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The demersal fisheries of Mauritania in 2003: description of the fleets and assessment of resources

First report of a joint IMROP/RIVO project

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Abstract

Demersal fisheries in the Mauritanian Exclusive Economic Zone (EEZ) are described, with a review of the state of the stocks that are exploited by these fisheries. First a review is presented of the different sources of information on Mauritanian demersal fishery that were used for this report. Next we describe the various fleets that exploit the demersal resources of Mauritania. These are the octopus fleet, the shrimp fleet, the hake fleet, the roundfish fleet, and the artisanal fleet. The report also considers the pelagic fleet because of by-catch of demersal species by this fleet. A comparison of the catches taken by boats operating under different types of licenses demonstrates that within a certain fleet, there is little difference between the catch composition of a vessel using a national license and a vessel under foreign license. The octopus fleet has the most diverse catch. A comparison between logbook data and data collected by observers on board shows that considerable discarding occurs in the octopus fleet, the shrimp fleet and the hake fleet. For the artisanal fleet, data on fishing effort and catches are presented. The artisanal fleet consists of a number of sectors, each targeting a different group of species. However, artisanal fishermen are flexible, and they can rapidly change from one type of fishery to another, depending on market demand.

The assessment of the various stocks is based primarily on the results of the “Groupe de Travail” (GT), held in December 2002 at the Mauritanian fisheries research institute IMROP, Nouadhibou. Octopus stock assessment was recalculated using new data for 2002. The results of the CECAF working group on demersal stocks in Conakry, September 2003, are included and discussed.

The conclusions of these assessments are that the octopus stock in the Mauritanian EEZ is overexploited and that fishing effort is about 30% above the optimum level. Shrimps appear to be exploited near their maximum level. Fishing mortality on hake should be reduced, and the fishing effort in the round fish fleet should not be further increased.

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1. Introduction

This report has been prepared in the framework of the joint IMROP-RIVO demersal project. This is a three-year joint enterprise by the Mauritanian fisheries research institute IMROP and its Dutch sister-institute RIVO. The objective of the project is twofold: (1) to assess demersal resources of Mauritania using existing information, and (2) to collect new information that is needed to increase the accuracy of current assessments. The project is sponsored by the Netherlands Ministry of Foreign Affairs (North Africa and Middle East Department). It started in June 2003 and it is scheduled to last until May 2006.

The demersal project is one out of four bilateral projects between Mauritania and the Netherlands that are sponsored by the Dutch government. The other projects in the framework of this cooperation are aimed at assessment of small pelagics, application of remote sensing data and the prevention of by-catches of protected species. These three projects started in 2001 and are scheduled to last until December 2004.

One of the outputs of the demersal project will be a series of annual reports, presenting updates of stock assessment for the various demersal resources of Mauritania. These include octopus, shrimps, and various finfish species. The current report is the first in this series. It presents assessments based on catch and survey data up to and including 2002.

The preparation of the present report has been facilitated by the availability of a large amount of data, prepared by IMROP for the “Groupe de Travail” in December 2002 (GT 2002). This meeting brought together a large number of scientists from Mauritania as well as from foreign countries. The assessments performed by this working group can be considered as the current “state of the art” in assessment of Mauritanian fish stocks. The present report has borrowed heavily from the work produced by the December 2002 working group. However, the assessments made by this Working Group have been refined by a wider exploitation of observer data and the addition of catch and effort data for 2002.

The report starts with a description of the various data sources that have been used for the description of the fisheries and the assessment of the various species. Then there is a chapter with a description of the various fleets that operate in Mauritanian waters. These fleets are defined by the type of license under which they operate. This section shows the catches of the target species in each fleet, as well as the catch of auxiliary species. The level of interaction between the different segments of the demersal fishery is analysed in chapter 4. The next chapter deals with stock assessment of the main demersal species in. It estimates the fishing pressure on each species, and its position on the scale from lightly exploited to over-exploited.

2. Data available

Data have been derived mainly from the IMROP statistical database. For the industrial fleets, these are based on logbooks submitted to the Surveillance de Pêche and on observer data collected in the framework of the existing RIM-EU fisheries agreement.

A second source of information on the industrial fishery was the annual list of vessels operating in Mauritanian waters, provided by the Surveillance de Pêche. From this source, statistics on the number and type of licenses issued each year to each vessel were obtained.

For the artisanal landings, data were based on surveys by IMROP.

Most historic data series have been taken from the report of the GT in December 2002. These series have been updated by new data for 2002, provided by IMROP. The information used by the GT 2002 also contained data provided by the Instituto Espanol de Oceanografia (IEO) on landings in Las Palmas of catches taken by Spanish vessels in Mauritania.

In this section, a brief review is presented of the various types of data, their origin and their quality.

2.1. Logbook data

Logbook data are the main source of information on the Mauritanian fishery. An elaborate system of logbooks has been in operation since 1991, and each fishing vessel (except the canoes) is obliged to keep these logbooks. Until 1994 the coverage was not complete, particularly for the EU vessels. However, starting from 1995 there is agreement between the logbook data and landing statistics provided by the Mauritanian producer's organisation SMCP. This indicates that from this time onwards, logbook statistics cover more or less the entire industrial fleet.

For each trip, the logbook contains information on:

- type of license(s)
- type of fishing gear
- details of the vessel

Daily entries are made concerning:

- statistical rectangle
- number of fishing hours
- total catches, split into the following categories:

horse mackerel	red snapper	Carabineros
pilchard	squid	other shrimp species
sardinella	cuttlefish	Germon
anchovy	octopus	other crustaceans
mackerel	shrimps	rape
hairtail	lobster	other fish
tunas	gamba	other cephalopods
hake	Alistado	Various shellfish

The logbooks are submitted directly by the vessels to the inspection service. Here the data are computerised, and a copy of the data files is made available to IMROP. The data are loaded directly into the database of IMROP, without further quality control. Data analysis by IMROP includes aggregation of data by vessel type, license category, and statistical area. The absence of quality control before entering the data into the IMROP data base must result in a certain number of errors. Some of these are detected when working with the data, such as for instance errors in the name of the vessel, country of origin, and type of license. Other errors, such as incorrect quantities of catch, cannot be corrected at a later stage.

2.2. Observer data

Within the framework of the EU-Mauritania fisheries agreement, an observer programme on board EU vessels was initiated in 1996. Under this programme, some 30 observers were recruited that were assigned either inspection tasks or scientific tasks. The observers had to collect information on catch composition, discards, and biological parameters. The programme is managed by the inspection service ("Surveillance de Pêche"). Coverage of the catches by observers varied according to type of vessel, season, and year. A summary of the number of trips covered by fleet and by years is presented in the text table below.

	1996	1997	1998	1999	2000	2001	2002
octopus	3	11	19	22	15	8	13
roundfish		4		1	4	2	2
hake	15	44	18	24	15	6	6
shrimp		8	4	2	4	2	3

In recent years, sampling has been directed mainly towards the octopus fleet whereas the coverage of the other fleets has declined. It is not clear what the cause of this change has been. The observers take samples of the unsorted catch and record in detail the species composition of the sample. They also take length measurements of a number of species. They record their data on log sheets that are deposited at IMROP. Here the data are computerised and stored in a database.

The observer database contains an impressive amount of information that so far has been used only to a limited extent. For the preparation of this report, extensive use was made of this database. During the analysis of the data, the following problems were encountered:

- The weight of all the fish in a sample often does not correspond with the total weight of the sample.
- The sampling seems to be biased as regards time of day. The observers apparently sampled only daytime hauls. During daytime, the vessels tend to work offshore in deeper waters, whereas during night the boats fish closer inshore for shallow-water shrimps. The samples collected by the observers will thus give a biased picture of total catch composition during the trip.
- Numerous errors were encountered in the data entry, such as for instance in the name of the fishing gear. It is suspected that other errors have been made as well, which cannot be corrected at a later stage.

These problems are partly related to the fact that the observer programme is managed by the inspection service and not by IMROP. Therefore, IMROP has only limited control over the work of the observers. As a consequence, scientific supervision of the work by IMROP and quality control of the data before computerisation has been limited.

2.3. Data collected during research vessel cruises

Data were available from cruises by Mauritanian research vessels during the period 1982-2002. The information collected during these cruises consists of abundance indices for a large number of species. This material was analysed extensively during the December 2002 Working Group.

2.4. Data originating from the Spanish research institute IEO

For the GT 2002, the Spanish institute IEO provided detailed data on shrimp, hake and octopus landings by Spanish vessels in Las Palmas. During a working group meeting in August 2003 in Malaga, IEO further provided detailed data on the hake fishery by Spanish vessels in Mauritania.

2.5. Other data sources

Some information on the actual size of the landings may be also derived from a number of other sources, such as the Mauritanian producer's organisation SMCP, custom declarations, and sanitary health declarations issued by the IMROP department on fish processing and sanitary inspection (DVIS). This information, however, is scattered and incomplete. For the purpose of the present report, these additional sources of information were not utilised.

3. Description of the fisheries

This chapter starts with a definition of the various fleets that are considered (section 3.1). Then in section 3.2 an overview is presented of the various fleets, based on data collected by the observers. Finally, each fleet is described in more detail in separate sections (sections 3.3 to 3.7).

3.1. General overview of the various fleets

The demersal fisheries of Mauritania consist of a number of different fleets, operating under different licences, and catching a number of different species. A description of the fisheries may be based either on fleets, licence categories, or species. Following the approach taken by the GT 2002, we have chosen for a classification based on fleets and licence categories. This description illustrates the complexity of the demersal fisheries in Mauritania, and the need to control fishing effort by concerted actions affecting different segments of the fishery.

The following fleet segments are distinguished:

Fleet type	Flag	Type of licence
Octopus fleet	Foreign	LD
	National	AD, ND
Shrimp fleet	Foreign	LV
	National	AV, NV
Hake fleet	Foreign	LM
	National	NM, AM
Pelagic fleet	Foreign	AP, NP, LP
Roundfish fleet	Foreign	LG, LH
	National	AE, NE
Artisanal fleet	National	

L = foreign owner, N= national owner, A = joint venture, D = demersal, P = pelagic, V = crustaceans except for lobster, G = demersal fish except hake, M = hake, H = deep water demersal fish, L = lobster, E = demersal fish (only used in combination with a national license).

The license code consists of two letters: indicating the type of ownership and type of fishery, respectively. Most of the vessels in a particular fleet hold only one license during the whole year (for instance foreign octopus vessels normally hold only a license LD). However, the licenses are renewed each quarter, and some vessels switch license from one quarter to another. In this case, they are categorised according to the license they have used most of the year. The number of vessels changing license during the year is very limited.

In this report, catches and effort have been split into the categories “national” and “foreign” on the basis of the type of license. Foreign licenses are held by vessels that are owned by foreign companies, land their catches in Las Palmas, and operate under a foreign flag (occasionally under Mauritanian flag). With a few minor exceptions, all demersal trawlers in this category operate under the EU-Mauritanian fisheries agreement. The foreign octopus fleet has been 100% EU since 1998.

The “national fleet” comprises vessels that are owned either by Mauritanian companies (licenses starting with “N”) or by joint ventures (licenses starting with “A” for “affrèté). These vessels may operate under Mauritanian flag or under foreign flag, but their catches are always landed in Mauritania. In the Octopus fleet, a large number of Chinese vessels operated under joint ventures (license AD) until 1994. In 1995, these vessels changed ownership and became truly Mauritanian vessels (license ND). This change did not affect their way of operation.

Figure 1 shows the relative importance of each fleet in terms of landings of demersal fish. The catches of the pelagic fleet presented in this figure only refer to the by-catches of demersal fish taken by this fleet.

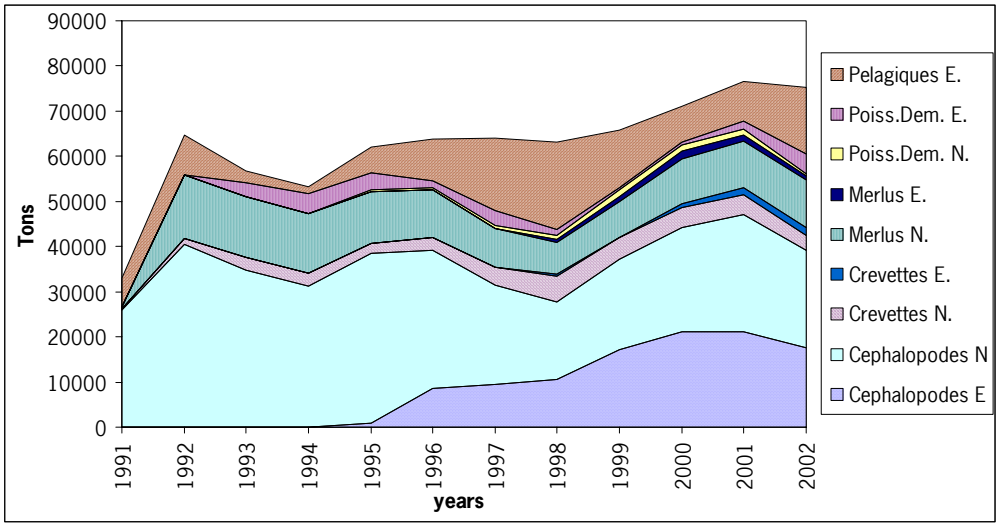


Figure 1. Landings of demersal species per fleet. Cephalopodes = octopus fleet; crevettes = shrimp fleet, merlus = hake fleet; Poiss.Dem = roundfish fleet; E = foreign fleet (European Union); N = national fleet.

Some small segments of the industrial fleet are not considered in this report. This concerns the vessels fishing specifically for crabs or for lobsters, and a small number of vessels classified as “others” or “unknown”. Each fleet catches not only its target species (e.g. octopus in the octopus fleet), but also a number of by-catch species. This aspect is further discussed in the next section (3.2). In sections 3.3-3.7 the various fleets are described, their fishing effort, catches and by-catches. The interactions between the various fleets are described in chapter 4.

3.2. Description of the fisheries according to observer data

This section presents an overview of the various fleets engaged in the demersal fishery. The overview is based on results of the observer programme. Observers record the precise composition of the catches at the moment the catch is taken on board, including the fraction that is later discarded. Therefore, observer data provide a more precise picture of the actual catches taken by each fleet than the logbook data. The latter refer only to the fraction of the catch that is landed, and they do not provide information on the species that are discarded. Besides, in the logbooks, only a limited number of species or groups of species are distinguished.

The observer database, consisting of material collected during the period 1996-2002, includes 523 different species or taxonomic groupings. It covers fleets with licenses of the type LD, LM, LV, LG, LH, and LP. Each of these fleets is considered below.

Fleet with license LD (octopus fleet)

Vessels operating under this license clearly target cephalopods (Figure 2). The contribution of cephalopods to the total catch, according to the observer data, varies around 40% during the period 1996-2002 (from 29% to 59%). Within this group, the octopus (*Octopus vulgaris*) makes up 83% of the total, followed at a large distance by the squid (*Loligo vulgaris*) and the cuttlefish (*Sepia officinalis*) which contribute respectively 7% and 5%. The decline of this group in recent years seems to be compensated by the demersal fish. This group consists mainly of Sparidae (22%), Merlucciidae (14%), Zeidae (10%), Uranoscopidae (8%), Ophidiidae (7%, mainly *Brotula barbata*), Scorpaenidae (5%) and Soleidae (4%, especially the genera Solea et Dicologoglossa). It is seen that pelagic fish make a contribution of about 15%. The most important species in this group are *Trachurus trecae* (31%), *Decapterus rhonchus* (26%), *Trachurus trachurus* (18%), *Scomber japonicus* (6%) and *Trichiurus lepturus* (4%).

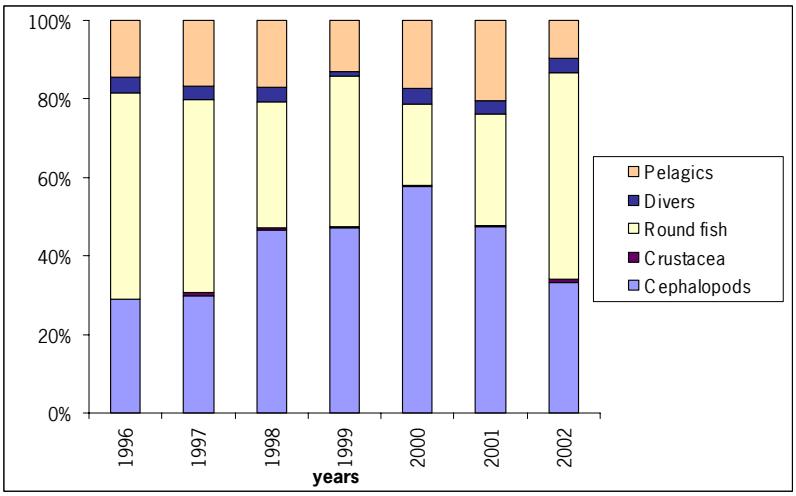


Figure 2. Catch composition fleet with license LD

Fleet with license LG or LH (roundfish fleet)

Vessels with these licenses do not show a sustained concentration on one group of species (Figure 3). They show a concentration on fish species, alternated with a concentration on cephalopods (as opposed to license LD). In 2002, crustaceans and the category “others” were important, whereas the cephalopods were hardly present anymore. The variations in degree of targeting on specific groups indicate a great flexibility in the orientation of this fleet to either octopus or coastal shrimps.

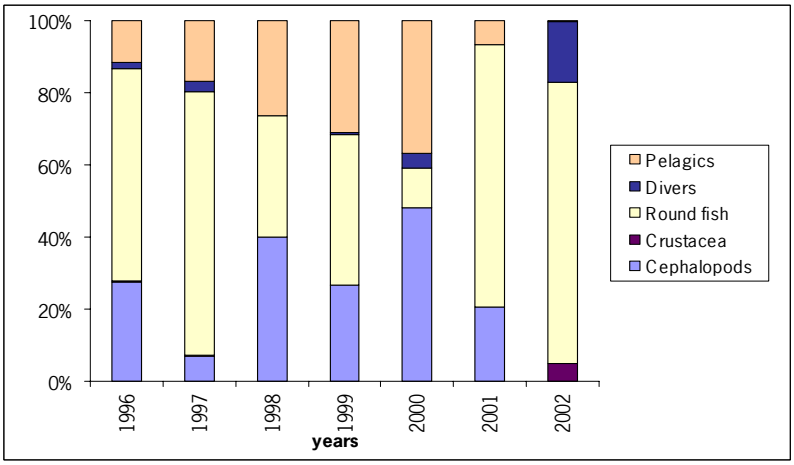


Figure 3. Catch composition fleet with license LG or LH

Fleet with license LV (shrimp fleet)

Vessels with this type of license have not been monitored in 2001 and the observations in 2002 are not consistent with those in the years prior to 2001 (Figure 4). In the period until the year 2000, the crustaceans contributed only 20% to the total catches, and the demersal fish more than 40%. The contribution of cephalopods is in the order of 6%, and this consists mainly of octopus (two-thirds), Sepeiidae (cuttlefish) and Lologinidae (squids). Pelagic fish consist mainly of Carangidae (horse mackerels), as in the case of licenses LD and LGLH.

