, 1986).

2.3 Growth

Although there are few studies on the growth of black hake in the literature, Inada (1981) reported that *M. senegalensis* and *M. polli* do not surpass a maximum length of 81 and 80 cm, respectively.

Black hake can live as long as 10-11 years. At a length of 30 cm, Senegalese hake are 3 years old and Benguela hake are 4-year-olds, as shown in table I (Wysokinski, 1986).

2.4 Reproduction

The only published information on black hake reproduction is collected in a FAO report (Anon., 1990a) presenting results obtained from Spanish-Senegalese experimental surveys (Caverivière *et al.*, 1986) and from Spanish scientists research based on fisheries data (Sobrino, Cervantes and Ramos, 1990).

The cruise data show differences between the maturity stages related to gender, depth and hydrological season; generally, an increase in the proportion of mature individuals with depth was observed. Mature specimens of *M. senegalensis* are caught from 100 to 300 m during the cold season; all *M. polli* specimens caught at depths of less than 300 m were in the pre-spawning stage or immature (Caverivière *et al.*, 1986).

2.5 Size at first maturity

According to the most recent studies, the size at first maturity of *M. senegalensis* varies from 25-29 cm for males, and 30-34 cm for females (Caverivière *et al.*, 1986). Sobrino, Cervantes and Ramos (1990)

have estimated this length at 26.4 cm for males and 29.7 cm for females, with ranges fluctuating between 21.6-34.7 cm and 25.8-38.1 cm. It is evident, therefore, that at a length of 30 cm there is a high proportion of individuals that have already reached sexual maturity, especially in males (table II).

Less recent reports (Maurin, 1954; Doutre, 1960) are quite inconsistent, placing the species's first-maturity length at 24 and 38 cm, respectively.

The only available data on the first-maturity size of *M. polli* are from Senegalese waters: 20-24 cm for males, and 35-39 cm for females (Caverivière et al., 1986).

2.6 Spawning season and zone

The spawning period is the same for the two black hake species: during the cold season, from October to March (Wysokinski, 1986; Sobrino, Cervantes and Ramos, 1990).

M. senegalensis seem to reproduce on the continental shelf-break, off southern Morocco, northern Mauritania and north of Cape Verde in Senegalese waters, as shown in figure 7 (Maurin, 1954; García, 1982; Wysokinski, 1986); no specific bathymetric range has been established. *M. polli* spawns in deep water, between 400-900 m, and the species has two known spawning zones: one in the Gulf of Guinea and another off Mauritania, as indicated in figure 7 (García, 1982). However, due to *M. polli*'s wide geographical distribution, there should be some other spawning areas.

3. ANALYSIS OF CATCH AND SIZE-COMPOSITION DATA

This section analyses data from the last 7 years on the total catch and the catch of individuals smaller than 30 cm (1990-96), together with the size-composition of available historical series (1987-1996). Both the statistical and length-distribution data refer to the two hake species together, *M. senegalensis* and *M. polli*, since it is impossible to separate them during the landings.

3.1 Catches

Black hake catches by Spanish trawlers off Mauritania have never exceeded 12000 tons, showing an annual average of 9400 tons (figure 8).

Due to the extreme specialisation of this fishery, which targets hake almost exclusively (Ramos and Fernández, 1992), the species have represented between 85-96% of total landings; therefore, the proportion of accessory species is very low.

As shown in figure 8, the annual landings of hake smaller than 30 cm have remained constant at around 1000 tons. Although they can represent more than 30% of the total number of specimens caught, they have only exceeded 10% of total weight in 1992 and 1993 (figure 9). The exact average for the data series analysed was 9.5%.

The high 1993 value of 17.5%, the highest in the historical series, occurred during a year of strong recruitment and high yields for other hake species in the area (Fernández, Ramos and González, 1998). However, the minimum size of specimens taken that year was 21 cm, as shown in figure 10.

Monthly percentages of individuals smaller than 30 cm vary widely throughout the year. These proportions are always higher during the cold season, between September and October, and from February to March (figure 11), corresponding to the recruits' entry into the fishery. During spring-summer, these proportions are at their lowest, with minimum percentages of 0.16% in August 1991 and 0.05% in July 1994.

3.2 Size composition

The size composition of the Spanish fleet's landings has been constant throughout the historical series, varying from a minimum of 17-18 cm to a maximum of 70 cm (Ramos and Fernández, 1992), as shown in figure 10, which presents the size distribution of total catches from 1987 to 1996.

4. EXPLOITATION STATE OF THE RESOURCE

Hake on the Mauritanian shelf belong to mixed stocks of two species, *M. senegalensis* and *M. polli*, shared also by Morocco and Senegal. For this reason, as well as the impossibility of separating the two species in commercial statistics, only a joint analysis is possible (Anon., 1990a; Ramos and Fernández, 1992).

The latest assessment of the *Merluccius* spp. stocks, made by the Ad Hoc Working Group for hake and deep-water shrimp in the northern CECAF area, showed that they did not present symptoms of overexploitation (Anon., 1990a). The cohort analyses carried out on the average catches during 1983-1985 and 1986-1988 showed a decrease in fishing mortality of 31% between both periods with exploitation levels which corresponded to maximum yield per recruit (figures 12 y 13). The improvement seems to be at least partly the result of a change in the exploitation strategy of the Spanish trawler fishery, which caught individuals of a higher mean size.

Even though more recent assessments are unavailable, there is a good historical series of yields that can be used as a relative abundance index. CPUE evolution shows a continuous increase since 1991, which corresponds to higher catches and lower values of effort (figure 14). The maximum yield was 3.6 t per fishing day in 1996. This value, similar to those of the 1986-1988 period, when the last assessment was made (Anon., 1990a), seems to indicate the good state of hake stocks in the Mauritanian fishing-grounds.

Another index providing information on resource state is the evolution of average size of individuals caught, since overfishing situations tend to be associated with a drop in individual length.

As shown in figure 15, average sizes have not decreased, nor undergone significant changes, showing a high stability at around 35 cm, and even a clear increase from 1994 onwards.

Also noteworthy is the information taken from the Guide de l'Armateur, a Mauritanian journal, which in 1990 assessed the exploitable potential of hake in the country's fishing-grounds at 133 000 tons (Anon., 1990b). This figure would represent more than 10 times the annual extractive capacity of the Spanish fleet, as shown by historical data series from 1983 to 1996 presented in figure 14 (Ramos and Fernández, 1992).

5. REGULATION OF THE BLACK HAKE FISHERY IN MAURITANIA

The Spanish fleet's fishing in the Mauritanian EEZ is subject to the conditions imposed by the agreements signed between the European Union and the Mauritanian government. The present protocol, in force since August 1996, will last five years, two more than the three previous protocols (Anon., 1996).

The agreements take into account a method of fishing that targets black hake, called black hake trawlers and longliners. Operating under this license are the traditional trawlers or bous fleet, based in Cadiz, and some longline units.

Although between 1993 and 1996, black hake were also fished by a trawler fleet with a license for a method denominated demersal trawling, this has disappeared under the present protocol (Anon., 1993a, 1996).

Due to the slight importance of the longline fleet (only 3-4 units), we refer exclusively to the trawling fishery, which would be affected directly by the application of the regulation analysed in our report.

Two conditions of the current agreement, the trawler mesh size and the authorised fishing zone, were directly related to the minimum size, and these will be analysed in more detail.

5.1 Mesh size

The 60 mm size is currently the required mesh in the cod-end for the black hake trawling fishery. This mesh size has been maintained in previous protocols, and is the same one imposed on this method of trawl fishing in the respective fishing agreements with Morocco and Senegal (Anon., 1997a, 1997b).

As indicated by data on European hake selectivity (Goñi, 1985), the only available information for hakes in the CECAF area, the size at first capture for this mesh size of 60 mm varies between 18 and 22 cm (table III).

5.2 Fishing zone

The fishery's authorised zones are defined in the agreement, which specifically fixes the geographical limits within which black hake fishing is prohibited.

To the north of Cape Timiris (19° 21' N parallel), the fleet can operate outside an imaginary line running through the following points:

20° 36' N - 17° 36,0' W
20° 03' N - 17° 36,0' W
19° 50' N - 17° 12,8' W
19° 50' N - 17° 03,0' W
19° 04' N - 16° 34,0' W

South of the 19° 21' N to the Senegalese border, the limit is marked by 18 nautical miles measured from the low-tide line (figure 16).

Under previous bilateral and private agreements, the fleet fished outside the 12 mile limit throughout the Mauritanian EEZ, and this remained in force until the signing of the 1990 protocol, which fixed the above limits. These were maintained in the 1993 agreement, and the current 1996 agreement.

In spite of the heavy restrictions regarding the fishing zone, trawlers can operate at depths of less than 100 m, especially in the north, where the continental shelf is very wide (figure 16).

5.3 Other considerations

We would like to highlight a particularity of this fishery, due to the implications that it could have regarding the measure under discussion: it is currently exploited by a single fleet, which has the possibility of using, either simultaneously or alternatively, Mauritanian, Moroccan or Senegalese fishing-grounds.

Down the years, the bous fleet operating in the northwest African fishing-grounds has used the Moroccan, Mauritanian and/or Senegalese zones to a greater or lesser degree, depending on the more or less favourable access conditions set out in the agreements signed with the different countries (Ramos and Fernández, 1992).

6. REGULATIONS IN OTHER FISHING GROUNDS

We have reviewed the ordinances and regulations currently in effect in hake fisheries around the world (table IV), paying special attention to those in the nearby fishing-grounds of Morocco and Senegal, and to the Spanish fisheries.

One general observation is that regulations concerning most of the fisheries involving the genus's 12 species (figure 17) are based on production models. Application of the VPA tends to be unfeasible, due to the lack of knowledge regarding some aspects of hake biology, including age estimation by otolith reading (Pitcher and Alheit, 1995).

The regulation that serves as the basis of exploitation in most hake fishing-grounds is the application of TACs or quotas. This would be the case of the fishery for European hake *M. merluccius* in the Atlantic (Casey and Pereiro, 1995), of South African hake *M. capensis* and *M. paradoxus* (Payne and Punt, 1995; Gordo, Macpherson and Olivar, 1995), or of the Pacific species *M. gayi*, *M. australis* and *M. productus* (Aguayo-Hernández, 1995; Colman, 1995; Methot and Dorn, 1995). Only in some fishing-grounds is the control exercised by means of effort limitation: either horse-power, as in the case of the Falklands, where hake are merely by-catch of the squid fishery (Tingley et al., 1995); or else the tonnage or number of licenses, as in the Moroccan or the eastern Mediterranean fisheries (Ramos and Fernández, 1995; Papaconstantinou and Stergiou, 1995).

Although nearly all countries have a regulation on mesh size (which seems to be the most generalised ordinance), there are some in which other kinds of measures are applied, including closing the fishery during certain periods to protect spawners or recruits, restrictions on fishing zones, by-catch limitation, or other, more concrete, measures, e.g. prohibiting the use of hake for meal manufacture (table IV).

Regulations on a minimum catch or market size seem to be scarce in the hake fishery worldwide, as shown in table IV. This regulation is found only in the fisheries of European hake (Casey and Pereiro, 1995), Peruvian hake (Espino, Castillo and Fernández, 1995) and in the artisanal fishery of austral hake in Chilean waters (Aguayo-Hernández, 1995).

The minimum sizes seem to be according to the maximum attainable length and the length at maturity, which can vary even within stocks of the same species (table V). Thus, taking into account this biological characteristic, Spanish regulations impose a minimum size of 27 cm on European hake in Atlantic fishing-grounds, but of only 20 cm in the Mediterranean Sea (Anon., 1995), where the species's maximum

size is smaller. The Spanish regulations follow EU norms on the minimum sizes of commercial fishing species in the Atlantic and Mediterranean zones.

The minimum size of hake authorised in the fishing-grounds off Mauritania is smaller than 30 cm. Morocco has established, for both European and Senegalese hake, a minimum market length of 20 cm (Anon., 1993b). We have not found any regulations for Senegal; however, to date there have been no problems with regard to the minimum sizes caught in these fishing-grounds, which are in keeping with the mesh size used there.

As to mesh size, it should be noted that Moroccan and Senegalese regulations establish a 60 mm opening for black hake fishing, the same minimum authorised in Mauritania.

In the case of multispecific fisheries, such as those of *M. merluccius* in the northeast Atlantic, Morocco and the Mediterranean (Casey and Pereiro, 1995; Ramos and Fernández, 1995; Oliver and Massutí, 1995), both the minimum mesh sizes and other regulatory measures are based on the characteristics of other species (Oliver and Massutí, 1995). This represents a serious problem for hake stock conservation. Due to the high proportion of illegal or immature catches in these overexploited stocks, regulations based on minimum sizes are not recommendable, since they result in high discard rates (Casey and Pereiro, 1995; Oliver and Massutí, 1995).

7. DISCUSSION

Since 1989, Mauritanian fishing regulations have prohibited the capture of hake *Merluccius* spp. in the country's territorial waters if they measure less than 30 cm from the snout to the crest or centre of the caudal fin (Anon., 1989).

Although to date this legislation has not been put into effect, we have tried to analyse in the present report what the implications would be at the fisheries level if this measure, which would affect the Spanish fleets exclusively, were to be applied.

Bearing in mind the wide bathymetric distribution of hake (20-850 m), the seasonal migration patterns which produce spatio-temporal abundance fluctuations (Overko, Boukatine and Ly, 1986; Boukatine, 1986) (figures 2, 3 and 4) and their flexible size-segregation with depth (Overko, Boukatine and Ly, 1986; Caverivière et al., 1986) (figures 5 and 6), Spanish vessels will continue to fish hake smaller than 30 cm under the prescriptions of the current fishing agreement (Anon., 1996).

With regard to the fishing zone, trawlers work far offshore, outside of the 18 nautical miles which the protocol imposes (figure 16). As sector sources argue, 'This is a very heavy reduction, more than 50% of the useful surface for trawl fishing in this zone'. In spite of this heavy restriction, vessels can operate at depths close to 100 m, especially in the north, where the continental shelf is wide. In this

zone, the probability of capturing hake smaller than 30 cm, and in substantial amounts during some times of the year, is very high (figures 4 and 5) (Overko, Boukatine and Ly, 1986).

Although as indicated in section 6, in some hake fisheries there are limitations on access to the fishing area, whether to protect spawners and juveniles or local artisanal fisheries (Payne and Punt, 1995; Aguayo-Hernández, 1995; Espino et al., 1995), in none of these is the limit fixed beyond 200 m (table IV).

As to mesh size, the fleet currently trawls with 60 mm nets. The size compositions of Spanish landings have remained constant throughout the historical series, oscillating between a minimum of 17-18 cm and a maximum of 70 cm (figure 10). Length distributions should be in keeping with the first-catch size of European hake obtained by Goñi (1985), which vary from 18-22 cm (table III). Although individuals smaller than 30 cm are caught, only in 1993 (an exceptional year with strong recruitment) did these exceed 10% of total landings, and they have gradually diminished over the last few years (figures 8 and 9). On the other hand, the fleet itself has no special interest in marketing small hake (Ramos and Fernández, 1992).

If the selectivity data of *M. merluccius* are applied to black hakes, in order to catch specimens larger than 30 cm it would be necessary to use a much larger mesh size (table III) (Goñi, 1985).

A change in the exploitation strategy, based on increasing the mesh size or the fishing zone's distance from the coast, should be studied in the event that a new assessment indicated overexploitation of the stock. But this is not the case for black hake, whose stocks seem to be in excellent health, without symptoms of overexploitation. Both yield increases and the evolution of the mean size of hake caught (figures 14 and 15) suggest this. The CPUE values of the last few years, in the same range as those of 1986-1988, when the last assessment was carried out (Anon., 1990a), would also seem to indicate the good state of the Mauritanian fishing-grounds' resource.

Although until the mid-1970s the Eastern European fleets landed more than 100 000 t of hake annually (figure 18) (Ramos and Fernández, 1992), at present the Spanish fleet is alone in exploiting Mauritanian hake stocks, and exerts moderate fishing pressure. Its landings have not surpassed 12 000 t, with an annual average of 9 400 t, while its efforts have decreased as a consequence of the different agreements in effect (figure 14). Nevertheless, even the high catches during the 1970s would be below the 133 000 tons that Mauritanian estimates have calculated as the potential annual amount that could be taken in the country's waters (Anon., 1990b).

From a biological point of view, there seem to be no clear reasons for setting the minimum catch size for *Merluccius* spp. precisely at 30 cm, at least in light of the few available studies.

The two black hake species, Senegalese and Benguela hake, whose stocks share Mauritanian waters, are mid-sized species, which do not exceed a length of 80 cm (Inada, 1981). They are fast-growing species, since at 30 cm the Senegalese and Benguela hakes are,

respectively, 3 and 4 years old (table I) (Wysokinski, 1986). At that size, a high percentage of individuals have already reached sexual maturity (Caverivière et al., 1986; Sobrino, Cervantes and Ramos, 1990).

When compared with other species of the genus, such as Cape hake *M. capensis* or European hake, *M. merluccius*, which can reach a length of 130 cm at 10 or 11 years of age (Payne and Punt, 1995; Gordo, Macpherson and Olivar, 1995; Casey and Pereiro, 1995), the maximum sizes of African hakes are much lower (Inada, 1981). The two black hake species are among the smallest in the *Merluccius* genus, and among those reaching sexual maturity at the smallest size (table V).

As discussed in section 6, the regulation of hake fisheries in other parts of the world is based mainly on fixing catch quotas and mesh size limits (table IV). Only in some countries are there regulations regarding minimum legal sizes, since, as we have seen, such measures can easily contradict those relating to mesh size and fishing zones.

Nevertheless, the authorised minimum legal size is only 30 or 35 cm for Peruvian hake *M. gayi* and European hake *M. merluccius* (Aguayo-Hernández, 1995; Casey and Pereiro, 1995) (table IV). Both species reach greater lengths than black hake, and their maturity also occurs at larger sizes. However, since in some species the maximum and first-maturity sizes vary greatly among stocks, these regulations take such characteristics into account, imposing different minimum sizes. Thus, in the case of European hake, the minimum size is fixed at 27 cm in the North Atlantic fishing-grounds, and at only 20 cm in the Mediterranean Sea, where the species's maximum size is smaller (Casey and Pereiro, 1995). Morocco has established a minimum market size of 20 cm for both the European and the Senegalese hakes (Anon., 1993b).

The establishment of such a high minimum size for black hake, two species that are among the smallest in their genus, seems illogical, or at least highly debatable, even more so when we consider that this measure would not protect more than partially the juvenile fraction of these stocks, which, at least in the case of Senegalese hake males, already presents a high percentage of mature individuals at 20-30 cm (table II) (Sobrino, Cervantes and Ramos, 1990).

A last consideration is the possibility that the *bous* fleet could use double licenses to operate simultaneously or alternately in Mauritanian and/or the Moroccan and Senegalese fishing-grounds. The use of double licenses in this fishery would clearly enter into conflict with such a regulatory measure. On the one hand, the minimum authorised sizes are different, in the case of Morocco, or non-existent, in the case of Senegal, which would mean that vessels could bring on board specimens smaller than 30 cm caught in neighbouring fishing-grounds. On the other hand, any change in the authorised mesh size would force the fleet to use two different trawling nets, with all of the logistical and economic difficulties that this would imply.

The application of a 30 cm minimum size to hake in Mauritanian fishing-grounds would originate a clash that would be difficult to solve, since it would clearly contradict the rest of the ordinances, especially for trawlers using double licences.

According to the information presented in our report, if the Mauritanian fishing measures were to be implemented, the fishing fleet would be forced to discard many specimens. In no way could the imposition of a minimum size of 30 cm be considered a conservationist measure; rather, it would be a very damaging one, since it would not protect hake resources in the Mauritanian EEZ.

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We also thank Vendeduría Trafalgar 96 SL, and especially Mr José Pereira, for providing all the data that we required.