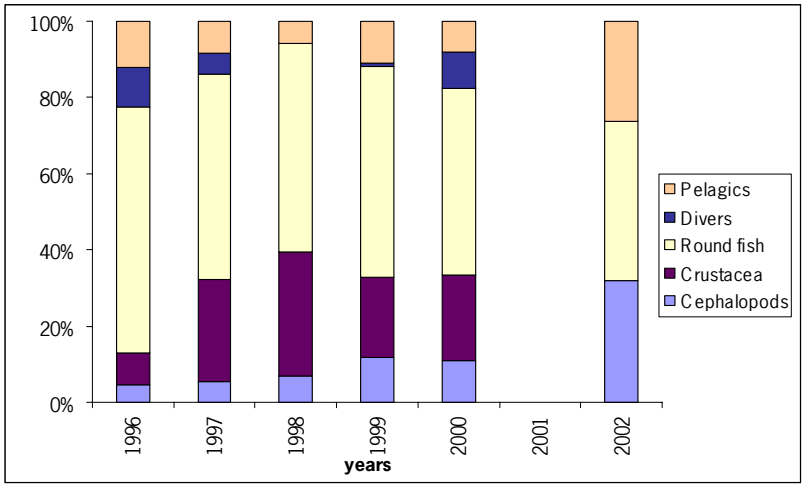


Figure 4. Catch composition fleet with license LV

Fleet with license LM (hake fleet)

A very strong dominance of demersal fish is observed in the total catches of these vessels (on average 92%, but with a value of 96% in 1999). This indicates a strong targeting on this group. Most of the demersal fish consist of hake. Shrimps constitute 4% on average during the whole period, but there is a downward trend since 1996 when this percentage was 29%. Cephalopods are poorly represented with only 1.36% of the total catch. They are composed of Ommastrephidae (63%), Octopodidae (26%) and Lologinidae (9%). Pelagic fish are also poorly represented with only 1.18%. They are mainly composed of Carangidae (83%), followed by Trichiuridae (8%) and Scombridae (7%).

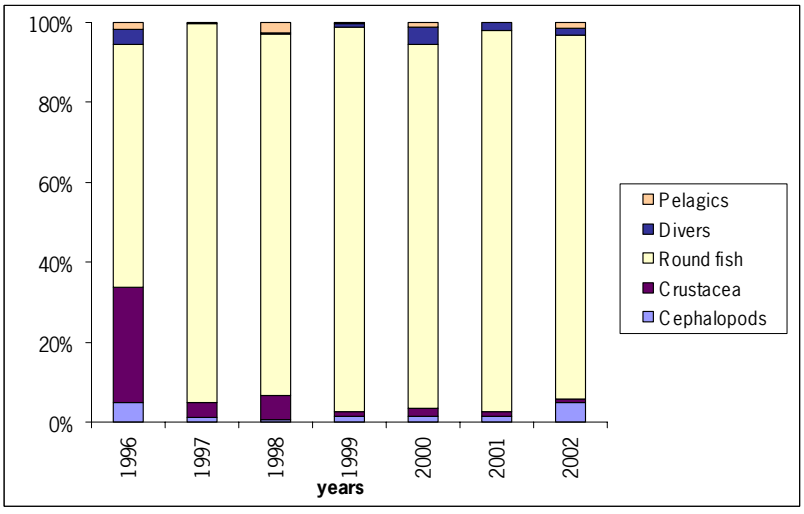


Figure 5. Catch composition fleet with license LM

Fleet with license LP (pelagic fleet)

The observer data only concern the EU-fleet (mainly Dutch), and they do not cover the remainder of the pelagic fleet (some 60 vessels) that operate under the flag of Russia and a number of other countries.

The observer data show a strong dominance of pelagic fish in the total catches (99%). Sardinella is the first species if the data for the whole period are considered, and it constitutes more than 80% of the total catch. However, a decline of this dominance is observed after 2000, and an increase in the families Carangidae and Scombidae (Figure 6).

Demersal fish contribute only 0.25% to the total catches. This group is represented by *Arius heudelotii* (24%) and *Sparus aurata* (12%). The sharks (*Mustelus*, *Leptocharias*, *Rhizoprionodon* and *Sphyrna*) contribute 12% to the catches of demersal species by vessels with a licenses LP. The cephalopods are very poorly represented (0.01%) and they consist mainly of Sepiidae and Loligonidae (and not of Octopodidae).

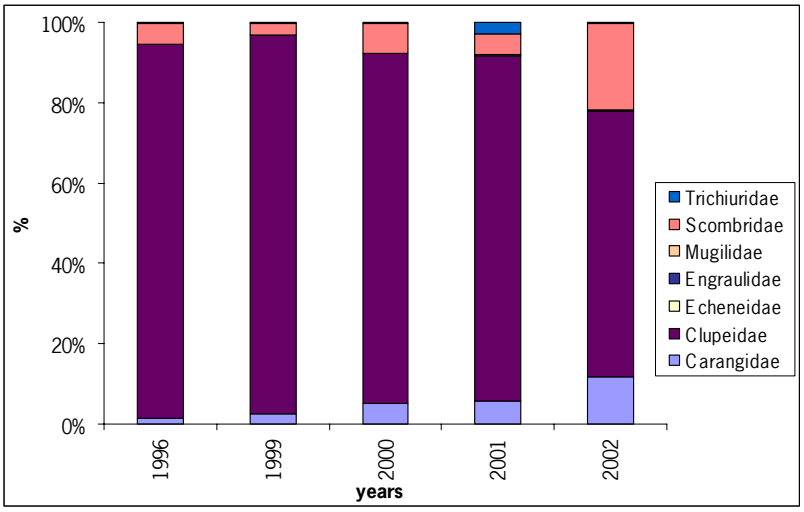


Figure 6. Catch composition fleet with license LP

3.3. The octopus fleet

3.3.1. Description of the fishery

The industrial fleet fishing for octopus can be divided into a national fleet and a foreign fleet. The national fleet consists of 125 trawlers of around 35 m. Most of these vessels are of Chinese origin, and they have a partly Chinese crew. They are owned, however, by Mauritanian companies. The octopus fishery in Mauritania was originally started by Japanese vessels in the 1960s. These vessels were replaced by Korean vessels starting from 1972, and by Mauritanian vessels from 1982 onwards. Chinese vessels started to operate in Mauritania in 1991. From 1995 onwards, all these vessels adopted the Mauritanian flag. The fleet operates from Nouadhibou, and the catches are landed either fresh or frozen. Most of the catches are taken in the area off Cap Blanc.

The foreign fleet consists of 65 vessels, on average slightly larger than the national vessels. The number of vessels registered in a given year does not accurate reflect fishing effort because some vessels work only for a short period during the year. Most of the ships fish under Spanish or Portuguese flag, and they all operate in the framework of the EU-Mauritanian fisheries agreement. The foreign trawlers operate from Las Palmas. Their catches are frozen on board and transhipped at sea.

The area of operation has changed over the years as a result of a development of fishing methods. The first trawlers that operated under Korean flag used to fish in inshore waters and they made short hauls of 1 – 1,5 hours. The Spanish trawlers that later joined the fishery, concentrated on the deeper areas, making longer hauls of about 3 hours. With the decreasing catch rates in coastal waters in recent years, Mauritanian vessels

have started to copy the Spanish fishing method, using longer fishing warps that allow them also to work in deeper water.

3.3.2. Fishing effort

The effort in the national fleet peaked in 1996 and then declined in 1998-1999 (Figure 7). This reduction was partly related to a reduction in catch rates of octopus, which forced ship owners to take some vessels temporarily out of operation. In addition, there was the withdrawal of some 30 Chinese vessels that left because of financial problems of the Chinese partners. Starting from 1995 the foreign (mainly EU) fleet started working in the area, and the effort of this fleet has steadily expanded.

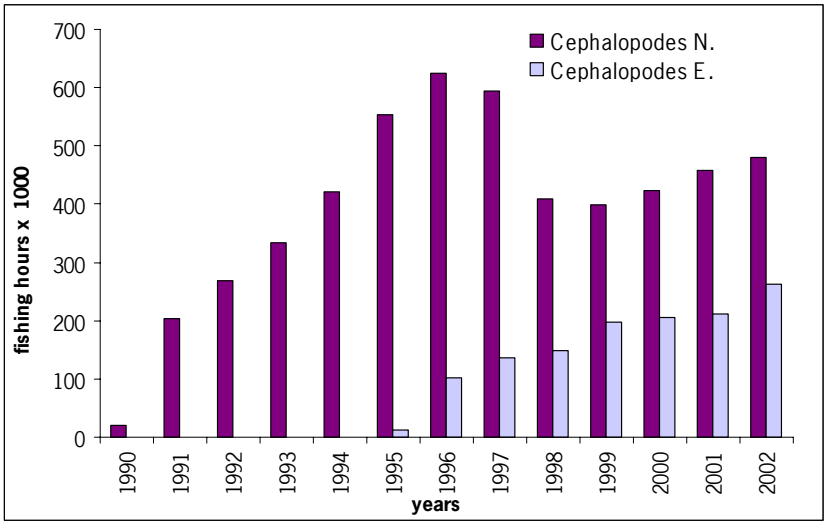


Figure 7. Fishing effort in the industrial fishery for octopus. Ceph N = national fleet, Ceph E = foreign (EU) fleet.

Catches per hour of octopus in the EU-fleet are on average 23% higher than those in the national fleet (logbook data for the period 1996 – 2002). Effort of the EU fleet can thus be converted into standard (national) fishing hours by raising them with 23%. Figure 8 shows the development of total effort in the combined industrial octopus fleet, expressed in standard fishing hours. It is seen that total effort, after a short dip in the years 1997-1999, has continued to rise in the latest years and reached a maximum of 800,000 standardised hours/year in 2002.

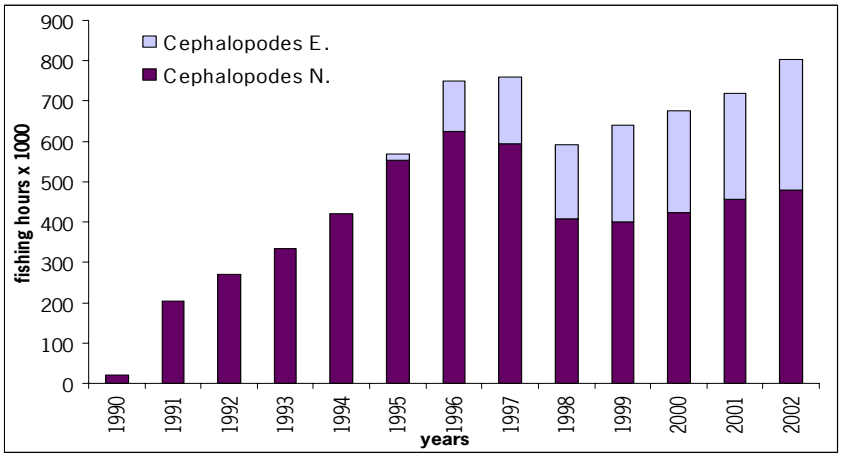


Figure 8. Total effort in the industrial fishery for octopus. Ceph N = national effort, Ceph E = foreign (EU) effort, corrected for fishing power.

3.3.3. Total landings of the industrial octopus fleet according to logbooks

The average percentage octopus in the landings is slightly higher for the national fleet (48% over 1996-2001) than for the foreign fleet (43% over the same period), although this percentage varies from year to year (Figures 9 and 10). For the year 2002 these figures are 45% and 35%. The landings of the foreign fleet in Las Palmas, therefore, contain a higher percentage of by-catch species than the landings of the national fleet in Nouadhibou. The difference in species composition of the landings is probably due to differences in market demand in the countries where the fish is landed. Apparently, the demand for by-catch species is higher in Las Palmas than in Nouadhibou, which stimulates the Spanish fisherman to either adapt their fishing strategy and catch more by-catch species, or else to retain more of the by-catch species on board.

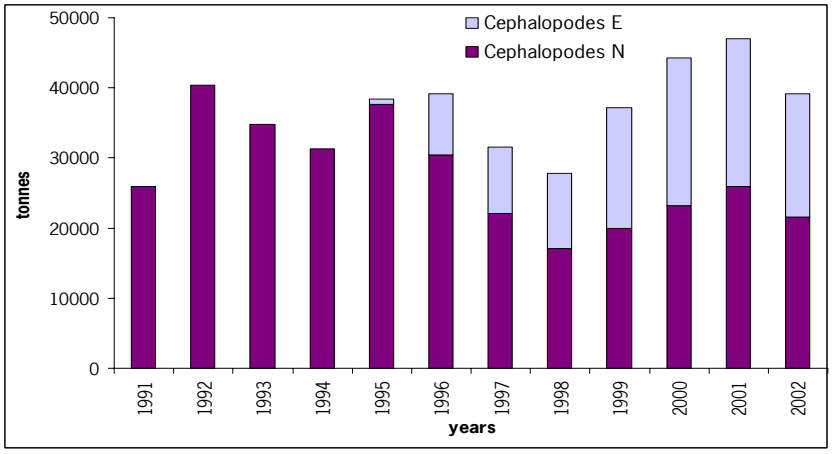


Figure 9. Total landings of cephalopods and other species of the octopus fleet.
N = national fleet, E = foreign (EU) fleet.

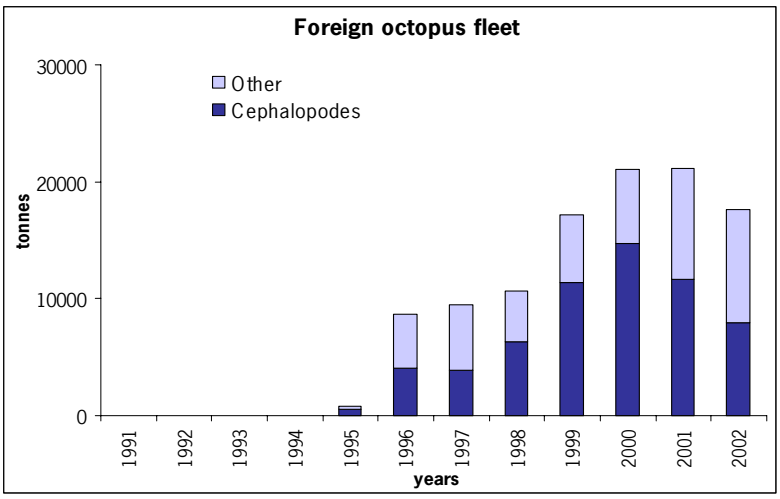


Figure 10a. Total landings of the industrial octopus fleet: foreign (EU).

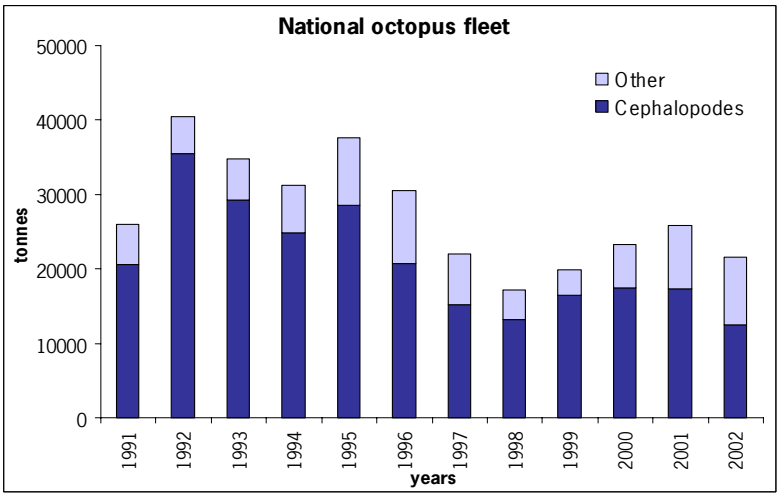


Figure 10b. Total landings of the industrial octopus fleet: national.

3.3.4. Species composition of the by-catches in the octopus fishery

By-catches in the octopus fishery consist of species that are retained on board and species that are discarded. The question which species are discarded depends on the type of vessel, the landing place and the size composition of the species concerned.

Information on by-catches in the octopus fishery is available from logbook data and from the observer programme on board EU-trawlers. In the logbook data, only a limited number of species categories are identified, whereas the observers identify all species in the catch.

Figure 11 presents a comparison of total catch composition, based on logbook data and observer data. The observer data are grouped into the same categories as the logbook data to allow a comparison between the two sets of data.

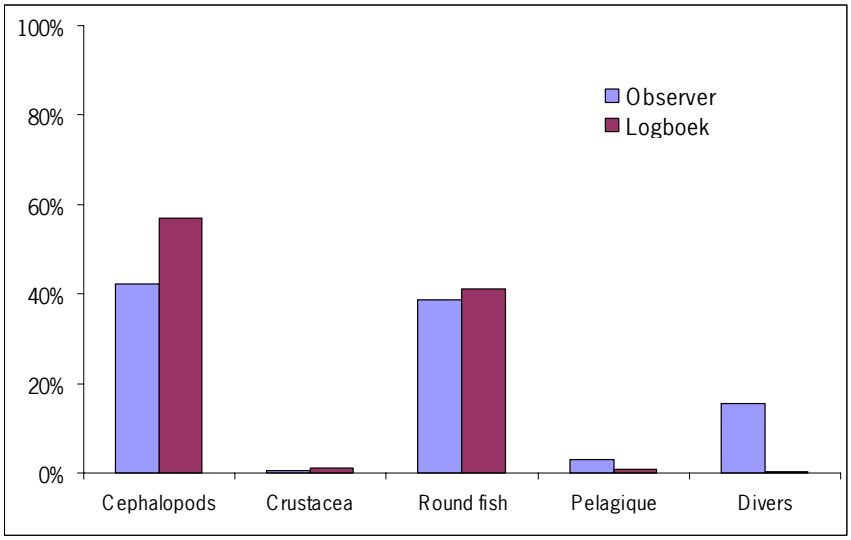


Figure 11. Mean catch composition of the foreign octopus fleet in 1996-2002. Logbook data compared with observer data.

The mean percentage of octopus in the observer data (42%) is lower than in the logbook data (58%). This difference is due to the fact that most pelagic species and fish in the category “others” are discarded. The percentage of the remaining commercial species will thus be higher in the landings (logbook data) than in the unsorted catch (observer data).

Observer data provide more detailed information on catch composition than the logbook data. The observers identify all species of fish (some 400 in total), whereas logbook data contain only 5 categories of fish. A more precise description of the species composition in the octopus fleet is presented in Annex 1 where the main 50 species in the catch (in terms of weight) are listed for the period 1996-2002

3.4. The shrimp fleet

3.4.1. Description of the fishery

The shrimp fishery in Mauritanian waters was started by Spanish trawlers in the 1960s. The boats operate from Las Palmas and freeze their catches at sea. The vessels tranship at sea, and make voyages of 4 - 6 weeks. The Spanish fleet presently consists of 31 vessels with an average length of 30 m. In addition to the Spanish fleet, the foreign fleet comprises 12 other vessels (from Portugal, Italy, Greece and others), which brings the total number of foreign shrimp trawlers at 43. Since 1999, the foreign fleet consists exclusively of trawlers from the EU. Starting from 1998, there has also been a rapid development of the national shrimp fishery.

Shrimps are caught both in shallow waters on the shelf and in deeper waters along the shelf edge. Catches in shallow waters consist of *Penaeus notialis* and *P. kerathurus* (both called Langostino), whereas catches along the shelf edge consist mainly of *Parapenaeus longirostris* (Gamba) and *Aristeus varidens* (Alistado). The shallow-water shrimps are exploited mainly between 19°00N and 20°00N, whereas the deep-water shrimp are mainly caught between 17°20N and 18°50N (Report IMROP GT 2002).

3.4.2. Fishing effort

The development of shrimp fishing effort during the last 12 years is shown in Figure 12. The effort in the EU-fleet increased until 1998 and has remained rather stable since (Figure 12). The national fleet started at a very low level around 1996, but has shown a substantial increase starting from 2000. In 2002 the effort of the national fleet jumped to a level of 140,000 hours, almost equal to that of the foreign fleet. The increased effort in 2002 was due to high catches/hour in the shrimp fishery, which stimulated octopus vessels to change license.

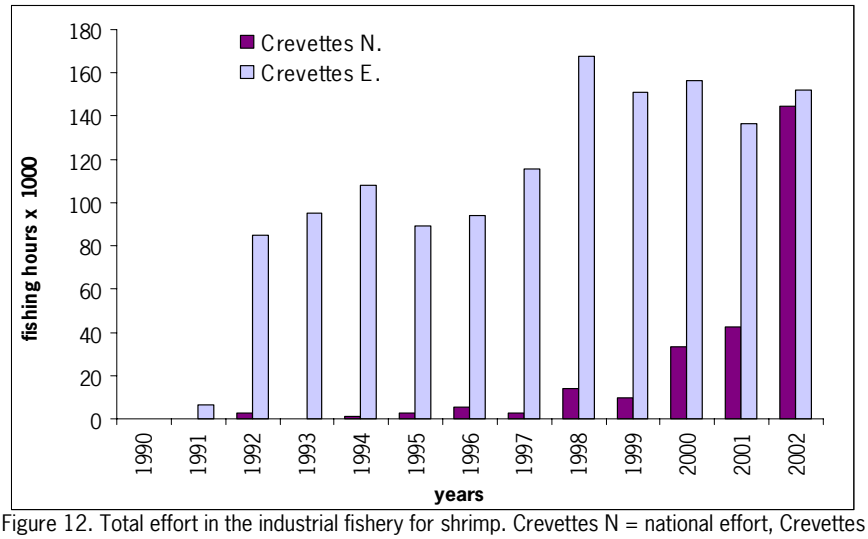


Figure 12. Total effort in the industrial fishery for shrimp. Crevettes N = national effort, Crevettes E = foreign (EU) effort, corrected for fishing power.

Total catches per hour of shrimp and by-catch species in the EU-fleet are 29% higher than those in the national fleet (logbook data for the period 1996 – 2001). Effort of the EU fleet has thus been converted into

standard (national) fishing hours by raising them with 29%. The combined effort in the entire shrimp fleet has been estimated by summing the national effort with the corrected foreign effort (Figure 13).

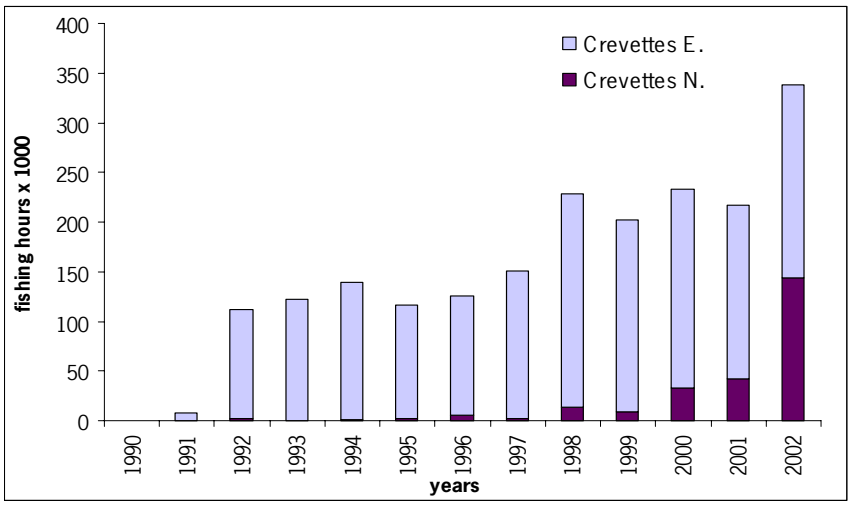


Figure 13. Total effort in the industrial fishery for octopus. Crevet N = national effort, Crevet E = foreign (EU) effort corrected for efficiency.

It is seen that the total effort in the shrimp fishery has steadily increased over the last decade, and particularly during the last year. The early increase was due to the expansion of the EU fleet, but the increase in 2002 was caused by a sudden expansion of the national shrimp fleet.

3.4.3. Total landings of the shrimp fleet according to logbooks

The catches of the shrimp fleet according to Mauritanian logbook statistics are presented in Figure 14 both for the EU fleet and for the Mauritanian fleet.

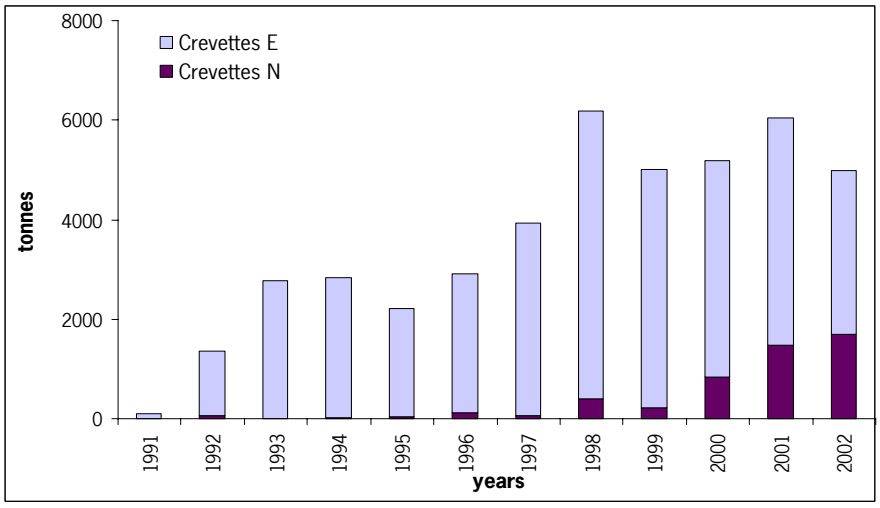


Figure 14. Total landings (shrimp + other species) of the shrimp fleet. Crevettes N = national fleet, Crevettes E = foreign (EU) fleet.

After a steady increase from 1991 tot 1998, catches stabilised at a level of 5,000 tons/year. The sharp increase in effort in 2002 did not result in a further increase in catches.

The landings of the shrimp fleet consist for about 20% of shrimps. The rest of the landings consist of by-catch species (see paragraph 3.2.4 below). The shrimp catches consist of a number of species, two of which are identified in the logbooks (Figure 15).

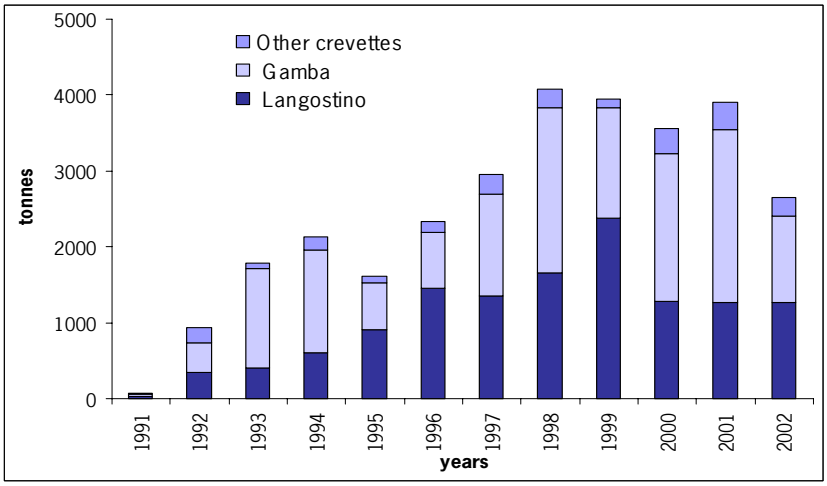


Figure 15. Shrimp catches EU fleet split into species according to logbooks

3.4.4. By-catches in the shrimp fishery

Information on by-catches in the shrimp fishery is available from logbook data and from the observer programme on board EU-trawlers. In the logbook data, only a limited number of species categories are identified, whereas the observers identify all species in the catch.

Figure 16 presents a comparison of total catch composition including by-catches, based on logbook data and observer data. The observer data are grouped into the same categories as the logbook data to allow a comparison between the two sets of data.

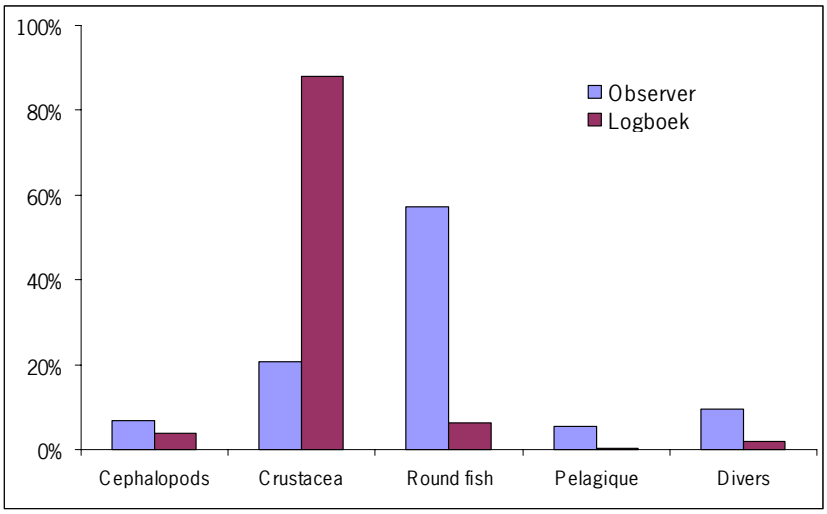


Figure 16. Mean catch composition of the foreign shrimp fleet 1996-2002. Logbook data compared with observer data.

It is seen that large differences exist between the logbook data and observer data. The landings according to the logbooks consist predominantly of shrimps, whereas the percentage of shrimp in the actual catches is relatively low according to the observer data. On the other hand, the catches contain substantial amounts of octopus, other cephalopods, hake and roundfish, which do not appear in the logbooks. Either these species are to a large extent discarded or they are under-reported in the logbooks. The observer data allow an even

finer split of by-catches. Annex 1 shows the percentage distribution (by weight) of the main 50 species in the catch during the period 1996-2002.

3.5. The hake fleet

3.5.1. Description of the fishery

The hake fishery in Mauritanian waters was started in the 1950s. At first, the fishery was conducted by trawlers from Russia, Romania, Spain and Portugal. In recent years, a national fleet has developed which is becoming increasingly important. In addition to the trawlers, a fleet of longliners, working under Spanish flag, has increased in recent years. The total fleet at the moment (2002) consists of 33 vessels, of which 29 operate under foreign (EU) flag. Hake is caught at depths ranging from 100-600m. During the cold season, the hake fleet operates between 19°00N and 17°00N. Starting from May, the hake migrates north, where they enter relatively shallower waters. From July to September, the fishery is concentrated north of 20°00N.

Two species of hake are caught in Mauritanian waters: *Merluccius senegalensis* and *Merluccius polli*. The first one is distributed mainly in waters of 150-400m depths, whereas *M. polli* is taken mainly at depths between 400-550m.

3.5.2. Fishing effort

Fishing effort by the foreign fleet decreased from about 90,000 hours per year in the early 1990s to less than 30,000 hours per year in 1998-99. During the last three years there has been an increase in fishing effort by the foreign fleet. (Figure 17). The national fleet started operating in 1998, but so far fishing effort in this segment has been low in comparison to the foreign fleet.

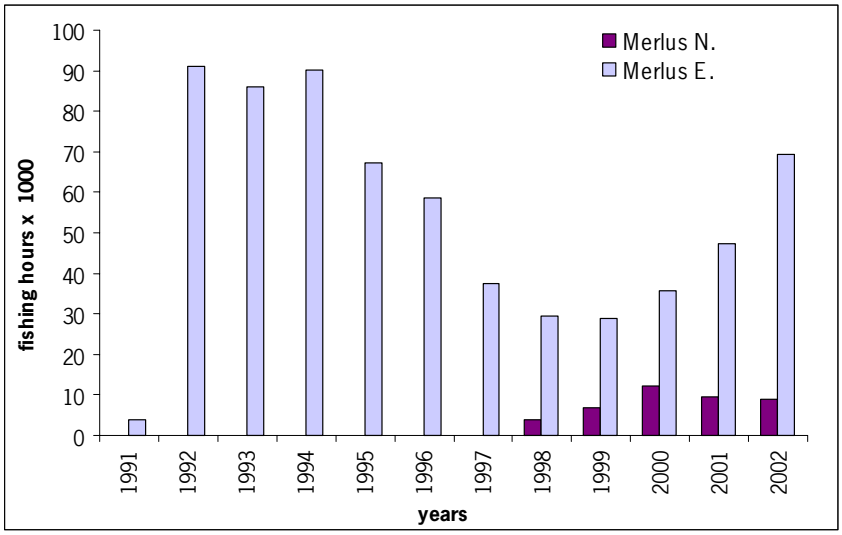


Figure 17. Effort in the national and foreign hake fleet. Merlus N = national effort, Merlus E = foreign (EU) effort.

Total catches per hour of hake plus by-catch species in the EU-fleet are 42% higher than those in the national fleet (logbook data for the period 1996 – 2001). Effort of the EU fleet has thus been converted into standard (national) fishing hours by raising them with 42%. The combined effort in the entire hake fleet has been estimated by summing the national effort with the corrected foreign effort (Figure 18).

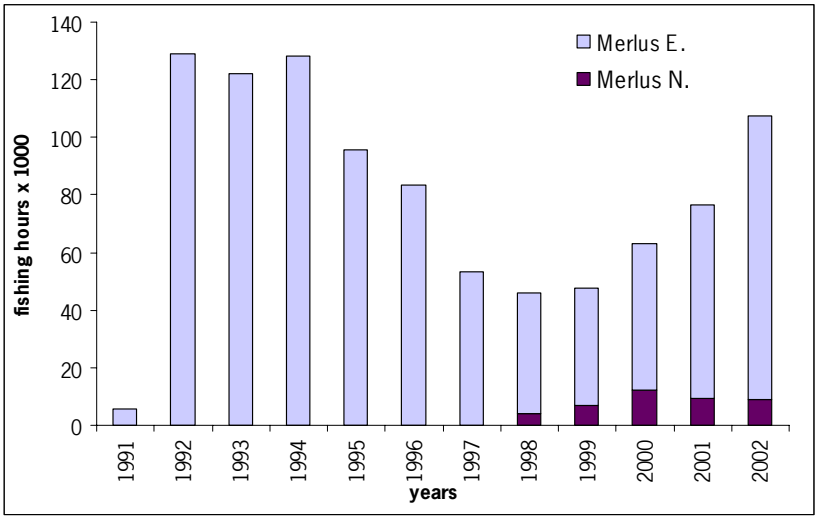


Figure 18. Total effort in the hake fleet. Merlus N = national effort, Merlus E = foreign (EU) effort corrected for efficiency.

3.5.3. Total landings according to logbooks

Landings of the hake fleet are presented in Figure 19. After a decline in catches in the late 1990s (corresponding to a reduction of fishing effort), total catches have now stabilised at a level of approximately 12,000 tons/year.

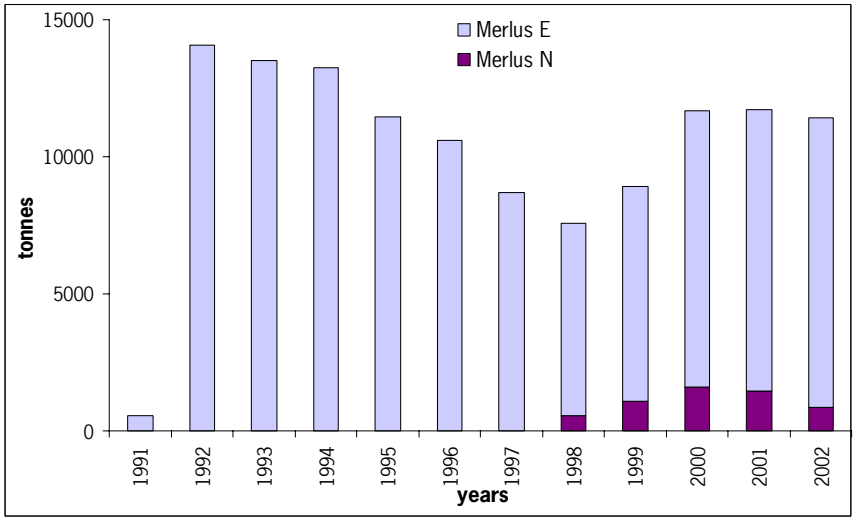


Figure 19. Total landings of the hake fleet. Merlus N = national fleet, Merlus E = foreign (EU) fleet.