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Table I. Theoretical relationship between age and size of three hake species in the CECAF area, based in 1967-1970 data from Wysokinski (1986) (*M. cadenati* = *M. polli*)

Age	<i>M. merluccius</i>	<i>M. senegalensis</i>	<i>M. cadenati</i>
1	17,0	16,7	16,4
2	25,1	23,2	21,2
3	32,6	29,3	25,7
4	39,6	35,0	29,8
5	46,1	40,3	33,5
6	52,2	45,3	37,0
7	57,9	49,9	40,1
8	63,1	54,2	43,1
9	68,0	58,3	45,8
10	72,6	62,1	48,2
11	76,8	65,6	--

Table II. Evolution of maturity percentage, with size for males and females of *M. senegalensis* from Sobrino, Cervantes and Ramos (1990)

Size (cm)	Males (%)	Females (%)
23	29	0
26	52	31
29	77	59
32	82	66
35	90	78
38	100	93
41	100	100
No. specimens	182	206

Table III. Selectivity data of *M. merluccius* off the Moroccan coast from Goñi (1985)

Author	Area	Method	Cod-end		L ₅₀ % (cm)	S.F.
			Material	Mesh (mm)		
Ancelín, 1956	Celtic Sea " "	Covered cod-end	Single polyamide	78,7	39,5	5,0
		" "	" "	59,4	32,0	5,4
Dardignac et al., 1968	Bay of Biscay	Covered cod-end	Double polyamide	62,8	29,1	4,6
		Alternate hauls	" "	62,8	28,9	4,6
		Lateral cod-end	" "	62,8	35,0	5,6
		Superior cod-end	" "	62,2	21,3	3,4
		" "	" "	63,4	21,9	3,5
		" "	" "	83,4	28,9	3,5
		" "	" "	83,8	35,0	4,2
		" "	" "	84,1	26,9	3,2
		" "	" "	99,2	38,8	3,9
		" "	" "	99,5	35,9	3,6
		" "	Alternate hauls	" "	99,5	48,8
" "	Superior cod-end	" "	100,6	39,3	3,9	
" "	" "	" "	102,2	39,3	3,8	
Dardignac et al., 1978	Bay of Biscay	Covered cod-end	Double polyamide	66,9	26,6	3,9
		" "	" "	66,4	26,9	4,0
Bravant and Guilloud, 1976	Bay of Biscay	Covered cod-end	Single polyamide	42,5	15,0	3,3
		" "	" "	42,5	18,5	4,4
Lozano et al., 1968	Cantabrian Sea	Covered cod-end	Single polyamide	80	32	4,0
		" "	" "	60	22	3,7
Alonso Allende et al., 1975	Galicia	---	Polyamide	61	24,2	4,0
Monteiro, 1966	Portugal	Covered cod-end	Single polyamide	63,4	19,8	3,6
		" "	" "	55,3	16,5	4,1
Larraneta et al., 1969	Spanish Mediterranean	Covered cod-end	Single polyamide	34-52	11,1-16,7	2,8
Belveze, 1975	Moroccan Atlantic	Alternate hauls	Single polyamide	68	29,5	4,3
Goñi, 1985	Moroccan Atlantic	Covered cod-end	Single polyamide	34	12,8	3,8
		" "	" "	39	14,5	3,7
		" "	" "	48	15,0	3,1
		" "	" "	60	18,0	3,0
		" "	" "	69	28,5	4,1
		" "	" "	70	26,9	3,9

Table IV. Regulation measures applied to different hake fisheries world-wide. (*): Regulation for other species. (1): For artisanal fisheries

Zone	Country	Specie	Main Regulation	Mesh (mm)	Minimum size (cm)	Others measures	Fishery type
ATL. NE (ICES N)		<i>M. merluccius</i>	TACs	80	30		Multispecific
ATL. NE (ICES S)		<i>M. merluccius</i>	TACs	65	27		Multispecific
MEDIT. E		<i>M. merluccius</i>					Multispecific
	Cyprus		Licenses Nb	34	Yes	Closed season	Multispecific
	Egypt						Multispecific
	Greece		Licenses Nb	28	12	Closed season	Multispecific
	Israel		Licenses Nb	48	Yes		Multispecific
	Turkey			40	?		Multispecific
MEDIT. W		<i>M. merluccius</i>		40			Multispecific
ATL. NE (CECAF)	Morocco	<i>M. merluccius</i>	TRB max.	50	20		Multispecific
ATL. NE (CECAF)	Morocco	<i>M. senegalensis</i>	TRB max.	60	20		
ATL. NE (CECAF)	Mauritania	<i>M. senegalensis</i> + <i>M. polli</i>	TRB max.	60	30		
ATL. NE (CECAF)	Senegal	<i>M. senegalensis</i> + <i>M. polli</i>	TRB max.	60			
ATL. SE (ICSEAF)	Southafrica (W)	<i>M. capensis</i> + <i>M. paradoxus</i>	TACs	110		5 miles	
	Southafrica (S)	<i>M. capensis</i> + <i>M. paradoxus</i>	TACs	75			Multispecific
	Namibia	<i>M. capensis</i> + <i>M. paradoxus</i>	TACs	110			
ATL. NW (NAFO)	USA+Canada	<i>M. bilinearis</i>		<140		By-catch limit. Experim. fishery	Multispecific
ATL. SW	Argentina+Uruguay	<i>M. hubbsi</i> + <i>M. australis</i>		120		Not for meal Closed season	
	Falkland Is.	<i>M. hubbsi</i> + <i>M. australis</i>	Effort lim.	90*		Restricted areas*	Squids
PACIF. SE	Chile	<i>M. gayi</i>	TACs	110		5 miles Not for meal	
		<i>M. australis</i>	TACs		YES(1)	Closed season	
	Peru	<i>M. gayi</i>		90	35	Closed areas Closed areas 200 m depth	
	New Zealand	<i>M. australis</i>	TACs				Macruronus
PACIF. NE	USA	<i>M. productus</i>	TACs				Midwater trawl

Table V. Biological parameters (growth and reproduction sizes) of *Merluccius* around the world

Species	Zone	Maximum size			Maturity size		
		Total	Males	Females	Total	Males	Females
<i>M. merluccius</i>	Atlant. NW	140					
	Atlant. NW-North	114			27-44		49-58
	Atlant. NW-South	100					
	Medit. E	94			22-35		30-43
	Medit. W	85			23-26		29-43
	Morocco	90			23-40		33-43
<i>M. senegalensis</i>	Morocco						
	Mauritania	81			22-35		26-38
	Senegal						
<i>M. polli</i>	Mauritania	80			25-29		30-34
	Senegal						
<i>M. paradoxus</i>	Namibia	92					
	Southafrica	82	53	92	38		47
<i>M. copensis</i>	Namibia	120			30	36	48
	Southafrica	112					
<i>M. bilinearis</i>	Atlant. NW	76	41	66	23-24		26-31
<i>M. albidus</i>	Atlant. NW-C	--	40	70			
<i>M. hubbsi</i>	Argentina	95	54	98	30		34
	Falkland				36		41
<i>M. australis</i>	Argentina		54	98			
	Falkland				36		40
	Pacific(N. Zel)	126	110	130	65		70
	Pacific(Chile)		110	121	65		72
<i>M. gayi</i>	Pacific-SE (Chile)	87	57	78		32	
	Pacific-SE (Peru)		74	86	31-32		
			66	115			
<i>M. productus</i>	Pacific-NE	91					37

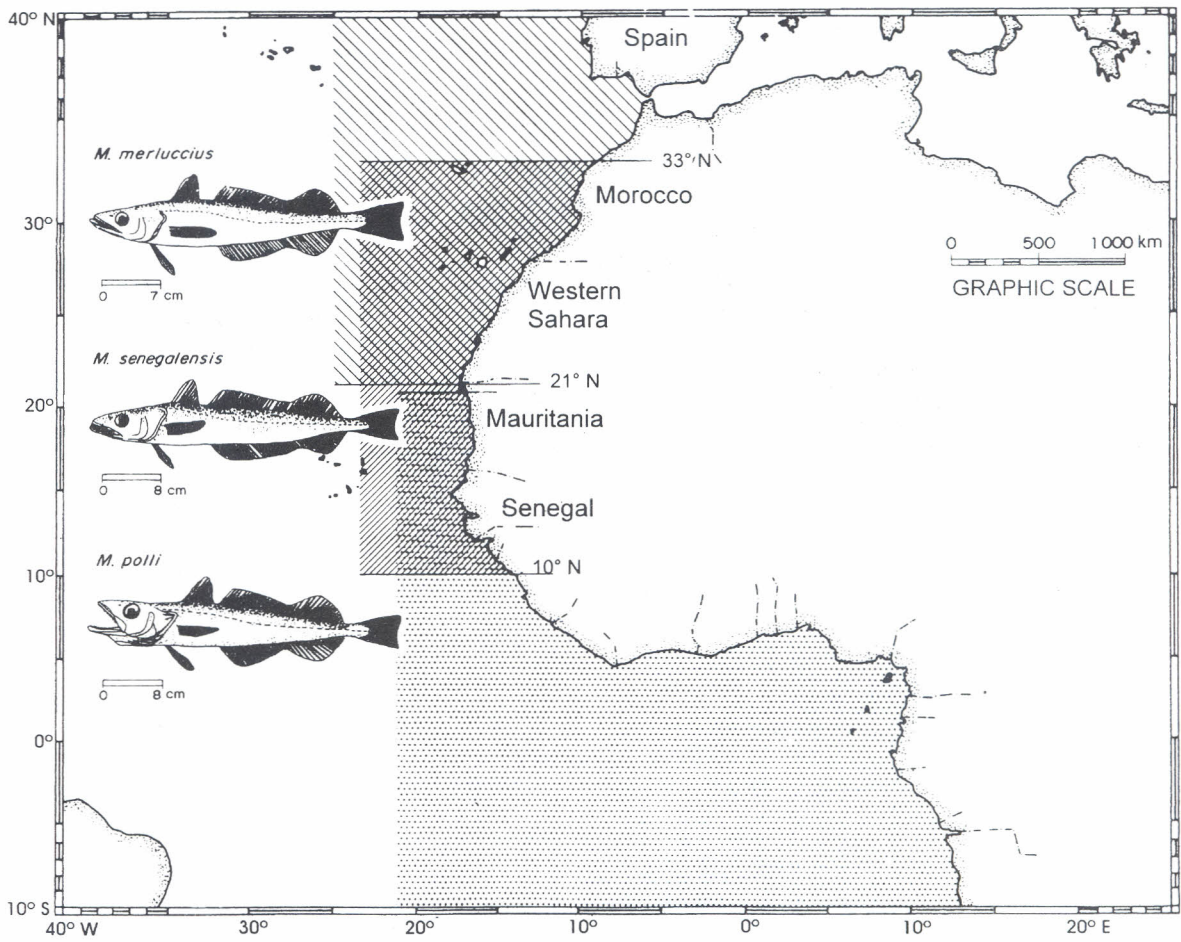


Figure 1. Geographic distribution of the three hake species in the CECAF area (from Ramos and Fernández, 1995)