3.5.4. By-catches

The species composition of the landings according to logbooks is compared with observer data in Figure 20. It is seen that the landings according to the logbooks consist almost exclusively of hake, with only a minor addition of other demersal species. The observer data show a similar picture, but here there are minor by-catches of crustaceans and cephalopods. These categories are apparently discarded at sea and do not show up in the landings. A more detailed species composition of catches in the hake fishery, based on observer data, is presented in Annex 1.

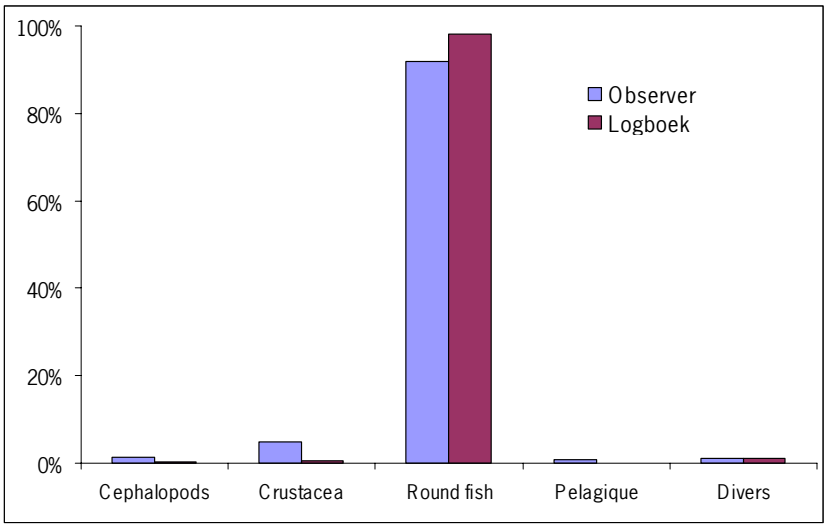


Figure 20. Mean catch composition of the foreign hake fleet in 1996 - 2002. Logbook data compared with observer data.

3.6. The roundfish fleet

3.6.1. Description of the fishery

Prior to 1993, no specialised roundfish fleet existed in Mauritania. Only from 1993 onwards, some vessels started to specialise in this type of fishery. The vessels use different types of gear such as long lines, trawls, and fixed gillnets. The roundfish fleet now consists of 42 vessels of about 30 m length. Thirty-two of them operate under foreign flag (mainly Spain), but the number of vessels in this category can vary from one year to the next. The national fleet, which started operations in 1995, has remained of relatively low importance until now.

3.6.2. Fishing effort

Fishing effort of the roundfish fleet is presented in Figure 21 for both the national and the foreign fleet. It is seen that fishing effort is quite variable, with large year-to-year changes particularly in the foreign fleet. After a strong decline in the foreign fleet in the period 1998-2001, effort in this fleet increased considerably in 2002. Presumably this was due to the freeze on licenses in the octopus fleet.

Total catches per hour in the EU-fleet are 20% higher than those in the national fleet (logbook data for the period 1996 – 2001). Effort of the EU fleet has thus been converted into standard (national) fishing hours by raising them with 20%. The combined effort in the roundfish fleet has been estimated by summing the national effort with the corrected foreign effort (Figure 22).

The effort in the national fleet has been relatively small, and it only surpassed foreign effort in the years 1999 and 2000. Total effort in the roundfish fleet (foreign + national vessels) has fluctuated between 20,000 and 60,000 hours per year. Compared to the octopus fleet and shrimp fleet, the effort in the roundfish fleet is relatively low.

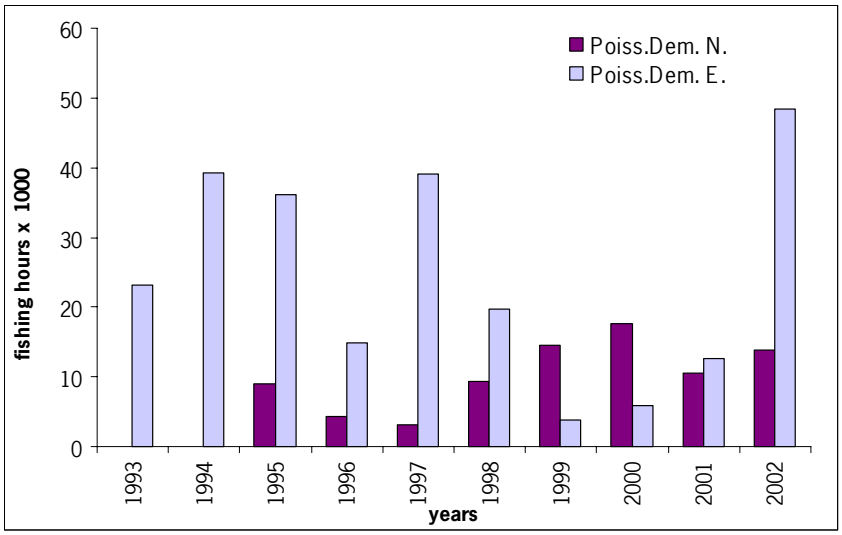


Figure 21. Effort in the national and foreign roundfish fleet.
Poiss. Dem N = national effort, Poiss. Dem E = foreign (EU) effort.

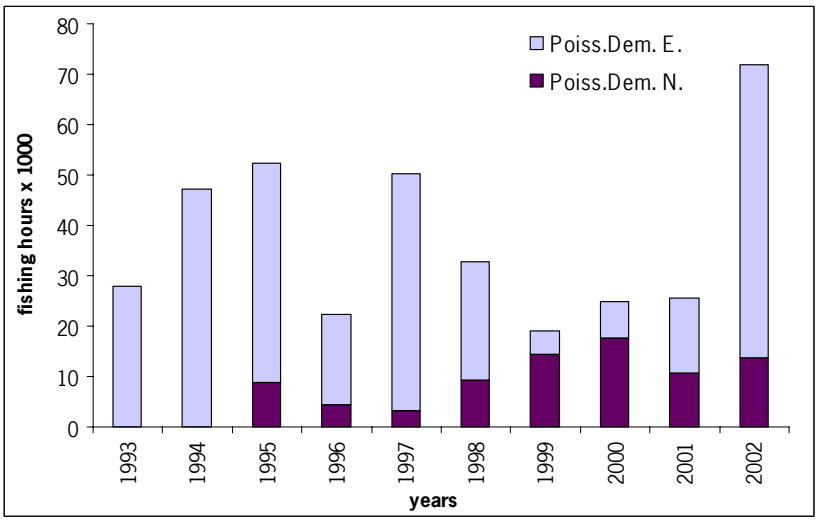


Figure 22. Combined effort in the roundfish fleet. Poiss Dem N = national effort, Poiss Dem E = foreign (EU) effort corrected for efficiency.

3.6.3. Total landings according to logbooks

Total landings of the roundfish fleet according to logbooks are presented in Figure 23. The landings show the same trend as the effort figures, with a decline in the years 1998-2001, and a revival in 2002. With landings in the order of 4,000 tons, the roundfish fleet is only the fifth fleet in order of importance for roundfish species (after the octopus fleet, the shrimp fleet, the pelagic fleet, and the hake fleet).

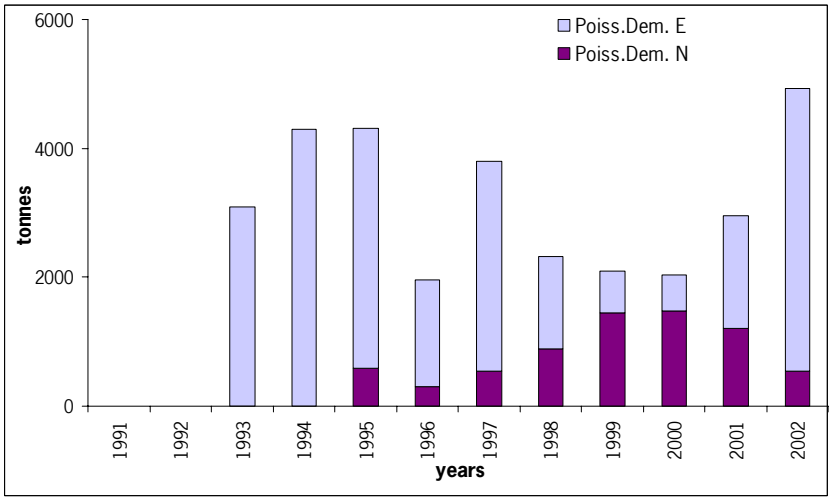


Figure 23. Total landings of the roundfish fleet. N = national fleet, E = foreign (EU) fleet.

3.6.4. By-catches

A comparison between the catch composition of the landings, reported in the logbooks, and the observer data, is presented in Figure 24. There is a reasonable agreement between the two sets of data. The observers report a higher percentage of cephalopods that the logbooks. Maybe part of the cephalopod catch is discarded at sea. The same is true for the category others ("divers" = various). A more detailed split of observer data in the roundfish fleet is presented in Annex 1.

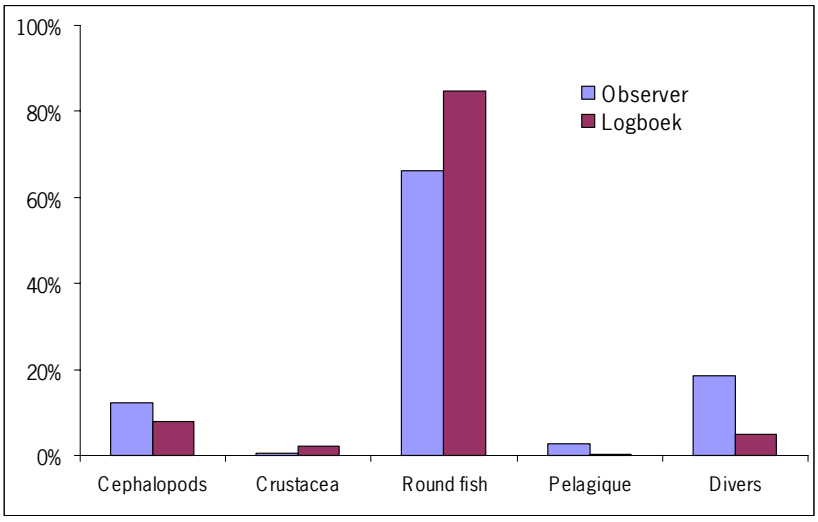


Figure 24. Mean catch composition of the foreign roundfish fleet in 1996-2002. Logbook data compared with observer data (1996-2002).

3.7. The pelagic fleet

3.7.1. Description of the fishery

The pelagic fleet consists of some 70 trawlers, ranging in size from 100-145m. All vessels operate under foreign flag. Two components can be distinguished: a fleet consisting of ex-USSR and Eastern European vessels, and a fleet consisting of vessels from the European Union. The Eastern European vessels are relatively old and their processing capacity ranges from 50-150 tons/day. The EU-fleet is composed of modern vessels, some of which belong to the largest trawlers in the world. Their processing capacity varies from 200-300 tons/day.

Pelagic trawlers target species such as sardinella, horse mackerel sardine and mackerel, and these species constitute the bulk of the catch. When fishing close to the bottom, the ships may take a by-catch of demersal species. According to the license, the vessels are not allowed to keep any cephalopods on board. The by-catch of demersal fish retained on board is limited to a maximum of 3%.

Although the by-catches of demersal fish, expressed as percentage of the total catch, are small, they may still constitute a large quantity in absolute terms. This is the reason that the pelagic fleet is also considered in this report.

3.7.2. Fishing effort

Fishing effort in the pelagic fleet is directed entirely to small pelagics. By-catches of demersal fish in this fleet are related much more to the type of gear, depth of fishing and fishing area than to total fishing effort. However, for the sake of consistency, fishing effort in the pelagic fleet is also presented in this report (Figure 25)

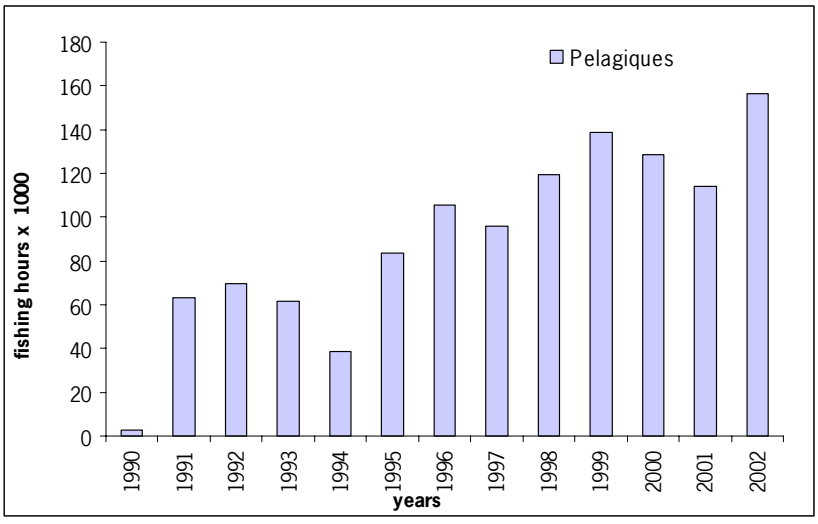


Figure 25. Total fishing effort in the pelagic fleet. All pelagic vessels operate under foreign flag.

3.7.3. Total landings according to logbooks

The composition of the landings according to logbook data is presented in Figure 26. It is seen that only a relatively minor part of the landings consist of other species than small pelagics.

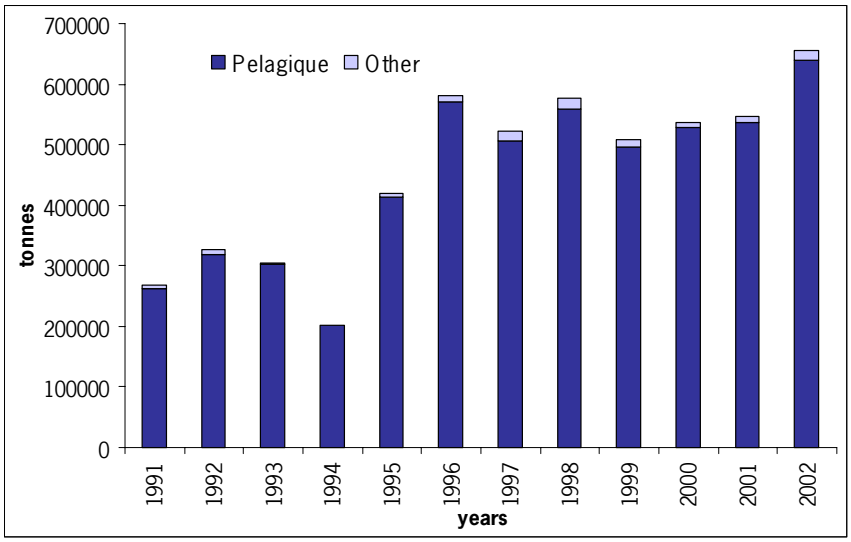


Figure 26. Landings of pelagic species and other (demersal) species for the total pelagic fleet. Data from logbooks

3.7.4. By-catches

By-catches of demersal species constitute only a relatively minor fraction of the total landings of the pelagic fleet. However, expressed in absolute terms, these by-catches are quite significant, as is shown in Figure 27.

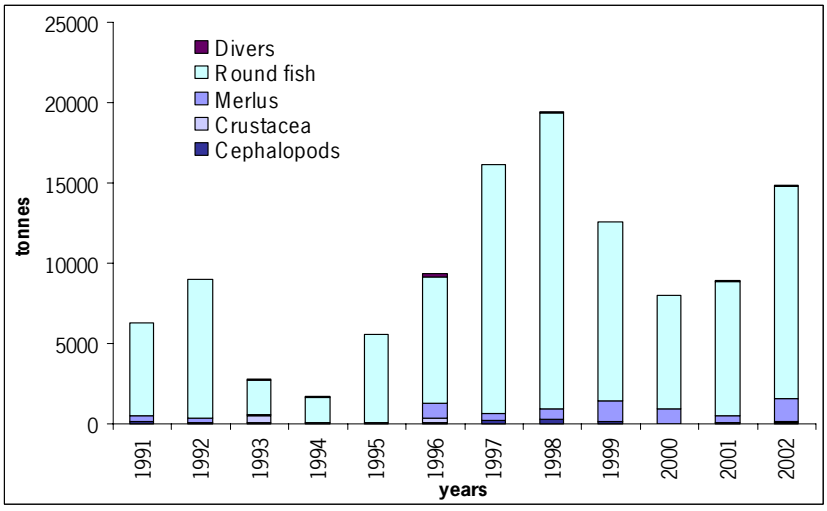


Figure 27. By-catches of demersal species in the pelagic fleet according to logbooks

For the pelagic fleet, very few data are available from the observer programme run by the Surveillance de Pêche. This lack of coverage is partly related to logistic problems of putting observers on board vessels that operate from Las Palmas. In order to increase the information on pelagic trawlers, IMROP together with RIVO initiated an observer programme on board Dutch trawlers in 1999. This programme uses IMROP scientists and technicians as observers, and the project is closely supervised in the framework of the IMROP/RIVO project on small pelagics. Data for the period 1999-2002 have been reported elsewhere (Ter Hofstede 2003).

3.8. The artisanal fishery

3.8.1. Description of the fishery

In the exploitation of demersal resources, the artisanal fleet plays an important role. There are 2000 - 3000 canoes involved in this fishery, operating from Nouadhibou, Nouakchott, and a number of semi-permanent settlements (campements) all along the coast (except for the Banc d'Arguin). The information available on this fishery is much less precise than for the industrial fleet, due to the fact that the canoes do not keep logbooks, and that their landings are spread out over many different sites. Still, one cannot assess developments in the demersal stocks without taking the artisanal fleet into consideration.

The artisanal fleet targets mainly species of high value, such as octopus, sole, sea breams, rays and sharks (for the fins), mullets (for the roe), and also the green lobster. The fleet can adapt itself very rapidly to the demands of the foreign markets, to which nearly its entire catch is exported.

The fleet of operational canoes has undergone drastic changes since 1993 (Figure 28).

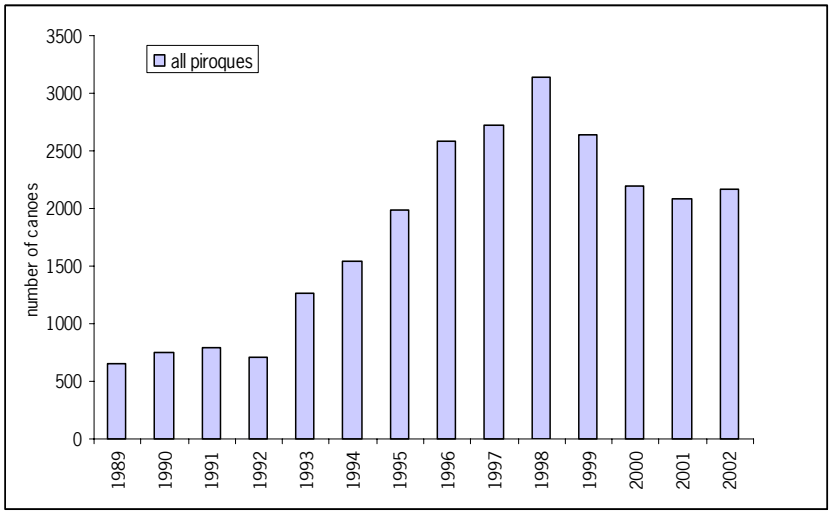


Figure 28. Average number of canoes according to IMROP surveys

A decline in number of active canoes is noted since 1998. In recent years the number of active has stabilised around 2000. Table 1 shows that the decline since 1998 did not occur in all segments of the artisanal fleet.

Table 1. Number of canoes utilising various types of fishing gear

year	Octopus pots	Lines and longlines	Sole nets	Courbine nets	others	Not-active canoes	Total
1989	162	163			283	47	655
1990	310	180			212	43	745
1991	280	79			297	129	785
1992	333	153	175		0	50	711
1993	558	368	6	72	181	76	1261
1994	634	403	54	101	239	109	1540
1995	856	390	82	61	343	254	1986
1996	1074	459	29	37	416	572	2587
1997	947	923	85	50	212	511	2728
1998	531	616	115	80	948	852	3142
1999	401	685	231	72	575	676	2640
2000	422	510	392	162	282	424	2192
2001	467	458	303	113	351	386	2078
2002*	1124	600	363	267	295	425	2168

*only one survey at the end of the octopus season

One of the most important sectors of the artisanal fleet is the fishery for octopus, conducted mainly with pots (Figure 29). First localised near Nouadhibou (since 1985), this fishery has extended south since 1995-1997 until Nouakchott, with its centre in the area between Nouakchott and the southern limit of the Banc d' Arguin. The octopus is also fished with the « turlutte » and fish cages, gears that have been introduced more recently. As in the industrial fleet, the octopus fishery has two main seasons: January-April and July-October.

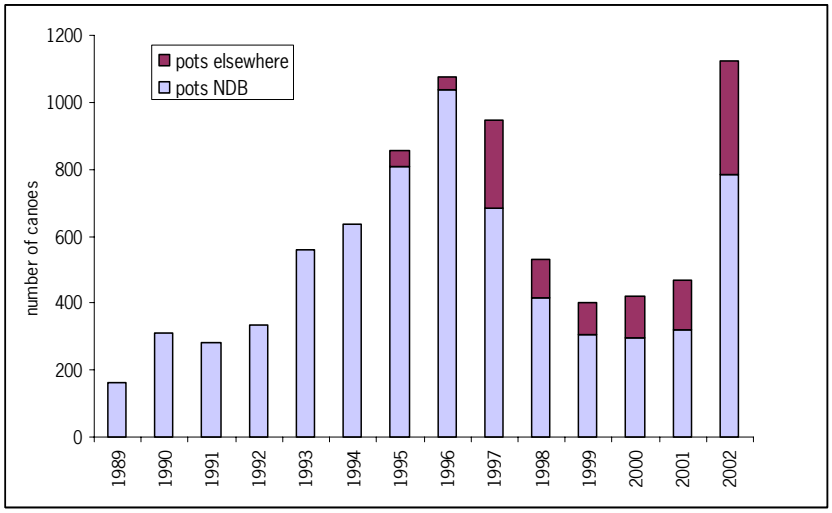


Figure 29. Number of canoes using octopus pots, split into canoes landing in Nouadhibou (NDB) and elsewhere. The sharp increase in numbers in 2002 is an artefact, due to a change in census methods (see text).

The number of canoes using octopus pots has decreased considerably since 1996. At the same time, there has been an important development in the sectors that target fish, in particular the canoes using sole nets.

In 2002 there was only one survey of the artisanal fleet along the whole of the Mauritanian coast. This survey was conducted in April, which is the end of the fishing season for octopus. This must have resulted in an under-estimate of the number of canoes fishing for octopus, especially in the region of Nouakchott where the main fishery took place between July and August. In December 2002, a survey that was unfortunately limited to the Nouadhibou area showed that the number of canoes was very low. In fact, the octopus canoes of Nouadhibou numbered 782. This was 61% of the total artisanal fleet, which consisted of 1281 canoes. Using the relation between the number of canoes in Nouadhibou that in and other regions, calculated on the basis of

surveys in December 2000 and 2001 (70 and 69% respectively), the total number of canoes fishing for octopus in 2002 was estimated at 1124. This high level is caused by the fact that the survey in 2002 for the first time took the canoes into account, which were at sea at the time of the survey. In earlier years, this was omitted, which must have caused a serious under-estimate of the number of octopus canoes in Nouadhibou.

The canoe-fleet that targets octopus has developed very rapidly following the high level of catches in 1992 and 1993. After these years, the catches of octopus have declined, without ever reaching the earlier levels (Figure 30). The development of the fishery with pots, however, has continued, thanks to the high prices for the product. This situation has persisted until 1998, the year when the explosion of octopus in Senegal caused a drastic reduction of prices. High prices for fresh fish have since then encouraged a change to other types of fishery.

A precise estimate of the catches in artisanal fleet in 2002 is not yet available. To get a rough idea of this value, we have used the average ratio between artisanal and industrial catches during the period 1991-2001. This ratio does not fluctuate very much; the catches of octopus by the artisanal fleet constitute on average 22.2% of the total catch. This ration has been used to estimate the artisanal catch in 2002 on the basis of the industrial catch for that year (15673 tons). This gives an estimated catch of 3500 tons for the artisanal fleet, and a total octopus catch of about 19200 tons.

The closed season that has been in force for the artisanal fleet since 1996 has changed the fishing strategy. Many canoes now seize the opportunity to take high catches of octopus immediately after the re-opening of the fishery, but change to other gears once this opportunity has passed.

With the declining abundance of octopus, the number of conflicts between artisanal canoes and industrial trawlers has increased. This results often in great losses of fishing gear for the artisanal fishermen. The new regulation concerning fishing limits, which does not allow trawlers to fish in depths of less than 20 m, is expected to reduce this type of spatial interaction.

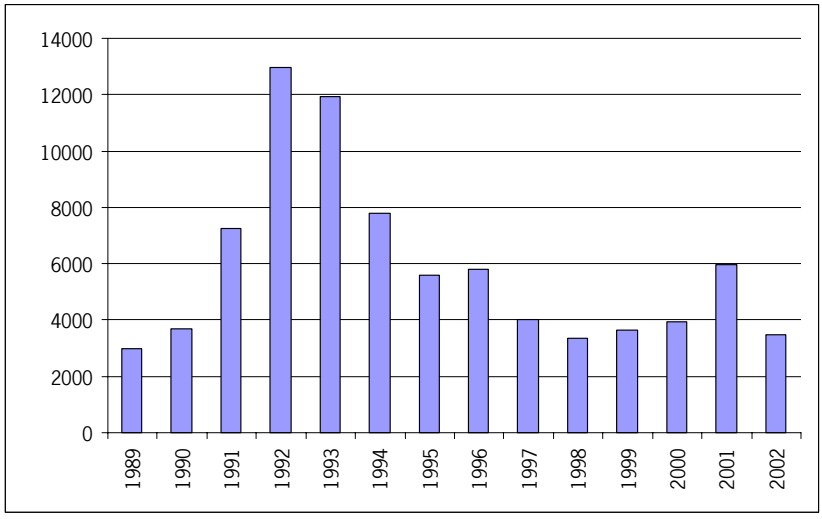


Figure 30. Octopus catch (tons) by the artisanal fleet. Catches in 2002 have been estimated indirectly (see text).

In the fishery for other species, the number of canoes using lines and longlines has increased since 1993 (Table 1). These gears are used in the region of Nouakchott and in the northern region in the ports of La Guëra and Nouadhibou. These gears are used especially to fish Serranids (“thiof”) and Sparids (“dorades”).

Figure 31 shows the percentage composition of the different gears used by the artisanal fleet. It is seen that the decline of the number of canoes using octopus pots has resulted in a relative increase of the number of canoes targeting fish, and using lines and nets.

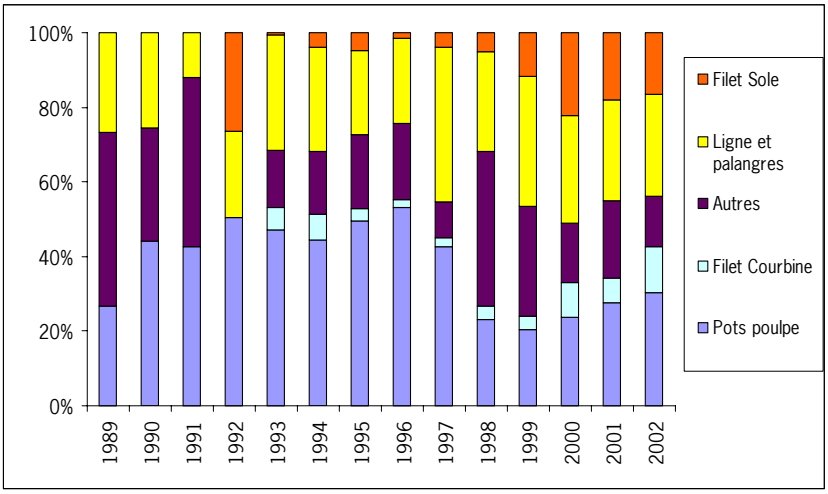


Figure 31. Relative importance of different fishing gears in the artisanal fleet.

Among the other important sectors of the artisanal fleet, one should mention those targeting pelagic fish such as mullets, sardinella and courbines.

Mullets

The two main species are the "mulet jaune" (*Mugil cephalus*) and the "mulet noir" (*Mugil capurrii*). Apart from the Banc d' Arguin where the "shoulder net" is the main fishing gear, the fishery for mullet is conducted with monofilament gill nets ("fele-fele") and purse seine. The peak in landings is observed in December and January. Since December 2001, an intensive fishery for "mulet noir" has developed near Nouadhibou.

Sardinella

The fishery for sardinella (*Sardinella aurita* and *Sardinella maderensis*) is conducted mainly near Nouakchott with the use of purse seines. Two hundred fifty Senegalese canoes, operating under a bilateral agreement between Mauritania and Senegal, target pelagic species excluding mullets.

Courbine

This fishery is conducted with fixed gill nets, purse seines and lines (Cap Blanc). The fishing season depends on the area, and the main fishery takes place during the migration period.

Landing statistics for the entire artisanal fleet, based on figures provided by export companies, show an average annual production in the order of 15-20,000 tons (Table 2).

Table 2: Total production (in tons) of the artisanal fishery, based on data submitted by export companies.

year	production		year	production
1986	16000		1994	15328
1987	19851		1995	20978
1988	22025		1996	22236
1989	14183		1997	15827
1990	10427		1998	18043
1991	12098		1999	14527
1992	15441		2000	19456
1993	17173		2001	14372

The IMROP Working Group in 2002 has revised these estimates. With data recently made available by local observers, a first assessment of the importance of the artisanal fishery in Mauritania was made. This work was based on the following three sources of information:

- The half-yearly surveys conducted by IMROP along the entire coast
- The surveys by fleet sector, which cover the de landings in Nouadhibou (since 1988) and in Nouakchott (since 1997). These data were available for the first time during this working group
- The professional experience of the participants to the meeting (scientists, fishermen and surveyors)

According to this analysis and the underlying assumptions, the total production of the artisanal fleet at this moment (reference year 2000) is in the order of 80,000 tons/year. The confidence interval on this estimate is ± 10,000 tons, taking into account the uncertainties in the variables used. The northern region contributes 62% to this total production (50,000 tons), the Banc d'Arguin 2% (1,600 tons), and the southern region 35% (28,000 tons)

As shown in Figure 32, the artisanal fleet exploits a large variety of mostly demersal species. This applies both to the northern and southern region. The species composition of the landings is similar in both regions. However, some species such as octopus and "Tollo" are fished more in the northern areas, whereas others such as sardinella are more typical for the southern region.

Despite the great variety of species, the catches are dominated by a limited number of species or groups of species. These are in order of importance the mullets (mainly the "mulet noir"), the Sparidae (mainly "Dorade grise" and "Dorade rose"), Courbine, Hake and Sea breams.

Taking into account the methods used for this evaluation, the results must be considered as preliminary. It may be used to demonstrate the importance of the artisanal fishery in the national economy, and to facilitate the dialogue between the various parties involved in the sector. It cannot be used, however, to replace real statistics. These must be constructed on the basis of disaggregated data available at IMROP.

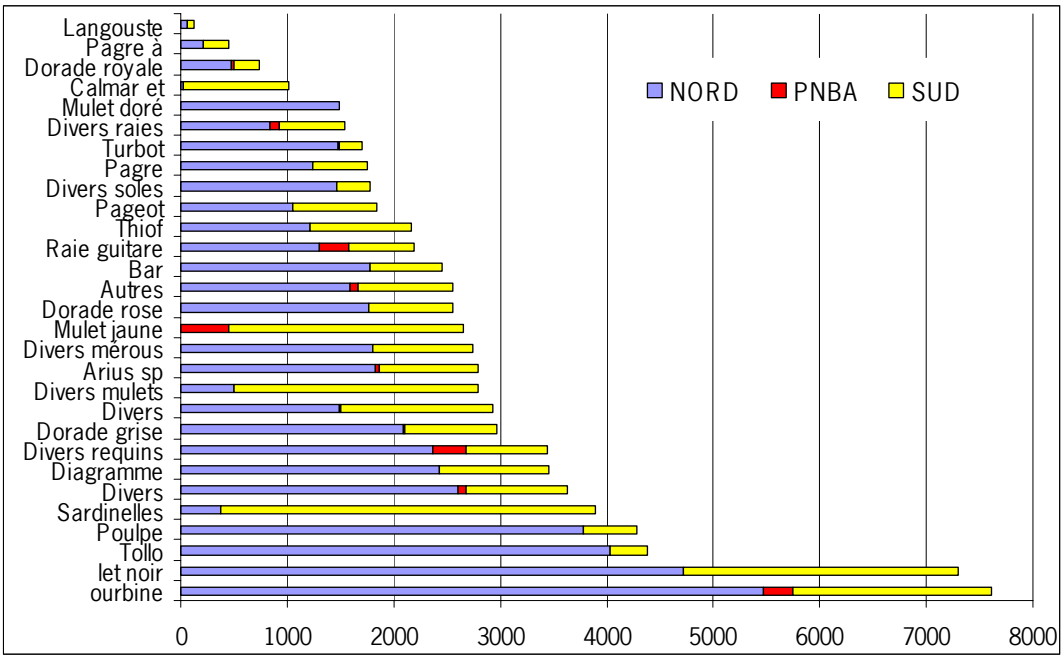


Figure 32. Estimated annual production of the artisanal fleet (average for the period 1998-2002). Source: Groupe de Travail IMROP, December 2002. NORD = northern region, PNBA = National park Banc d'Arguin, SUD = southern region.

4. Interactions between the different fleets

Note: This chapter is based on data from logbooks and observers and it concerns mainly the industrial fisheries

4.1.Introduction

The analysis of catches by type of license is used here as a means to assess the potential interactions between the various fleets. Two independent sources of information are used: the catches reported in the logbooks, and those monitored by the observers on board.

Only the interactions in terms of catches are considered in this chapter. Under this general objective, several related questions are considered. These are:

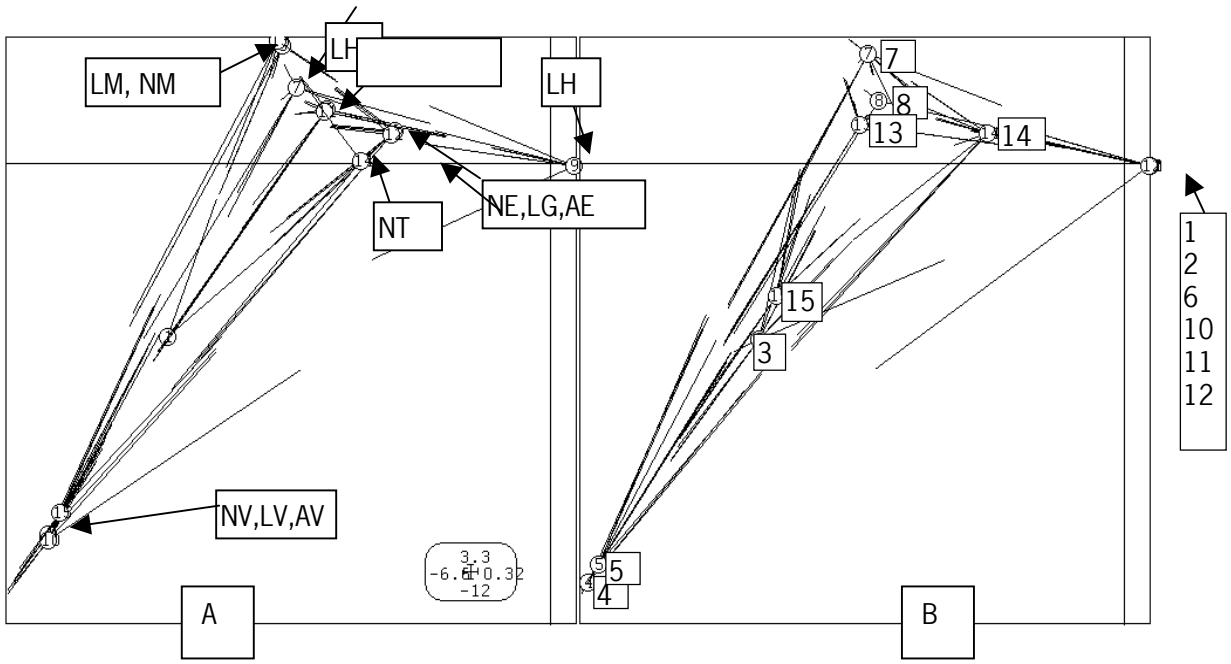
- the description of catch composition by license type
- an assessment of the coherence between catch compositions estimated on the two sets of data (logbooks and observer data)
- an assessment of the coherence between the type of license and the type of fishery
- an assessment of the degree of specialisation in each type of license
- the positioning of each type of license relative to the others, or in other words, the degree of overlap between different licenses
- and finally the evolution of catch composition over the years (for one type of license only : the category LD which is best covered by observer data

We will present successively the results of the analysis of logbook data (4.2), then those of the analysis of observer data (4.3), before proposing a synthesis (4.4), which will return to the questions posed in the introduction.