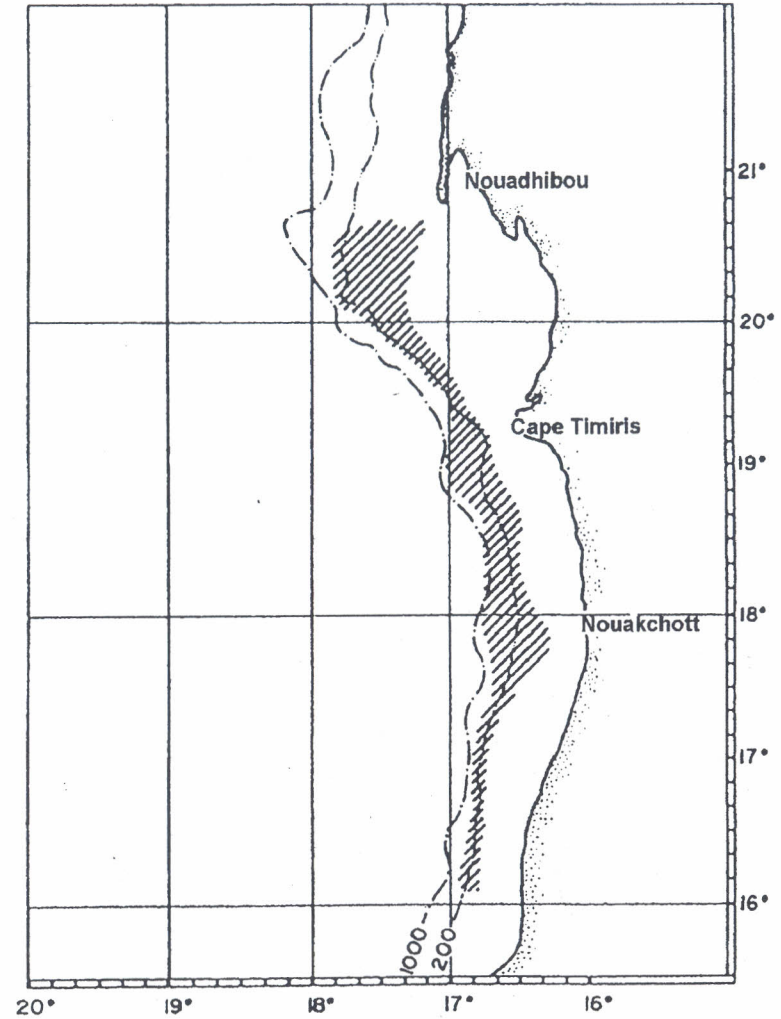
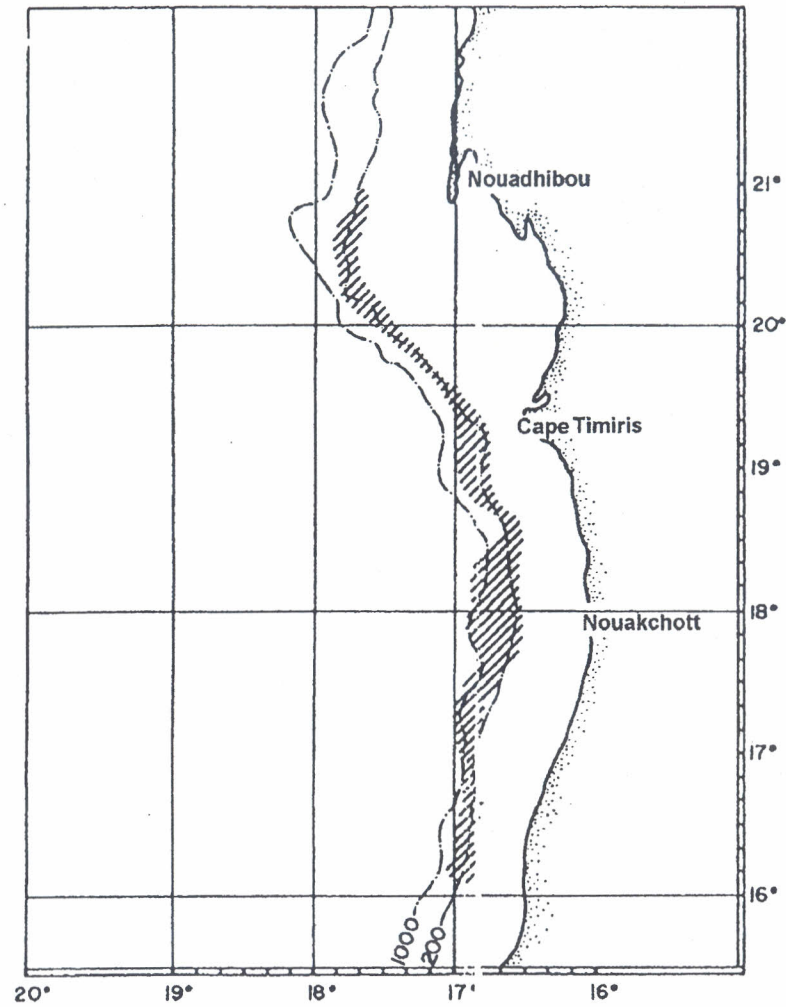


Figure 2. Distribution areas of *Merluccius* spp. in Mauritanian waters during surveys in 1982 (left) and 1983 (right) (from Overko, Boukatine and Ly, 1986)

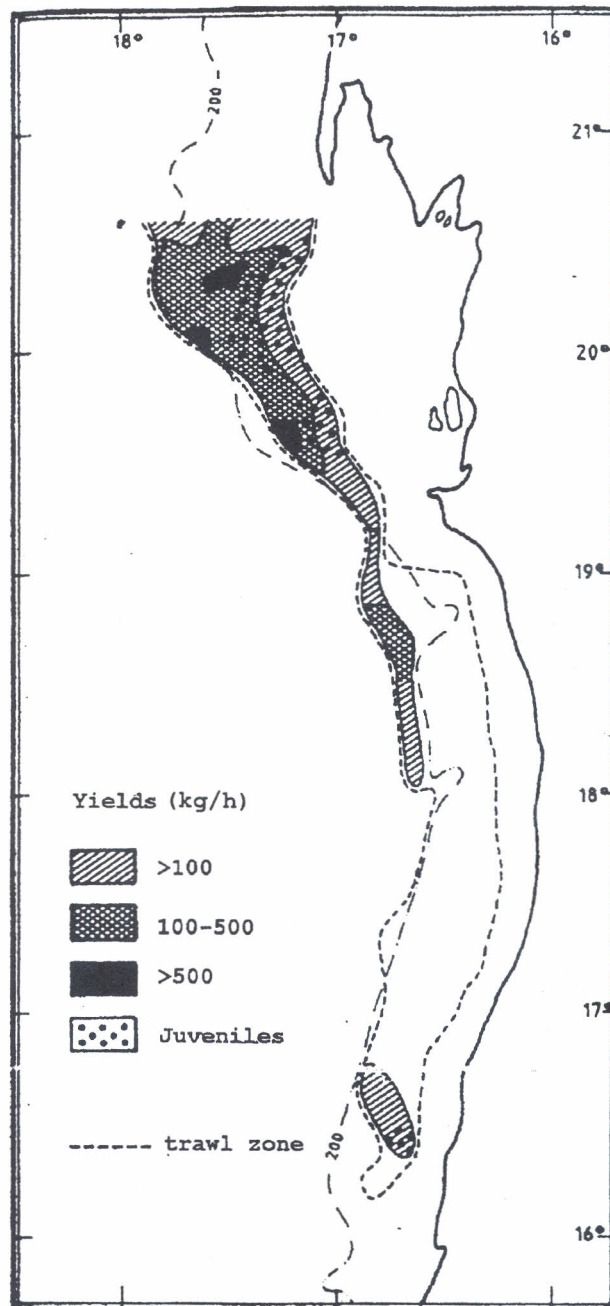


Figure 3. Distribution and abundance of *M. senegalensis* in Mauritanian waters, cruise of the R/V *Bakhichisaray* in April 1985 (from Boukatine, 1986)

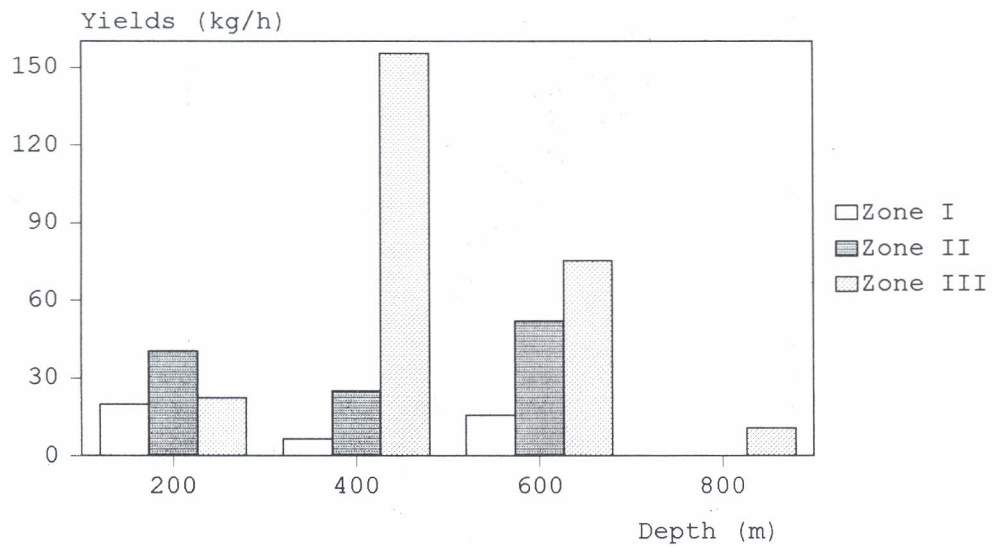


Figure 4. Abundances of *M. senegalensis* by zone and depth in March 1982 (Zone I = Cape Blanc - Cape Timiris; Zone II = Cape Timiris - Nouakchott; Zone III = Nouakchott - Saint Louis) (redrawn from Overko, Boukatine and Ly, 1986)