4. 2. The interactions as shown by the analysis of logbook data

In this report only the year 2002 has been considered. Using information contained in the logbook database, catches have been split into 15 major taxons (or groups of species) (Figure 33). A table was constructed of the 15 types of licenses and the 15 taxons, and a correspondence analysis (CA) was applied to this table.

The chart of the first principal components shows a clear pattern (Figure 33): licenses corresponding to the same type of fishery (such as for instance the licenses NV, AV and LV for the shrimp trawlers) generally coincide or are situated very close to each other. Conversely, the more licenses refer to fleets that target different species, the more the principal components are separated. One may distinguish three extreme poles, corresponding to shrimp trawlers (NV, AV and LV), hake trawlers (LM, NM) and pelagic trawlers (LP, AP). Figure 33B (projection of species in this same plan) leads to the conclusion that the catches reported by these three groups are in accordance with the species that they are supposed to target. In between the hake trawlers and the shrimp trawlers, we find a group consisting of licenses LH, ND and LD. This group may be classified as the cephalopod fleet, witnessed by its position centred on *Octopus vulgaris* (taxon 8). In the same area of plan 1-2 (and therefore with a catch composition similar to the previous group), we also distinguish another group consisting of licenses LE, LG and AE. This group represent the demersal roundfish fleet (it is centred at taxon 14). Still at the same level and thus with a similar catch composition, we find license NT which is supposed to be used for catching tuna. This peculiar position is explained by an examination of the data: in reality, this type of license has been used very little this year (one or two months in the beginning of the year). Catches consisted mainly of roundfish and not a single tuna.



N°	code	licence
1	AB	Affrété Crabes
2	AE	Affrété Démersal-Céphalo+Crevettes
3	AP	Affrété Pélagique
4	AV	Affrété Crevettes
5	LD	Licence Démersal
6	LG	Licence Especes démersal profondes
7	LH	Licence Especes démersal profondes
8	LM	Licence Merlus
9	LP	Licence Pélagique
10	LV	Licence Crustaces sauf langouste
11	ND	National Démersal+Céphalopode
12	NE	National Démersal
13	NM	National Merlus
14	NT	National Thons
15	NV	National Crevettes

N°	taxa
1	Anchois
2	Chinchards
3	crustacés
4	Gamba
5	Langostino
6	MAQUEREAU
7	MERLU
8	POULPES
9	SABRES
10	SARDINE
11	SARDINELLES
12	thons
13	Aut.ceph.
14	Pois.Dem
15	Div.coqu.

Figure 33. Analysis of the catches according to logbooks for year 2002. Projections of the licence (on the left) and of the taxa (on the right) on the first factorial plan (axes 1 and 2) of the correspondence analysis.

The last type of license, AB (crab vessels) takes an isolated position in the centre, coinciding with the catch of crustaceans and various shellfish species.

We may conclude that this typology allows us to verify the degree of targeting by type of license. The differences between licenses that are supposed to target different species are clearly shown, as is the correspondence between licenses that are supposed to target the same species (except for NT). The analysis also provides a comprehensive representation of fisheries that are related; this applies particularly to the group of the cephalopod trawlers and the roundfish trawlers. These show a large degree of overlap, and are thus potentially competing for the same species.

4.3. The interaction as shown by observer data

The typology of licenses presented in the previous chapter was based on catches reported in the logbooks. Without making a judgement on the quality of this type of data in the present situation, it is known that in general these data normally are in accordance with the catch composition allowed by the type of license.

Therefore, it is useful to verify if the same characteristics of the fisheries are found if one uses catch estimates made by observers on board. Moreover, the observer data are more precise at the taxonomic level and therefore provide a more detailed view on each license or group of licenses (fishery), as well as on their interactions.

Several types of results are presented successively:

- Tables with catch composition per year and per license as function of the main types of exploited resources (cephalopods, demersal fish, etc.). These compositions are presented as percentages of the total catch for the license in the year concerned.
- A comparative analysis of the degree of diversity of the catches in each type of license.
- Resuls of a factor analysis comparable to the one presented in section 4.1 for logbook data, this time applied to the catches as monitored by the observers.

4.3.1. Catch composition as function of the major type of resource exploited

The catches are split into the following five major taxonomic groups:

- CP : Cephalopods
- CR : Crustaceans
- DV : Others (divers)
- PD : Demersal fish (poissons démersaux)
- PP : Pelagics

Tables 4 - 11 present the contribution of each of these groups to the total catch taken by each license or group of licenses. The mean values for the period 1996-2002 are presented in Table 4, whereas values for the individual years 1996 – 2002 are presented in Tables 5 - 11.

Table 4: Relative composition of the catches for each licence: period 1996-2002.

	LD	LGLH	LM	LP	LV	Total
CP	42,22%	12,13%	1,36%	0,01%	6,79%	0,01%
CR	0,47%	0,51%	4,77%	0,00%	20,82%	0,00%
DV	3,04%	2,77%	0,93%	0,01%	5,55%	0,01%
PD	38,72%	66,14%	91,76%	0,25%	57,33%	0,25%
PP	15,56%	18,46%	1,18%	99,73%	9,51%	99,73%
Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Table 5: Relative composition of the catches for each licence: year 1996

	LD	LGLH	LM	LP	LV	Total
CP	28,93%	27,57%	4,99%	0,00%	4,68%	2,97%
CR	0,09%	0,19%	28,68%	0,00%	8,19%	0,91%
DV	3,81%	1,76%	3,62%	0,00%	10,39%	0,96%
PD	52,58%	58,98%	60,95%	0,00%	64,69%	9,37%
PP	14,59%	11,50%	1,75%	100,00%	12,05%	85,79%

Table 6: Relative composition of the catches for each licence: year 1997

	LD	LGLH	LM	LP	LV	Total
CP	29,88%	6,87%	1,05%		5,47%	14,95%
CR	0,72%	0,51%	3,85%		26,87%	2,88%
DV	3,40%	3,08%	0,11%		5,40%	2,78%
PD	49,36%	72,77%	94,71%		53,83%	66,39%
PP	16,64%	16,76%	0,29%		8,42%	13,00%
Total	100,00%	100,00%	100,00%		100,00%	100,00%

Table 7: Relative composition of the catches for each licence: year 1998.

	LD	LGLH	LM	LP	LV	Total
CP	46,48%	39,89%	0,60%		6,94%	25,85%
CR	0,59%	0,00%	5,91%		32,60%	6,34%
DV	3,61%	0,05%	0,14%		0,22%	1,94%
PD	32,29%	33,78%	90,74%		54,58%	54,95%
PP	17,04%	26,28%	2,61%		5,65%	10,91%
Total	100,00%	100,00%	100,00%		100,00%	100,00%

Table 8: Relative composition of the catches for each licence: year 1999.

	LD	LGLH	LM	LP	LV	Total
CP	47,17%	26,54%	1,46%	0,00%	11,70%	0,01%
CR	0,35%	0,17%	1,17%	0,00%	21,15%	0,00%
DV	1,07%	0,78%	0,76%	0,00%	0,83%	0,00%
PD	38,41%	41,59%	96,31%	0,21%	55,44%	0,22%
PP	12,99%	30,93%	0,30%	99,78%	10,89%	99,78%
Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Table 9: Relative composition of the catches for each licence: year 2000.

	LD	LGLH	LM	LP	LV	Total
CP	57,53%	47,98%	1,32%	0,00%	11,07%	0,00%
CR	0,30%	0,02%	2,01%	0,00%	22,42%	0,00%
DV	3,77%	4,09%	4,25%	0,00%	9,48%	0,00%
PD	20,99%	11,19%	91,21%	0,17%	48,82%	0,17%
PP	17,41%	36,72%	1,21%	99,83%	8,21%	99,82%
Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

Table 10: Relative composition of the catches for each licence: year 2001.

	LD	LGLH	LM	LP	LV	Total
CP	47,53%	20,52%	1,49%	0,00%		0,00%
CR	0,13%	0,16%	1,19%	0,00%		0,00%
DV	3,36%	0,10%	1,98%	0,05%		0,05%
PD	28,46%	72,62%	95,35%	0,21%		0,21%
PP	20,52%	6,59%	0,00%	99,74%		99,74%
Total	100,00%	100,00%	100,00%	100,00%		100,00%

Table 11: Relative composition of the catches for each licence: year 2002.

	LD	LGLH	LM	LP	LV	Total
CP	33,25%	0,07%	4,99%	0,05%	32,02%	0,05%
CR	0,72%	4,98%	0,84%	0,00%	0,10%	0,00%
DV	3,65%	16,93%	1,60%	0,04%	0,00%	0,04%
PD	52,76%	77,84%	91,05%	0,86%	41,56%	0,87%
PP	9,63%	0,18%	1,53%	99,05%	26,32%	99,04%
Total	100,00%	100,00%	100,00%	100,00%	100,00%	100,00%

The demersal licenses (LD, LG et LH[1]) clearly are shown to have the most diversified catches. The vessels using a pelagic license or a license for hake are much more specialised.

Some changes are seen over the years that probably reflect variations in availability of the resources in time. It is also noted that at this taxonomic level (large groupings) the catch of the shrimp trawlers appears relatively diverse (less specialised than one would have expected).

4.3.2. Diversity of catches within each type of license

Figure 34 presents for each type of license the number of species (or taxonomic group) in the total catch, and also the corresponding numbers for different threshold values (e.g. after removing the 1% tail end, the 2% tail end and so on).

Figure 34 confirms that license LD corresponds to the largest diversity in the catch (more than 90 taxons represented, which is almost twice the number in the next most diverse license, LV). The majority of the taxons, however, consists of rare species that contribute little to the total catch (less than 1%). If one looks taxons that contribute at least 1% to the total catch, the diversity drops considerably (to 5 – 15 taxons). Therefore, the licenses are split in two groups only: those with high diversity (LD, LM and LV) and those with low variety (LP and LGLH)

4.3.3. Typology of licenses by correspondence analysis

Several analyses have been performed successively. They refer to the two different sets of data that cover respectively:
- the entire period for which data are available, i.e. 1996 – 2001 (analysis 1)
- the year 2002 only, selected because this is the year for which the most comprehensive observer data are available (analysis 2)
- the year 2002 only, selected because this year allows a more direct comparison with the results of section 4.2 which refers with the same year (analysis 3).

[1] The data do not allow a distinction between these two licenses, due to the high number of boats that alternated between the two licenses during the year.

In order to reduce the volume of this report, and because the different analyses arrive at the same results, only the analysis referring to the total period (analysis 1) is presented here (see Annex 1). Figure 35 presents the first two components of the factor analysis covering the period 1996-2002.

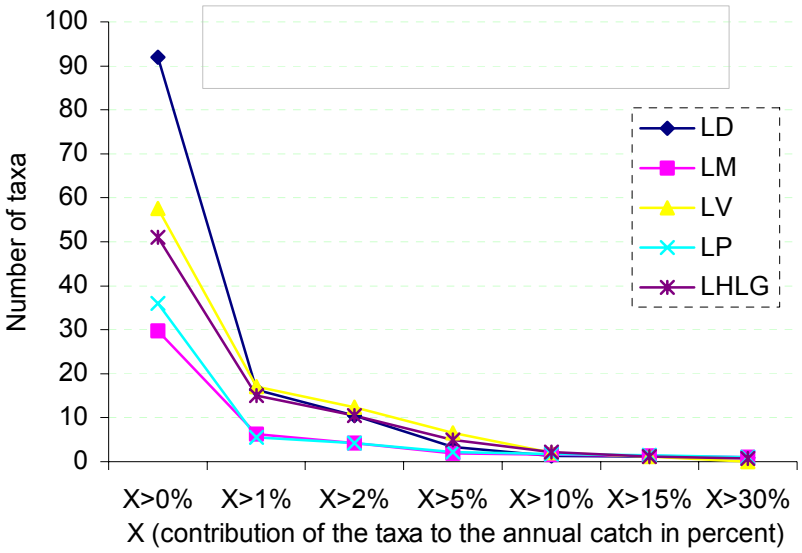


Figure 34. Number of taxa contributing to the annual composition of the catches in the periode 1996-2002 for each type of licence, cutting of different percentages at the tail end of the distribution (0%, 1%, 2% etc).

Figure 35B presents a typology in which the six types of licenses can be distinguished, although they show some overlap. The pelagic license LP (code 5) stands out most clearly, and at the other extreme we find two poles corresponding with the demersal license LD (code 2) and the shrimp license LV (code 6). The group LG and LH, with its rich catch of cephalopods (octopus vulgaris, code 3) and demersal fish, appears to be situated relatively close to LD, whereas the hake license shows more relationship to the shrimp license. Figure 35A is hard to read due to the large number of taxons involved. Although a detailed study of this graph is not feasible; the observation of its general structure is interesting. It shows that the demersal pole is characterized by a much more diversified catch (a large number of species) than the pelagic pole, and especially the much more specialised shrimp and hake fisheries.

4.3.4. Factor analysis of the temporal evolution of catches under license LD

License LD is both the one that represents the largest variety of catches, and the one for which most observer data are available. This was the reason for conduction an analysis of the species composition of this license in the course of the successive years (Figure 36). We have investigated whether there was stability in the average catch composition over the years, or whether there was a trend over the period 1996-2002. The statistical method was the same as used in the previous section (CA).

It is noted in Figure 36 that the average catch composition of license LD varies over time (the points representing the annual means are not superimposed (B)). Moreover, this evolution seems rather consistent and not due to random variation: the annual points are arranged in a chronological order on the first factorial plan (C). Finally it seems that something unusual has happened in 2002. This year appear to be an outlier; its species composition is most different from that in other years.

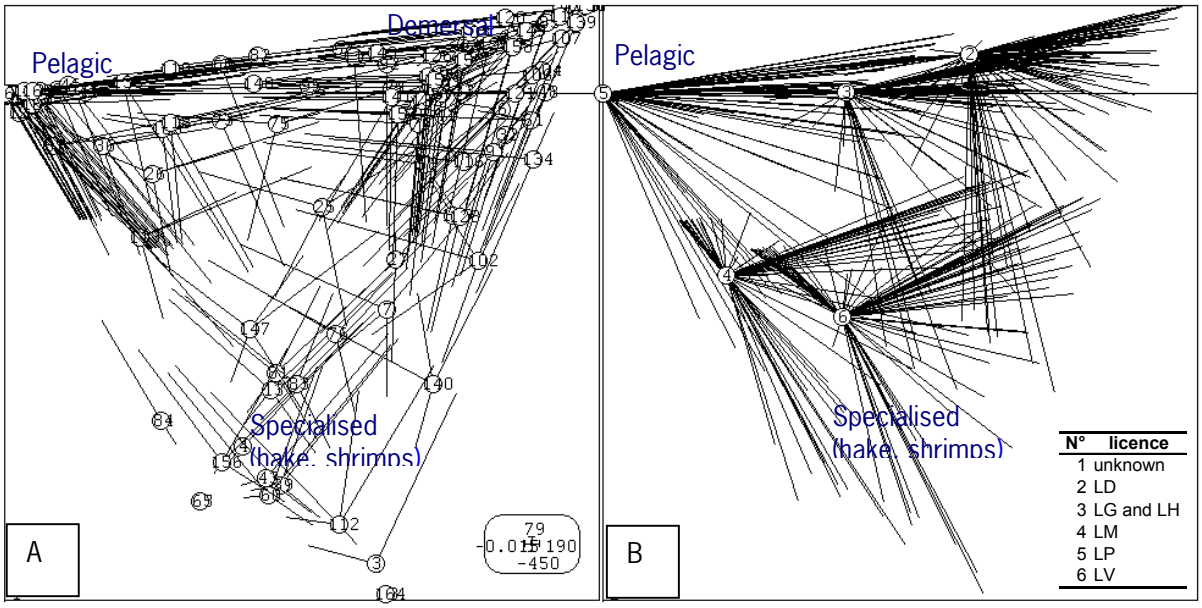


Figure 35. Analysis of the catches according to observers data for the period 1996-2002. Projections of the taxa (A) and of the licence (B) on the first factorial plan (axes 1 and 2) of the correspondence analysis.