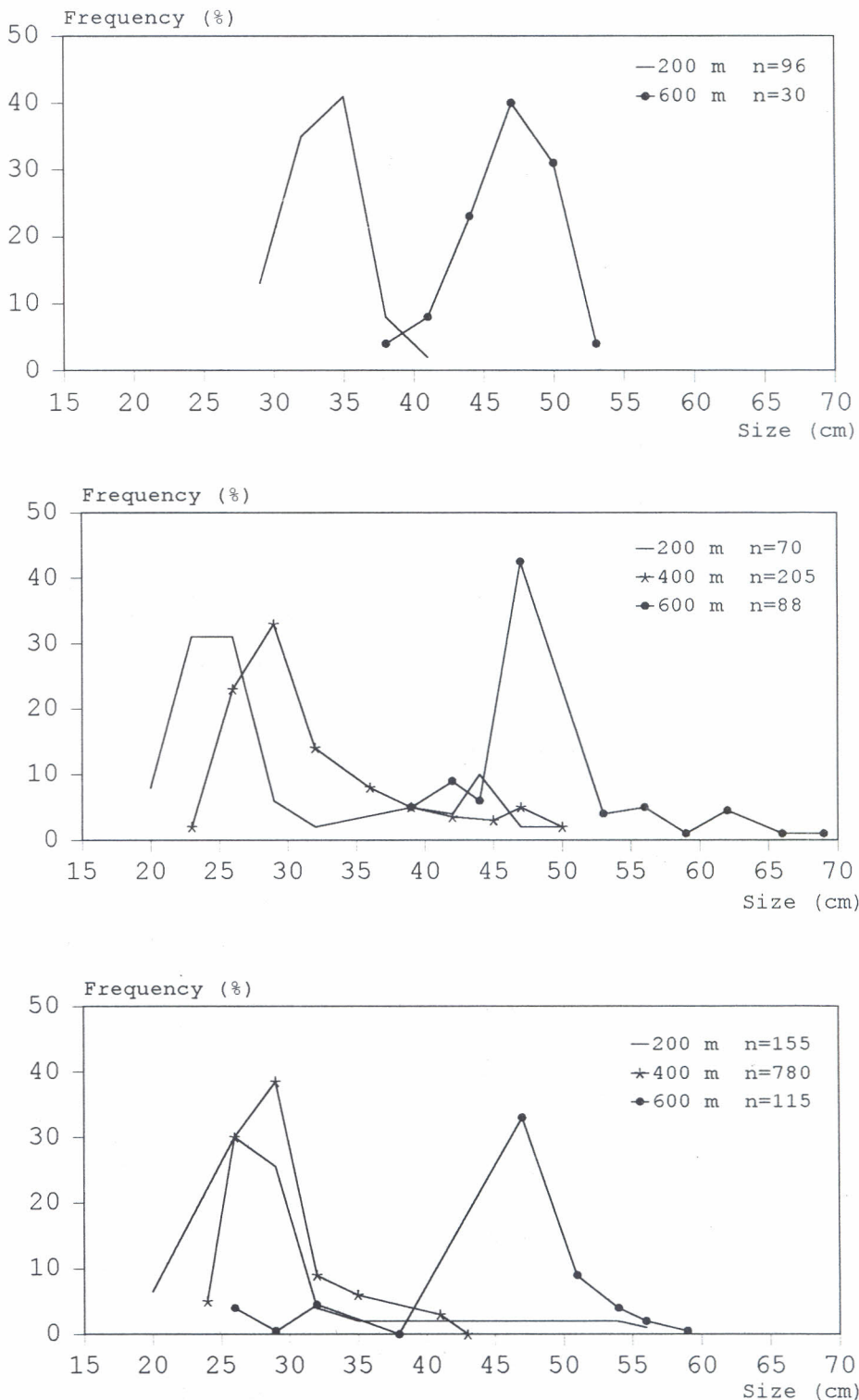


Figure 5. Size distribution of *Merluccius* spp. by zone and depth in the Mauritanian EEZ, March 1982 (redrawn from Overko, Boukatine and Ly, 1986)

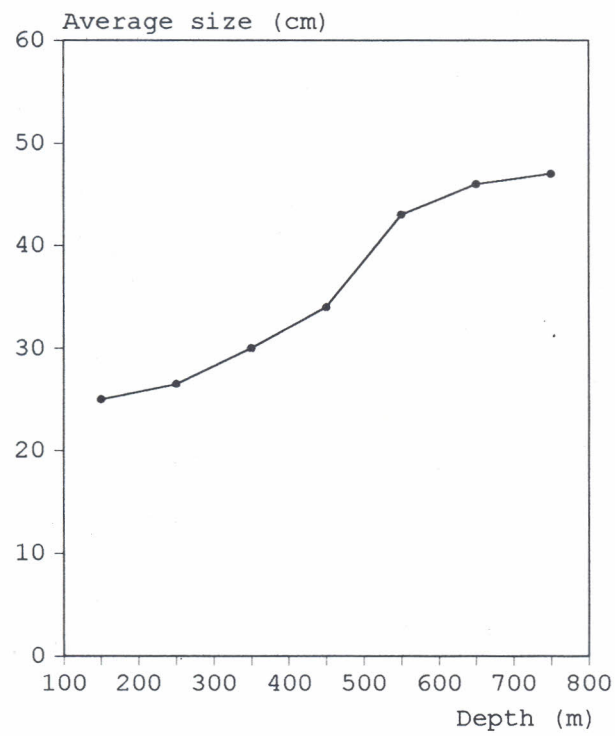
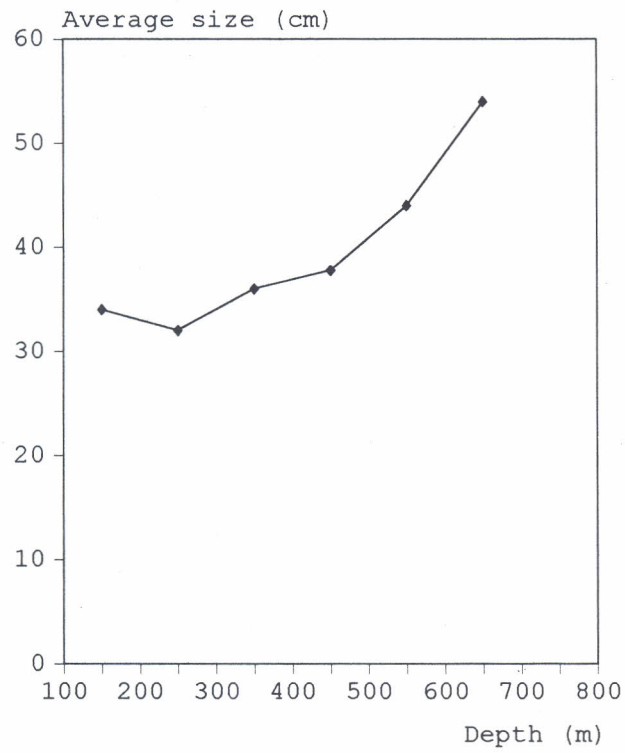


Figure 6. Distribution of average size by depth of black hake in Senegalese waters: (top) Senegalese hake and (bottom) Benguela hake (redrawn from Caverivière et al., 1986)

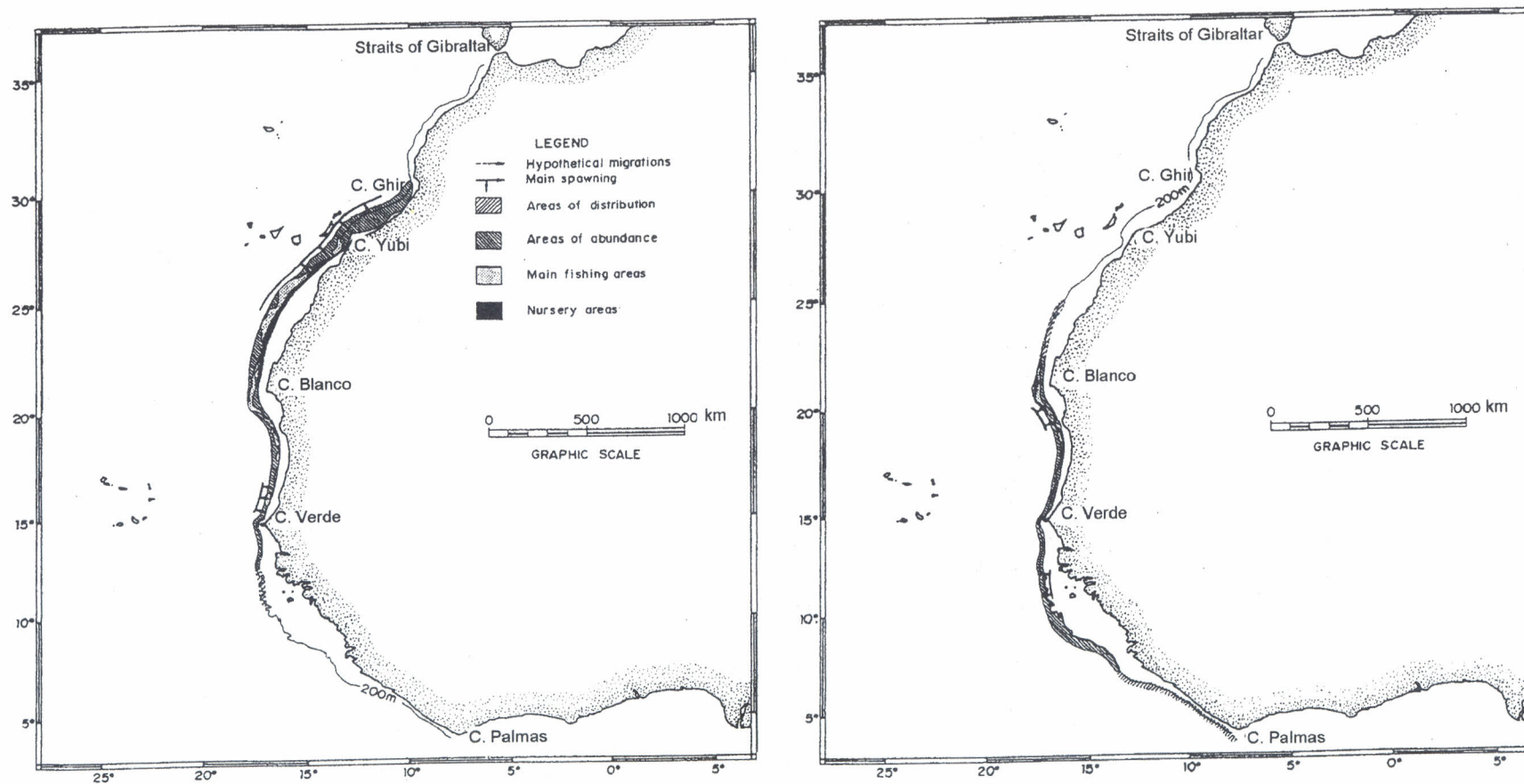


Figure 7. Spawning zone distribution of Senegalese and Benguela hake on the northwest African coast (redrawn from García, 1982)