Legend of Figure 35A (list of taxa and their code)

1 Albulidae
2 Alepocephalidae
3 Anguilliformes
4 Antennariidae
5 Apogonidae
6 Araignées
7 Argyrosomus regius
8 Ariidae
9 Ariommatidae
10 Aulopidae
11 Balistidae
12 Batrachoididae
13 Berycidae
14 bivalves
15 Blenniidae
16 Bothidae
17 Bramidae
18 Cancridae
19 Caproidae
20 Carangidae
21 Centracanthidae
22 Centrolophidae
23 Centrophoridae
24 Cepolidae
25 Chaetodontidae
26 Chelonidae
27 Chimaeridae
28 Chlorophthalmidae
29 Citharidae
30 Clupeidae
31 Congridae
32 Coryphaenidae
33 crabes
34 Crevettes
35 Crustacés
36 Cynoglossidae
37 Dactylopteridae
38 Dalatiidae
39 Dasyatidae
40 Dentex macrophthalmus
41 Diodontidae
42 Divers
43 Drepaneidae
44 Echeneidae
45 Elopidae
46 Emmelichthyidae
47 Engraulidae
48 Ephippidae
49 Epigonidae
50 Epinephelus aeneus
51 Fistulariidae
52 Gasteropodes
53 Gempylidae
54 Geryon maritae
55 Gobidae
56 Haemulidae
57 Halosauridae
58 Hemigaleidae
59 Hexagrammidae
60 Himantolophidae
61 Kyphosidae
62 Labridae
63 Langouste rose
64 Langouste verte
65 Leptochariidae
66 Lethrinidae
67 Loliginidae
68 Loligo vulgaris
69 Lophiidae
70 Lutjanidae
71 Macrouridae
72 Malacanthidae
73 Melanostomiatidae
74 Merlucciidae
75 Molidae
76 Monacanthidae
77 Monognathidae
78 Moridae
79 Moronidae
80 Mugilidae
81 Mullidae
82 Muraenesocidae
83 Muraenidae
84 Myctophidae
85 Myliobatidae
86 Nomeidae
87 Notacanthidae
88 Octopodidae
89 Octopus vulgaris
90 Ogcocephalidae
91 ommastrephidae
92 Oneirodidae
93 Ophichthidae
94 Ophidiidae
95 Pagellus bellottii
96 Paralepididae
97 Paralichthyidae
98 Parapenaeus longirostris
99 Penaeus notialis
100 Peristediidae
101 Phycidae
102 Platycephalidae
103 Polychelidae
104 Polynemidae
105 Pomacentridae
106 Portunidae
107 Priacanthidae
108 Psettodidae
109 Rajidae
110 Rhinobatidae
111 Sardinella aurita
112 Scaridae
113 Sciaenidae
114 Scomber japonicus
115 Scombridae
116 Scorpaenidae
117 Scyliorhinidae
118 Scyllaridae
119 Sebastidae
120 Sepia officinalis
121 Sepiidae
122 Serranidae
123 Setarchidae
124 Solea vulgaris
125 Soleidae
126 Sparidae
127 Sparus caeruleostictus
128 Sphyraenidae
129 Sphyrnidae
130 Squalidae
131 Squillidae
132 Sternoptychidae
133 Stomiidae
134 Stromateidae
135 Synaphobranchidae
136 Synodontidae
137 Tetraodontidae
138 Torpedinidae
139 Trachichthyidae
140 Trachinidae
141 Trachipteridae
142 Trachurus trecae
143 Triakidae
144 Trichiuridae
145 Triglidae
146 Uranoscopidae
147 Zeidae

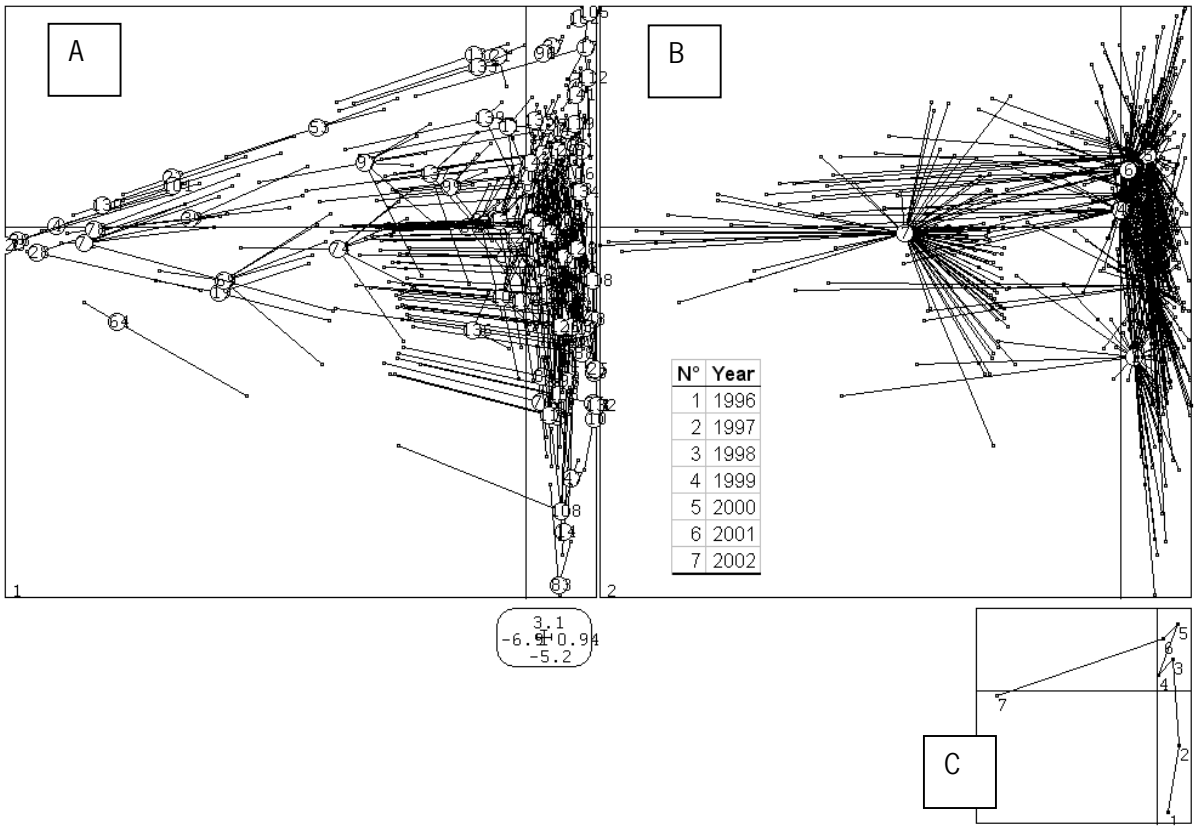


Figure 36. Analysis of the catches according to observers data for the period 1996-2002. Projections of the taxa (A) and of the years (B) on the first factorial plan (axes 1 and 2) of the correspondence analysis. In C the projections of years (exactly the pattern presented in B) are related according to chronology, in order to focus on the trajectory of the evolution. Below: Figure 36 A – list of taxa and their code.

1 Albulidae
2 Alepocephalidae
3 Anguilliformes
4 Antennariidae
5 Apogonidae
6 Araignées
7 Argyrosomus regius
8 Ariidae
9 Ariommatidae
10 Aulopidae
11 Balistidae
12 Batrachoididae
13 Berycidae
14 bivalves
15 Blenniidae
16 Bothidae
17 Bramidae
18 Cancridae
19 Caproidae
20 Carangidae
21 Centracanthidae
22 Centrolophidae
23 Centrophoridae
24 Cepolidae
25 Chaetodontidae
26 Chelonidae
27 Chimaeridae
28 Chlorophthalmidae
29 Citharidae
30 Clupeidae
31 Congridae
32 Coryphaenidae
33 crabes
34 Crevettes
35 Crustacés
36 Cynoglossidae
37 Dactylopteridae
38 Dalatiidae
39 Dasyatidae
40 Dentex macrophthalmus
41 Diodontidae
42 Divers
43 Drepaneidae
44 Echeneidae
45 Elopidae
46 Emmelichthyidae
47 Engraulidae
48 Ephippidae
49 Epigonidae
50 Epinephelus aeneus
51 Fistulariidae
52 Gasteropodes
53 Gempylidae
54 Geryon maritae
55 Gobidae
56 Haemulidae
57 Halosauridae
58 Hemigaleidae
59 Hexagrammidae
60 Himantolophidae
61 Kyphosidae
62 Labridae
63 Langouste rose
64 Langouste verte
65 Leptocharíidae
66 Lethrinidae
67 Loliginidae
68 Loligo vulgaris
69 Lophiidae
70 Lutjanidae
71 Macrouridae
72 Malacanthidae
73 Melanostomiatidae
74 Merlucciidae
75 Molidae
76 Monacanthidae
77 Monognathidae
78 Moridae
79 Moronidae
80 Mugilidae
81 Mullidae
82 Muraenesocidae
83 Muraenidae
84 Myctophidae
85 Myliobatidae
86 Nomeidae
87 Notacanthidae
88 Octopodidae
89 Octopus vulgaris
90 Ogcocephalidae
91 ommastrephidae
92 Oneirodidae
93 Ophichthidae
94 Ophidiidae
95 Pagellus bellottii
96 Paralepididae
97 Paralichthyidae
98 Parapenaeus longirostris
99 Penaeus notialis
100 Peristediidae
101 Phycidae
102 Platycephalidae
103 Polychelidae
104 Polynemidae
105 Pomacentridae
106 Portunidae
107 Priacanthidae
108 Psettodidae
109 Rajidae
110 Rhinobatidae
111 Sardinella aurita
112 Scaridae
113 Sciaenidae
114 Scomber japonicus
115 Scombridae
116 Scorpaenidae
117 Scyliorhinidae
118 Scyllaridae
119 Sebastidae
120 Sepia officinalis
121 Sepiidae
122 Serranidae
123 Setarchidae
124 Solea vulgaris
125 Soleidae
126 Sparidae
127 Sparus caeruleostictus
128 Sphyraenidae
129 Sphyrnidae
130 Squalidae
131 Squillidae
132 Sternoptychidae
133 Stomiidae
134 Stromateidae
135 Synaphobranchidae
136 Synodontidae
137 Tetraodontidae
138 Torpedinidae
139 Trachichthyidae
140 Trachinidae
141 Trachipteridae
142 Trachurus trecae
143 Triakidae
144 Trichiuridae
145 Triglidae
146 Uranoscopidae
147 Zeidae

4.4. Synthesis and discussion

The detailed description of the catch composition by type of license allows us to establish in which respect each type of license is more or less selective. In this way it is shown clearly that license LD is directed at a variety of species. The observer data are very informative in this respect.

The comparison between the catches reported in the logbooks and those recorded by observers on board has allowed us to verify the general correspondence between the catch composition as estimated by these two sources of information. This correspondence does not exist to a degree that would make one of the two sources superfluous. The two sources are in fact complementary. Their collection and analysis should be continued in order to utilise the particular information contained in each of them: the better coverage of the logbooks and the higher degree of taxonomic precision and inclusion of discards in the observer data.

The present analysis also allows us to verify the general correspondence between type of license and type of fishery actually practised. The different types of license correspond effectively to the same type of fishing behaviour regardless of nationality or type of ownership. This result, which stands out very clearly from the logbooks, cannot be verified on the basis of observer data since these observer do not sample national vessels. For a distinction between types of ownership in the same type of fishery (are there differences or not), one should continue the analysis of logbook data at a more detailed level (using spatial and temporal strata). At the general level, in fact not a single difference seems to exist between the types of ownership.

The present analysis has finally provided an overall view of the position of each type of license in relation to the others, in other words, of the degree of difference or overlap between the different types of licenses. This type of information is useful since it summarises the level of potential interaction between the various fisheries and/or licenses. On the basis of this analysis, on could for instance much easier conclude that all management measures concerning the cephalopod licenses have very strong repercussions on the fisheries using a demersal fish license, and vice versa. In the same way, it appears also that the pelagic and demersal licenses, situated a priori very far apart, nevertheless have a certain degree of interaction. Their catches overlap to an extent that cannot be neglected.

We have noted furthermore that within a certain type of license the catch composition may show a trend over time. A preliminary analysis, made only for one type of license, type LD, which is the best documented in terms of observer data, has confirmed this.

In the last place a practical remark can be made concerning the improvement of the quality of the observer data. It is noted that observers during their trips to record the type of license under which the vessel operates. We have come across a number of cases where vessels had either used different licenses during the year, or where the type of license was unknown. This lack of information has presented problems during the analysis. It is not always easy to recover this information afterwards in case the vessel has changed license during the course of the year.

5. Assessments

5.1. Assessment of octopus

5.1.1. General remarks

The population of octopus in Mauritanian waters is treated as one unit stock. In view of the sedentary habits of the species, there is little likelihood of a substantial exchange of adult individuals with the waters of neighbouring countries.

It is possible that the population in the Mauritanian EEZ consists of two more or less separate stocks, a northern stock with a relative offshore distribution, and a southern stock with a more coastal distribution. For the purpose of this report, however, all octopus in Mauritanian waters is considered to belong to one single stock.

Earlier studies have shown that the maximum sustainable yield of octopus in Mauritanian waters depends on the strength of the upwelling. Periods with strong upwelling correspond with periods of increased landings of octopus. It is possible to construct separate production models for periods of high and low upwelling. In the present report, no distinction has been made between periods of high and low upwelling. The estimated maximum sustainable yield is an average for both situations. It should be noted that the optimum level of fishing effort is independent of the amount of upwelling and the productivity of the stock (GT 2002).

5.1.2. Total catches

Total landings of octopus have been estimated by summing the logbook data for the various industrial fleets and adding to this an estimate for the total landings of the artisanal fleet (Figure 38). For the period 1990 – 2002, this calculation is presented in Table 13.

Table 12. Total landings of octopus by the industrial fleet and the artisanal fishery.

year	Industrial fleet	Artisanal fleet	Total landings
1990	19150	3690	22840
1991	22363	7253	29616
1992	33150	12963	46113
1993	28325	11929	40254
1994	20438	7795	28233
1995	21320	5596	26916
1996	18408	5818	24226
1997	13626	4024	17650
1998	13117	3368	16485
1999	18887	3631	22518
2000	24256	3953	28209
2001	20651	5963	26614
2002	15673	3500	19173

The contribution to the total octopus catch by each of the main sectors of the industry (artisanal fleet, national industrial fleet and foreign (EU) industrial fleet is illustrated in Figure 37. It is seen that the foreign (EU) fleet gradually increased its share in the total octopus catch over the last 7 years.

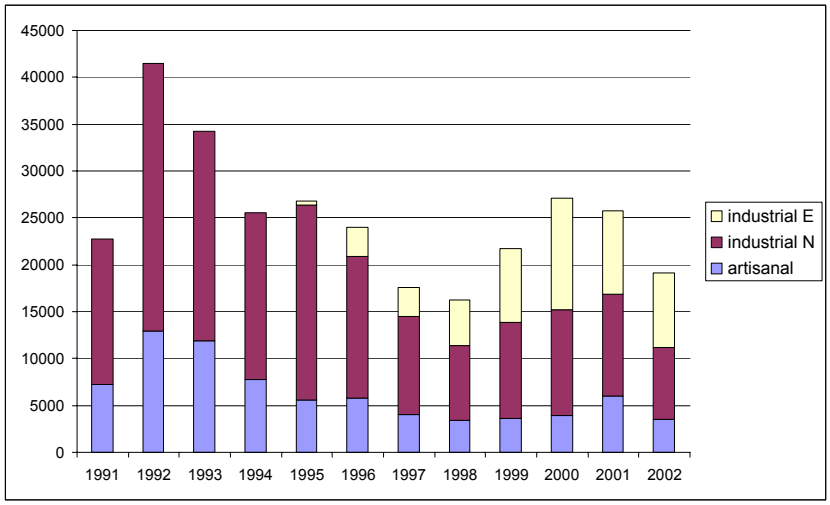


Figure 37. Contribution by the various sectors to the total catch of octopus. Catches in tons

For the years prior to 1990, estimates of total landings have been taken from the GT 2002. The development of the total octopus landings since 1966 is presented in Figure 38.

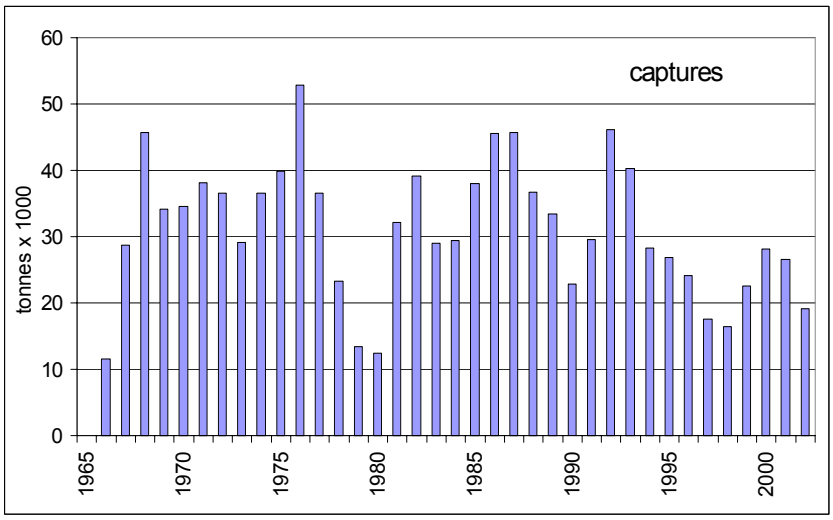


Figure 38. Total landings of octopus by all fleets combined. Data from GT 2002, extended with an estimate for 2002.

5.1.3. Abundance indices

In order to assess the current state of the stock, a series of abundance indices is required that spans as much as possible the entire history of exploitation of the stock. Such abundance indices can be derived either from catches per unit of effort in a particular fleet, or from trawl surveys by research vessels. A number of abundance indices has been calculated in the past, referring to different fleet segments and survey data. During the GT 2002, all these series were combined into a single series, using a GLM model (Anon. 2003). This index was based on:

- research vessel data collected by IMROP
- catches per unit of effort in different segments of the industrial octopus fleet
- catches per unit of effort in the artisanal octopus fleet

The index calculated during the GT 2002 is represented in Figure 39. It is seen that the abundance index declined sharply in the 1960s and 1970s. The abundance stabilised at a low level during the 1980s, but it

dropped further in the 1990s. The small revival in the most recent three years has not brought the index back to the average level of the 1980s.

No index for 2002 was available at the time this report was prepared.

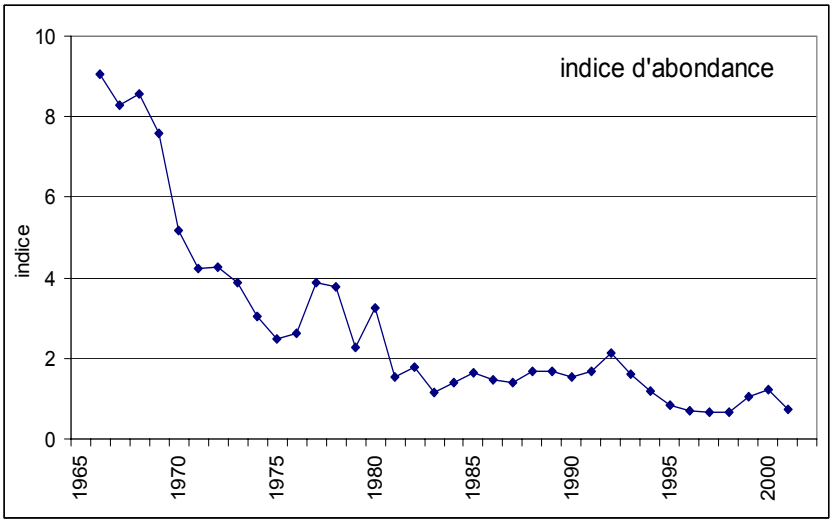


Figure 39. Combined abundance index for octopus, based on several cpue series for the industrial fleets, research vessel surveys, and a cpue for the artisanal fleet.