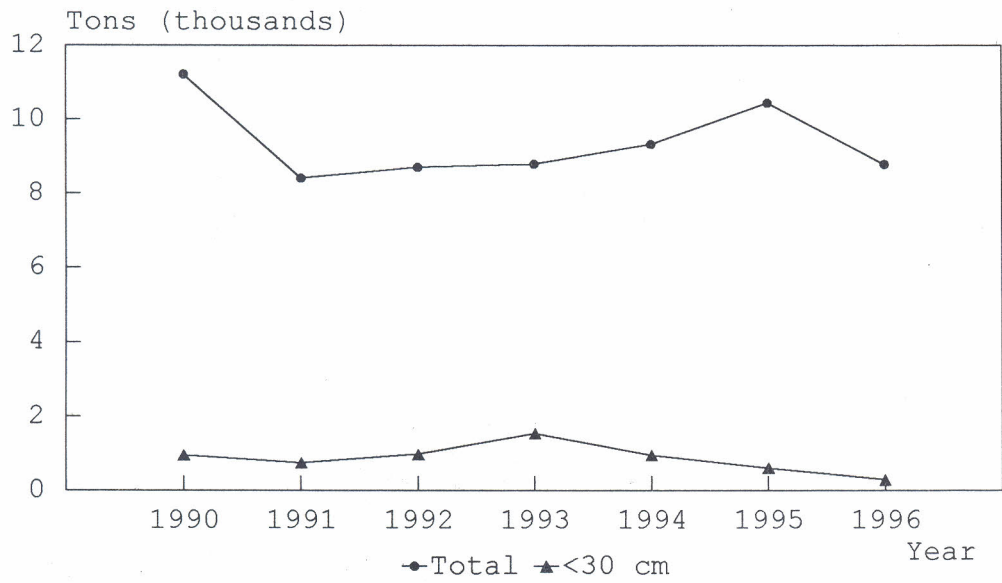


Figure 8. Evolution of black hake catches (total and individuals smaller than 30 cm), 1990-1996

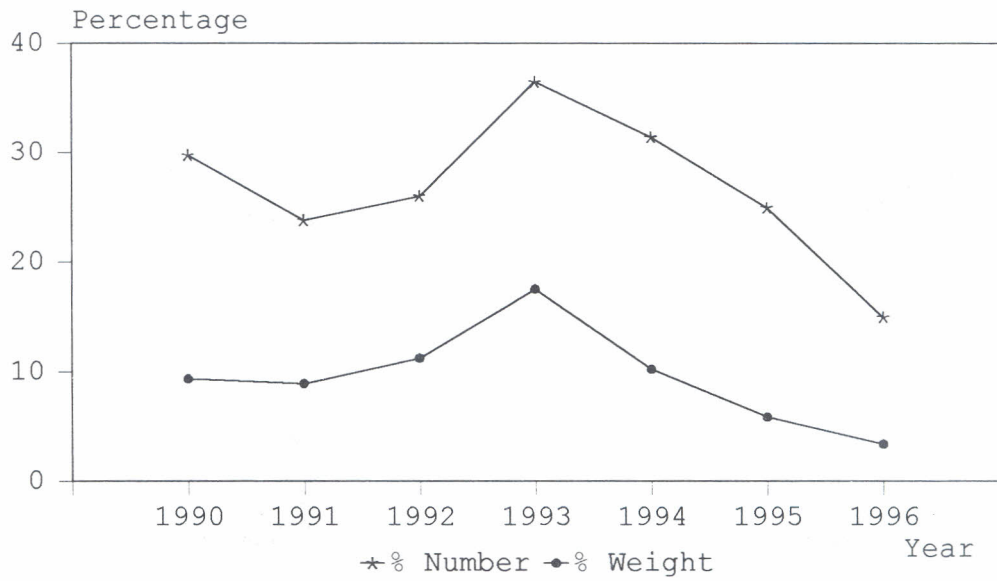


Figure 9. Evolution of percentage, in terms of weight and number, of individuals smaller than 30 cm in the total of black hake catches, 1990-1996

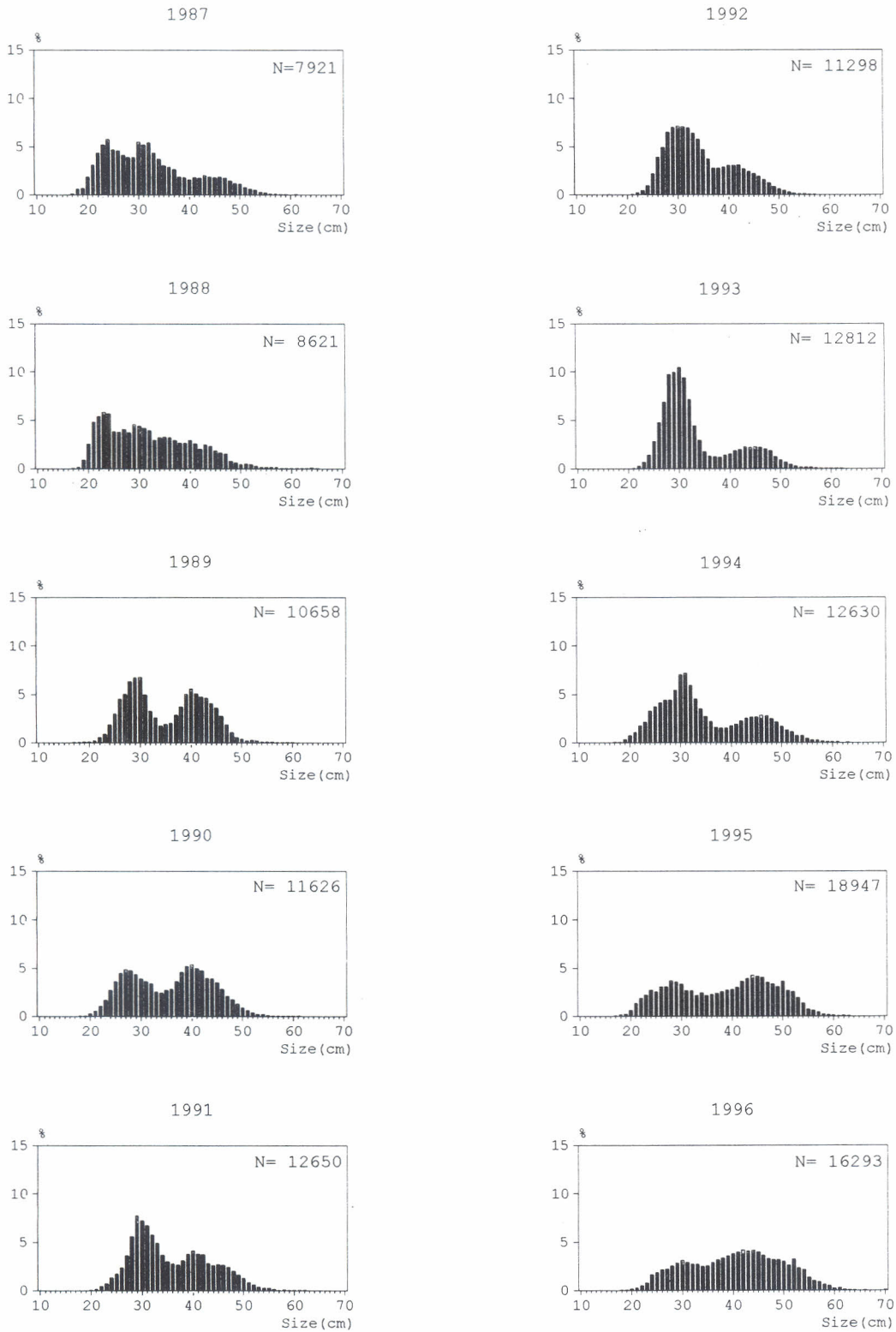


Figure 10. Annual size distribution of *Merluccius* spp. (Senegalese and Benguela hake) caught in Mauritanian waters, 1987-1996

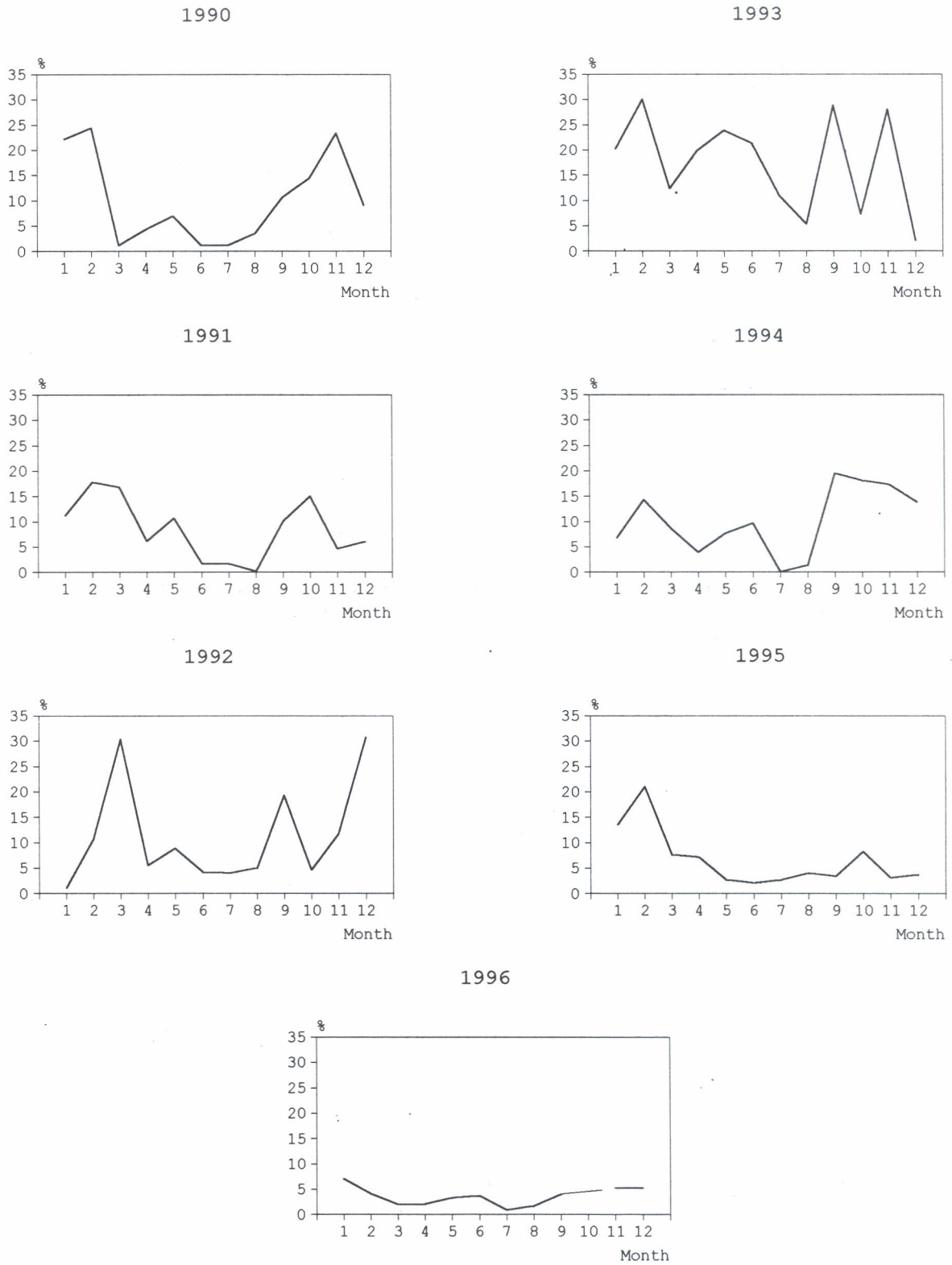


Figure 11. Monthly evolution of weight percentage of individuals smaller than 30 cm in 1990-1996 landings

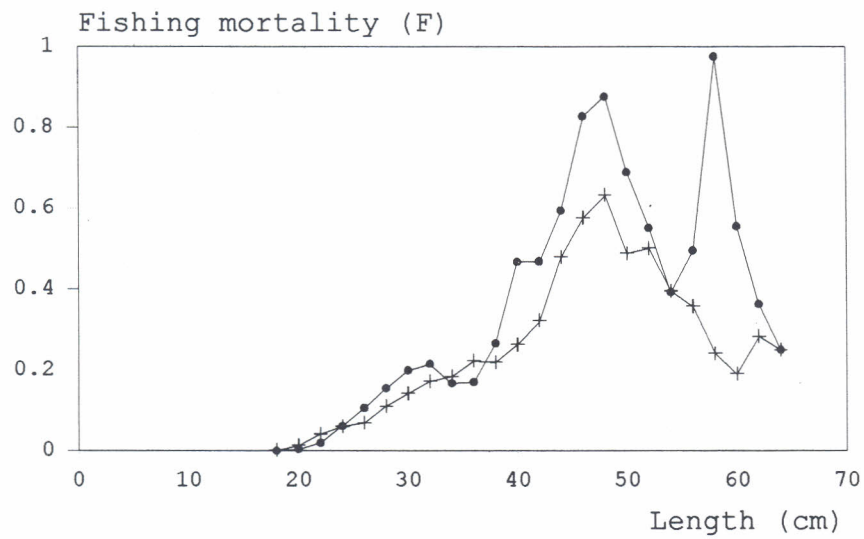


Figure 12. Fishing mortality by size classes of Senegalese and Benguela hake during 1983-1985 (●) and 1986-1988 (+) (in Ramos and Fernández, 1995; from Anon., 1990a)

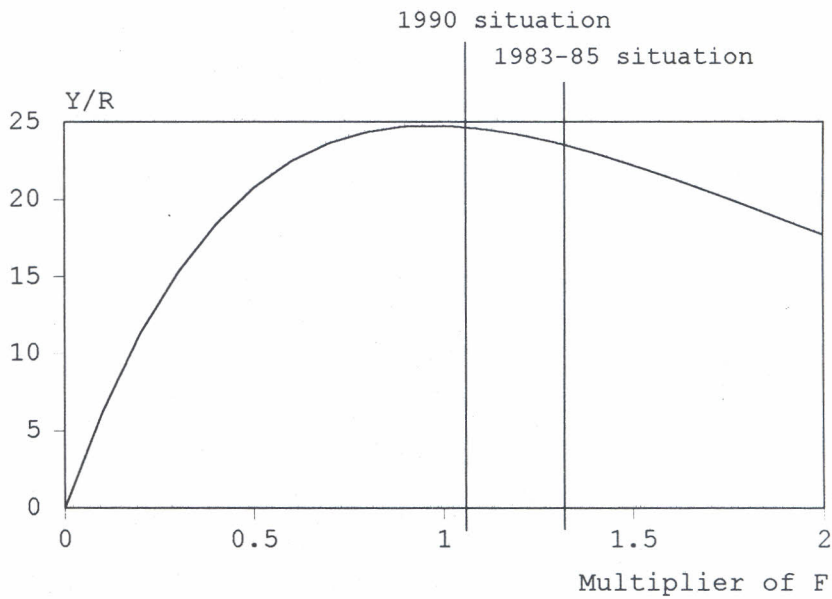
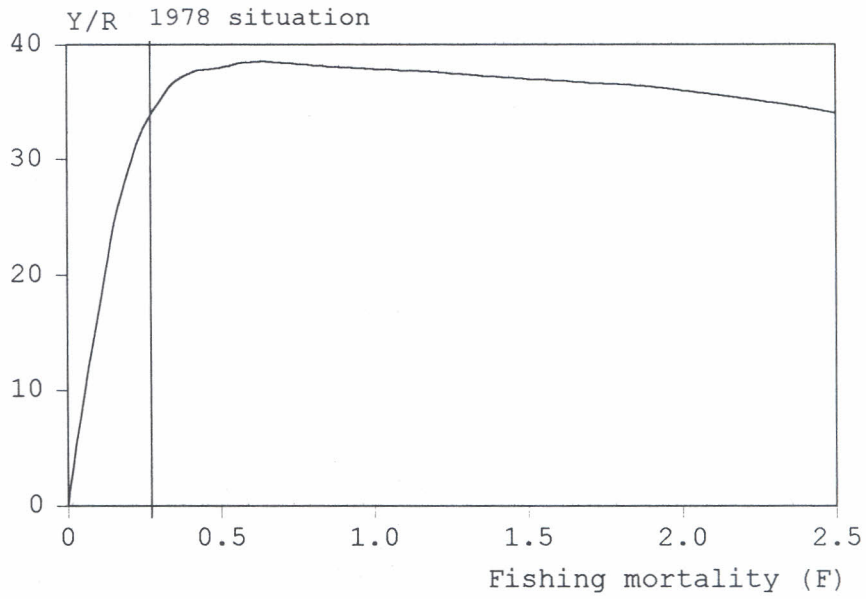


Figure 13. Relationships between yield per recruit and fishing mortality rate for Senegalese and Benguela hake in the 1978 (top) and 1990 (bottom) assessments (from Anonymous, 1978, 1990a)

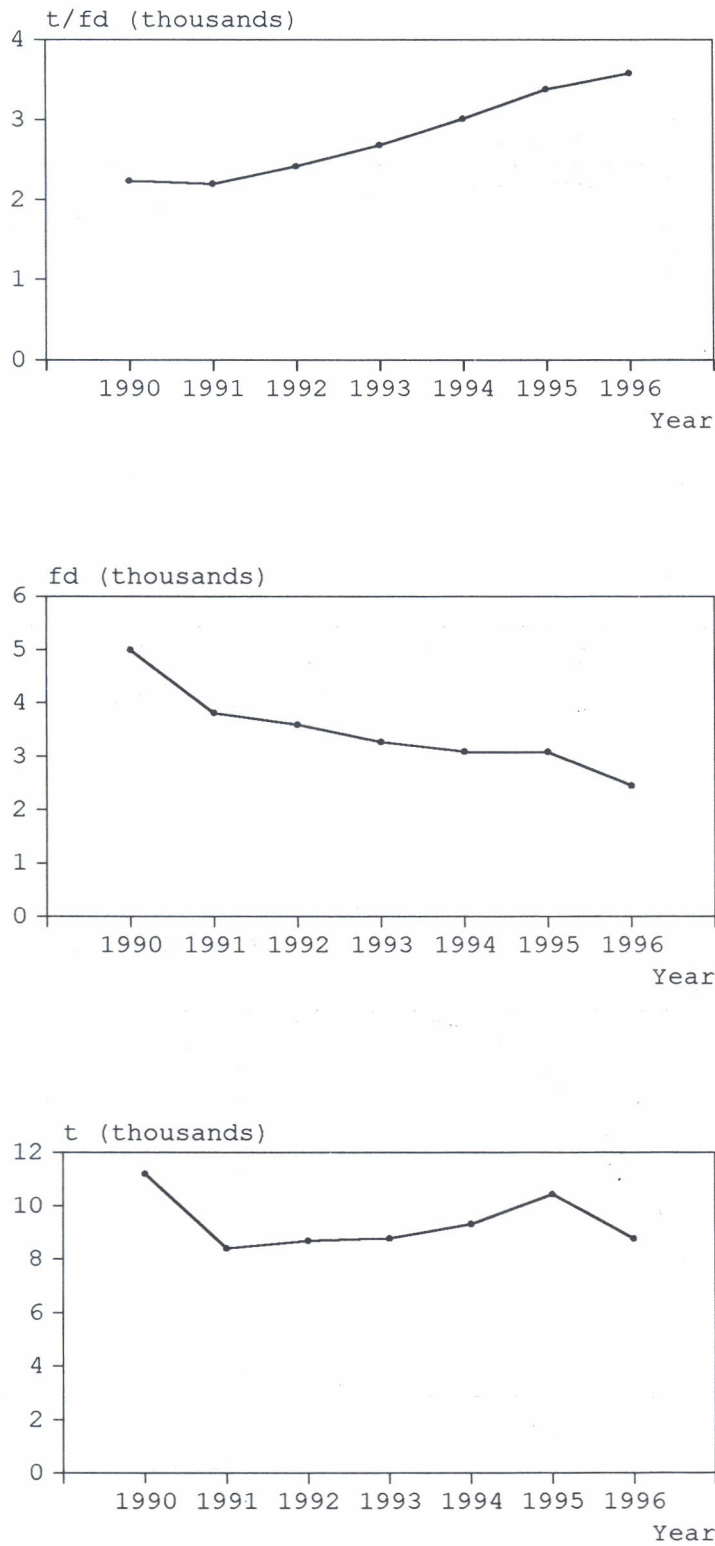


Figure 14. Effort, catch and yield evolution of the black hake trawler fleet, 1990-1996 (fd = fishing day)

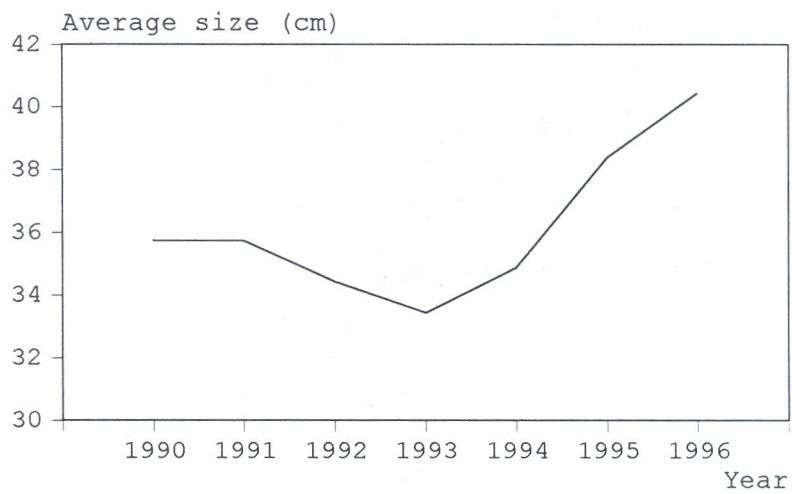


Figure 15. Evolution of the average size of black hake caught by the Spanish trawler fleet in the Mauritanian EEZ, 1990-1996

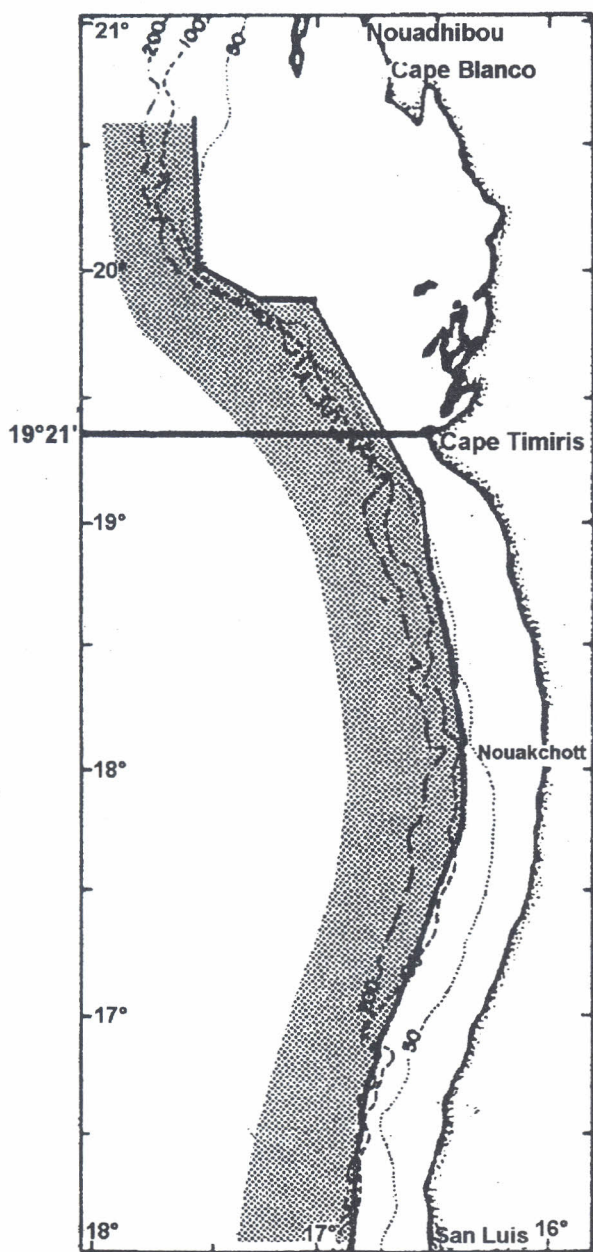


Figure 16. Fishing area of the Spanish trawler fleet in the Mauritanian EEZ (from Ramos and Fernández, 1992)

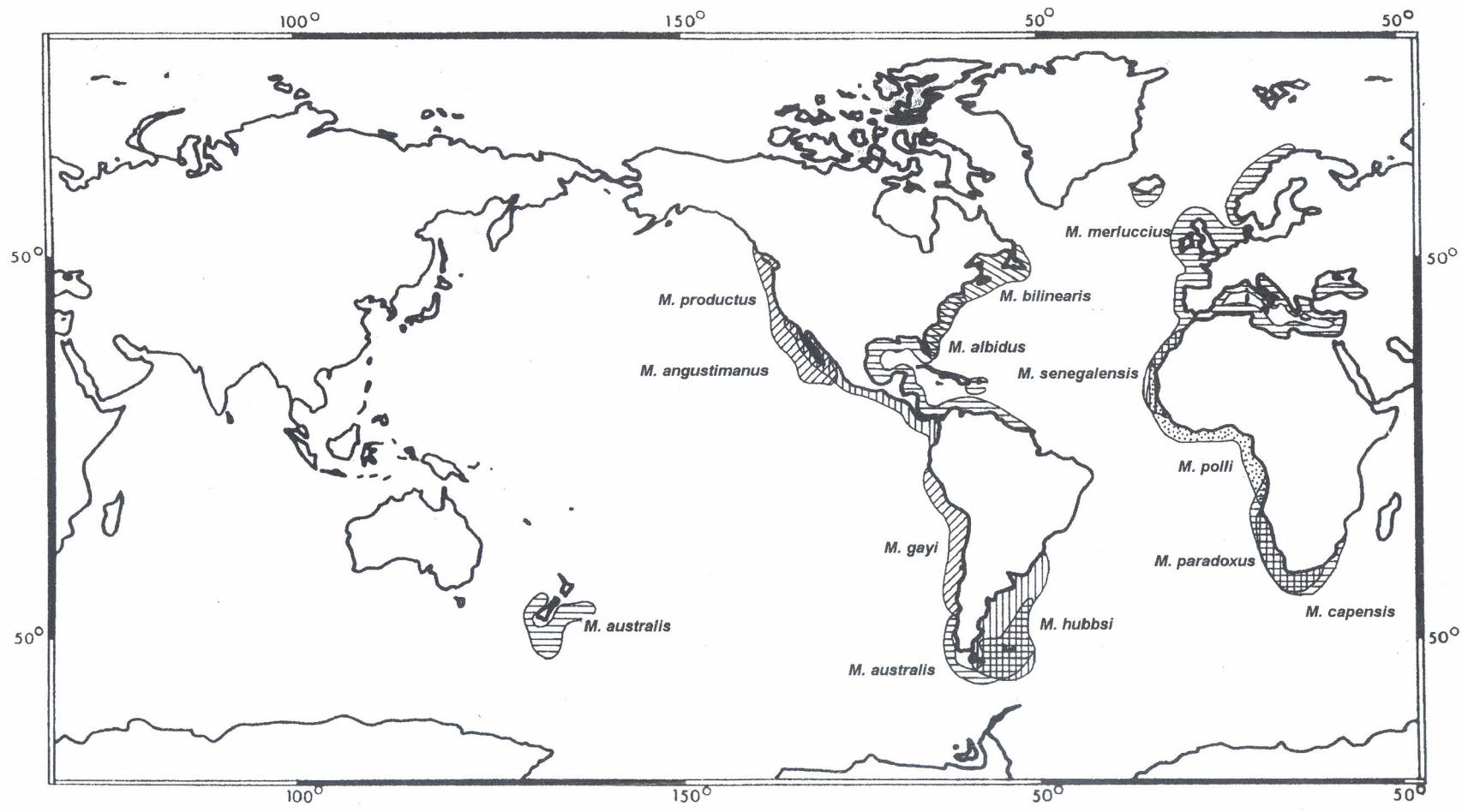


Figure 17. World distribution of the major hake species

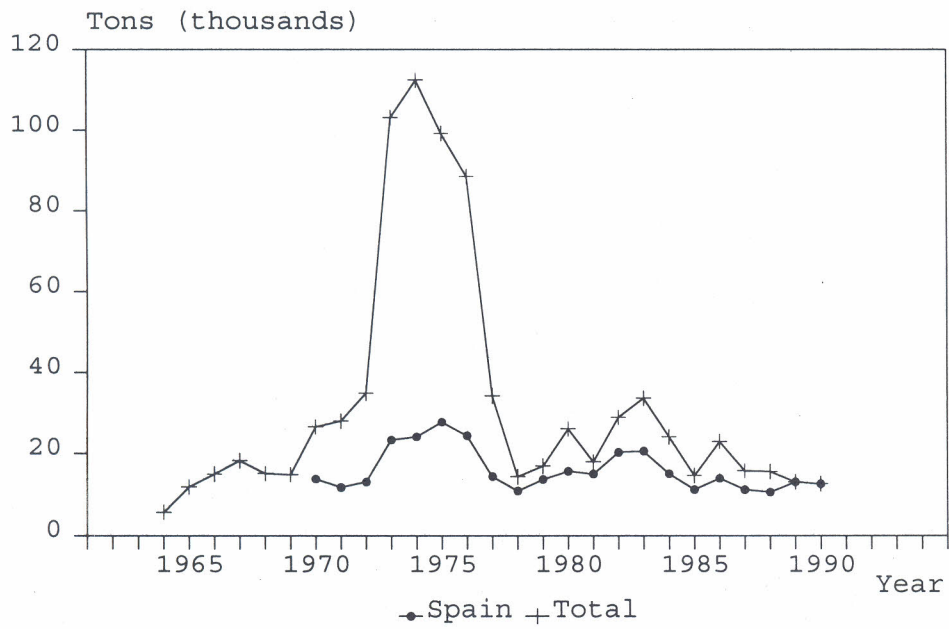


Figure 18. Historical catch series of Senegalese and Benguela hake, from Spanish trawler fleet (dots)(•) and total fisheries (+) in the North CECAF area (from Ramos and Fernández, 1992)



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