5.1.4. Theoretical total fishing effort

Dividing total catches by the abundance index, one obtains an estimate of theoretical fishing effort (Figure 40). In this case, effort is expressed as an index, rather than in numbers of fishing days. Since no abundance index was available for 2002, the theoretical effort for that year could not be calculated.

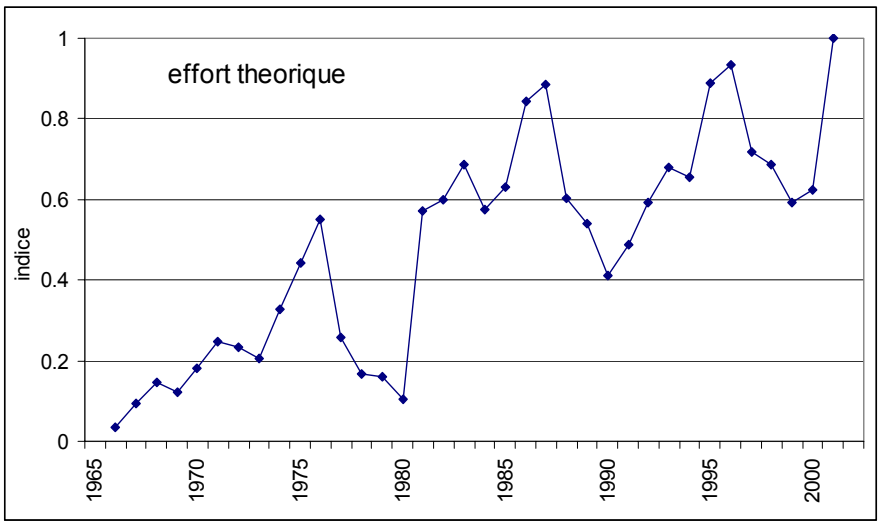


Figure 40. Theoretical effort, calculated on the basis of total catches and the combined abundance index. Effort expressed as fraction of the value in 2001. Data from GT 2002

Comparing the index of theoretical effort with the estimated industrial effort in the octopus fleet (Figure 41), it is seen that the actually measured effort in the industrial fleet rises more sharply in recent years than the theoretical effort calculated above. The trend in both series, however, is the same.

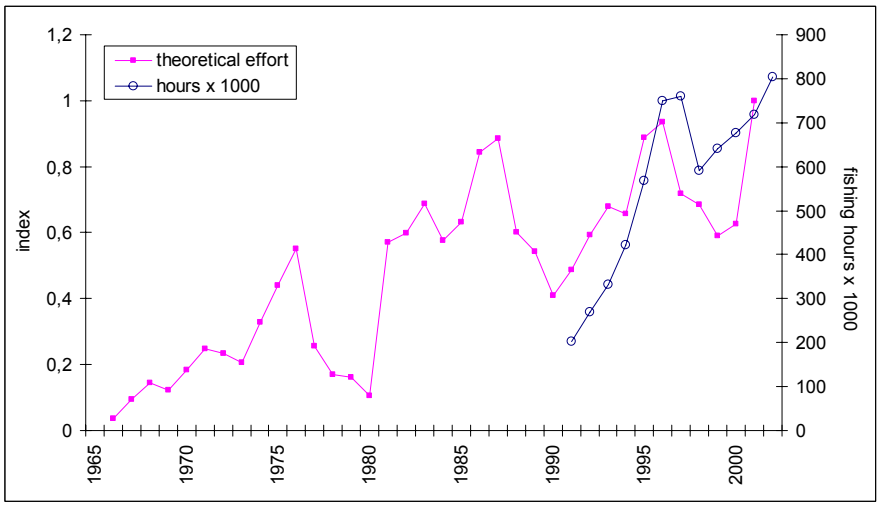


Figure 41. Comparison of theoretical fishing effort (index) in the total octopus fishery with calculated total effort in the industrial fleet fleet (hours x 1000)

5.1.5. Comparison of total catches and total fishing effort

Figure 42 compares total catches over the period 1991-2002 with total fishing effort during this period. It is seen that total effort has risen by a factor 3, whereas catches show a decreasing trend. Even without statistical analysis, one may conclude on the basis of these data that the stock is in a state of over-exploitation.

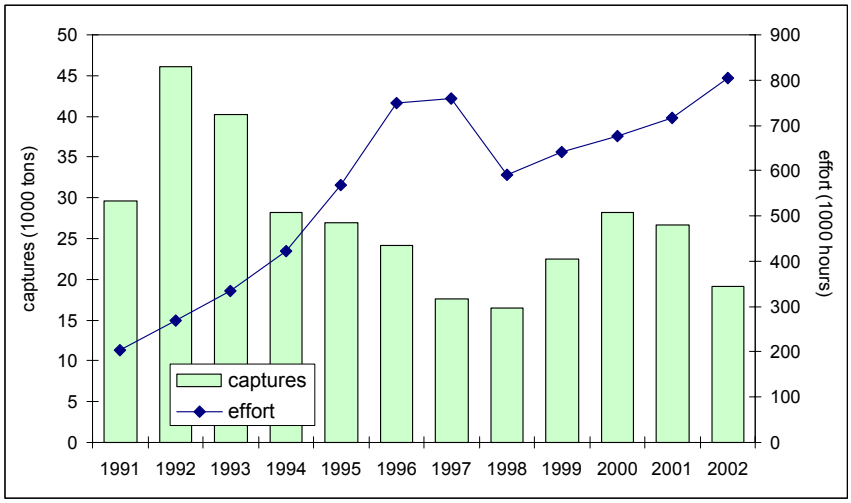


Figure 42. Comparison between fishing effort in the industrial fleet and total landings of octopus in Mauritania

5.1.6. Assessment by means of production models

The Groupe de Travail in December 2002 used a production model to estimate the maximum sustainable yield, optimum fishing effort, excess of fishing effort in the current situation, and the loss of potential yield due to this excess fishing effort (Anon. 2003). On the basis of the results obtained, the group concluded that:

- The octopus is in a state of over-exploitation, with fishing effort being about 30% above the optimum level (confidence interval 25-40%)
- The maximum sustainable yield (MSY) is 34,000 tons/year (confidence interval 32,000-36,000). This is the mean catch level that can be obtained at the optimum fishing effort.
- Because fishing effort has been too high for a number of years, catches have now been reduced below the MSY level. Continued exploitation at the current level of effort will mean that catches will remain 25% below the MSY level (confidence limits 15-40%).
- All models indicate that catches will increase after a reduction of fishing effort.
- Apart from its effect on the octopus stock, the octopus fleet also has a strong influence on a number of demersal fish species, some of which have been declining for a number of years. In managing the octopus fishery, one also has to take into account its effect on the other demersal species.

For the present report, the calculations of December 2002 were repeated with the addition of new catch and effort data for 2002. The addition of these data did not change the conclusions of the GT 2002 (Laurans and Gascuel, pers. comm. 2003). These calculations, therefore, have not been included in this report.

In September 2003, the CECAF working group on demersal stocks made a new evaluation of the octopus stock in the Cap Blanc region, based on catch and effort data from the commercial fisheries and data from research vessel surveys. Using catch and effort data from the commercial fishery, the group arrived at the same conclusions as the GT 2002 (Inejih, pers. comm.). When data were used from research vessel surveys, a different conclusion was reached. In the end the group concluded that the octopus stock was over-exploited and the group recommended to reduce fishing mortality.

5.2. Assessment of shrimps

The GT 2002 tried to assess the stock of gamba (*Parapenaeus longirostris*) using various production models. However, no clear results were obtained. There seemed to be no relationship between total effort and catch per unit of effort. This could mean either that the stock was still under-exploited, or that the data used for the assessment were not sufficiently accurate.

New data presented in this report show a strong increase in fishing effort on shrimps in 2002. These rapid changes in the shrimp fleet urgently require a further analysis of the current state of the stock.

The CECAF working group on demersal stocks in September 2003 evaluated the stocks of two shrimp species. For *Parapenaeus longirostris* the group concluded that the stock was fully exploited and it advised not to increase fishing mortality any further. For *Penaeus notialis* the group concluded that the biomass was close to the level corresponding with MSY, and for this stock the group also recommended not to increase fishing mortality.

5.3. Assessment of hake

The GT 2002 estimated the state of the stock using two production models (BIODYN and Fox). Both models arrived at similar results, and estimated the maximum sustainable yield (MSY) at 12.000 tons/year. This is considerably above the current catch level. The working group, however, advised to keep fishing effort at its present level as a precautionary measure (Anon. 2003).

The CECAF working group on demersal stocks in September 2003 concluded that the hake stocks in Mauritania were exploited close to their MSY level. The group advised a reduction of fishing mortality caused by the fleets targeting hake and other roundfish species because of their high level of by-catches of other commercial species.

5.4. Assessment of other roundfish species

No assessment of individual roundfish species has been attempted in the present report. The GT 2002 investigated long-term trends (1982-2001) in abundance of 17 roundfish species, as measured during surveys by Mauritanian research vessels. These species were selected on the basis of their importance in the commercial fishery.

Seven species showed a clear downward trend over the period concerned. These were octopus (*Octopus vulgaris*), cuttlefish (*Sepia officinalis*), thiof (*Epinephelus auneus*), rouget (*Pseudupeneus prayensis*), rays (*Raja miraletus* and *straelini*) and machoiron (*Arius heudeloti*). These species are either targeted by commercial fisheries, or they are sensitive to exploitation because of their low reproduction (rays). The working group concluded on the basis of these data that the octopus was over-exploited, and that the developments in thiof, cuttlefish and rouget had to be watched very carefully. Individual assessments of these species had to be made as soon as possible.

Five other species appeared to remain stable during the period concerned. These were courbine (*Argyrosomus regius*), dentex spp., pageot (*Pagellus bellottii*), diagramme (*Plectorhynchus mediterraneus*) and pagre à point bleu (*Sparus caeruleostictus*). However, the species showed large inter-annual variations, and the working group recommended a close watch on these species. In other countries in the region (Senegal and Guinea), these species are already being over-exploited.

On the basis of these results, the working group recommended a freeze of fishing effort on roundfish species.

Acknowledgements

This report could not have been written without the help of many colleagues, both at IMROP and elsewhere. Thanks are due to Martin van der Knaap who assisted in the analysis of observer data for the shrimp fishery. Martial Laurans, in cooperation with Didier Gascuel, updated the production model for octopus. Mahfoud Ould Taleb Sidi and Moustapha Ould Bouzouma contributed to the analyses and provided valuable input during the discussion of the manuscript.

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Annex 1. List of 50 most important species (by weight) in each fleet according to observer data.

Octopus fleet	LD
Octopus vulgaris	35,22%
Carangidae	7,91%
Merlucciidae	5,59%
Sparidae	5,10%
Trachurus trecae	4,84%
Zeidae	3,80%
Loligo vulgaris	3,07%
Divers	3,03%
Uranoscopidae	2,93%
Ophidiidae	2,84%
Sepia officinalis	2,29%
Pagellus bellottii	1,94%
Soleidae	1,84%
Scorpaenidae	1,84%
Dentex macrophthalmus	1,45%
Triglidae	1,25%
Haemulidae	1,15%
Sciaenidae	1,09%
Rajidae	1,02%
Scomber japonicus	0,94%
Sepiidae	0,89%
Clupeidae	0,64%
Trachinidae	0,63%
Mullidae	0,60%
Trichiuridae	0,58%
Malacanthidae	0,56%
ommastrephidae	0,49%
Lophiidae	0,43%
Serranidae	0,42%
Argyrosomus regius	0,33%
Sardinella aurita	0,31%
Solea vulgaris	0,30%
Ariidae	0,28%
Citharidae	0,28%
Triakidae	0,28%
Albulidae	0,22%
Chlorophthalmidae	0,22%
Octopodidae	0,21%
Scombridae	0,20%
Epinephelus aeneus	0,19%
crabes	0,18%
Trachipteridae	0,16%
Psettodidae	0,15%
Cepolidae	0,13%
Cynoglossidae	0,12%
Bothidae	0,11%
Macrouridae	0,11%
Ophichthidae	0,10%
Congridae	0,10%
Penaeus notialis	0,09%

Hake fleet	LM
Merlucciidae	79,92%
Lophiidae	4,53%
Geryon maritae	2,21%
Triglidae	2,06%
Crevettes	1,62%
Triakidae	1,27%
Macrouridae	0,95%
Divers	0,93%
Carangidae	0,88%
ommastrephidae	0,85%
Batrachoididae	0,62%
Parapenaeus longirostris	0,61%
Trachichthyidae	0,43%
Dalatiidae	0,43%
Scorpaenidae	0,39%
Octopus vulgaris	0,29%
crabes	0,18%
Dentex macrophthalmus	0,18%
Zeidae	0,16%
Loligo vulgaris	0,13%
Rajidae	0,10%
Trachurus trecae	0,10%
Trichiuridae	0,10%
Soleidae	0,07%
Phycidae	0,07%
Serranidae	0,07%
Ophidiidae	0,07%
Octopodidae	0,07%
Squillidae	0,07%
Uranoscopidae	0,06%
Gonostomatidae	0,04%
Scomber japonicus	0,04%
Gymnuridae	0,04%
Portunidae	0,04%
Scombridae	0,03%
Langouste verte	0,03%
Sparidae	0,03%
Squalidae	0,03%
Centracanthidae	0,02%
Sepiidae	0,02%
Ophichthidae	0,02%
Pagellus bellottii	0,02%
Sardinella aurita	0,02%
Leptochariidae	0,01%
Haemulidae	0,01%
Sepia officinalis	0,01%
Centrolophidae	0,01%
Majidae	0,01%
Scyliorhinidae	0,01%
Sciaenidae	0,01%

Shrimp fleet	LV
Merlucciidae	14,78%
Sparidae	10,02%
Parapenaeus longirostris	8,17%
Carangidae	7,02%
Divers	5,55%
Penaeus notialis	5,29%
Solea vulgaris	4,36%
Geryon maritae	4,35%
Triglidae	3,98%
Dentex macrophthalmus	3,20%
Octopus vulgaris	2,96%
Crevettes	2,94%
Soleidae	2,70%
Scorpaenidae	2,17%
Ophidiidae	2,01%
Sciaenidae	1,74%
Pagellus bellottii	1,63%
Haemulidae	1,62%
Trachurus trecae	1,51%
Octopodidae	1,10%
Argyrosomus regius	1,07%
Congridae	1,04%
Zeidae	0,95%
Sepia officinalis	0,92%
Loligo vulgaris	0,90%
Lophiidae	0,78%
Sepiidae	0,60%
Macrouridae	0,59%
Trachinidae	0,58%
Mullidae	0,53%
Uranoscopidae	0,40%
Polynemidae	0,38%
Trichiuridae	0,29%
Sardinella aurita	0,29%
Chlorophthalmidae	0,25%
Dalatiidae	0,25%
Cynoglossidae	0,23%
Clupeidae	0,22%
Triakidae	0,21%
ommastrephidae	0,20%
Epinephelus aeneus	0,16%
Psettodidae	0,15%
Rajidae	0,12%
Serranidae	0,12%
Loliginidae	0,12%
Ariidae	0,11%
Albulidae	0,11%
Alepocephalidae	0,09%
Citharidae	0,08%
Priacanthidae	0,08%

(Annex 1, continued)

Roundfish fleet	LGLH
Carangidae	12,64%
Sparidae	11,14%
Merlucciidae	8,42%
Soleidae	8,21%
Octopus vulgaris	7,68%
Pagellus bellottii	5,93%
Ophidiidae	5,64%
Scorpaenidae	5,64%
Haemulidae	4,38%
Trachurus trecae	3,04%
Loligo vulgaris	2,89%
Serranidae	2,87%
Zeidae	2,84%
Divers	2,77%
Dentex macrophthalmus	1,54%
Uranoscopidae	1,15%
Mullidae	1,11%
Triakidae	1,08%
Scomber japonicus	1,04%
Triglidae	0,89%
Sepia officinalis	0,70%
Sardinella aurita	0,66%
Trachinidae	0,63%
Rajidae	0,53%
Ariidae	0,51%
Sciaenidae	0,48%
Sepiidae	0,42%
crabes	0,39%
Trichiuridae	0,35%
Albulidae	0,35%
Loliginidae	0,31%
Scombridae	0,31%
Trachipteridae	0,27%
Clupeidae	0,27%
Argyrosomus regius	0,22%
Sparus caeruleostictus	0,15%
Torpedinidae	0,15%
Tetraodontidae	0,14%
Polynemidae	0,14%
Citharidae	0,13%
Caproidae	0,13%
Stromateidae	0,11%
Coryphaenidae	0,11%
ommastrephidae	0,09%
Epinephelus aeneus	0,09%
Congridae	0,09%
Cynoglossidae	0,09%
Rhinobatidae	0,08%
Lophiidae	0,08%
Crevettes	0,08%

Pelagic fleet	LP
Sardinella aurita	80,43%
Clupeidae	7,48%
Scomber japonicus	4,64%
Trachurus trecae	3,46%
Scombridae	1,43%
Carangidae	1,32%
Trichiuridae	0,85%
Mugilidae	0,13%
Ariidae	0,06%
Sparidae	0,03%
Haemulidae	0,03%
Bramidae	0,02%
Tetraodontidae	0,02%
Divers	0,01%
Sphyrnidae	0,01%
Engraulidae	0,01%
Merlucciidae	0,01%
Triakidae	0,01%
Pagellus bellottii	0,01%
Stromateidae	0,01%
Sphyraenidae	0,00%
Uranoscopidae	0,00%
Carcharhinidae	0,00%
Argyrosomus regius	0,00%
Zeidae	0,00%
Leptochariidae	0,00%
Acanthuridae	0,00%
Echeneidae	0,00%
Sciaenidae	0,00%
Loligo vulgaris	0,00%
Sepiidae	0,00%
Triglidae	0,00%
Gempylidae	0,00%
Molidae	0,00%
Dentex macrophthalmus	0,00%
Coryphaenidae	0,00%
Myliobatidae	0,00%
Sepia officinalis	0,00%
crabes	0,00%
Squalidae	0,00%
Mullidae	0,00%
Dasyatidae	0,00%
Epinephelus aeneus	0,00%
Dactylopteridae	0,00%
Priacanthidae	0,00%
Albulidae	0,00%
Penaeus notialis	0,00%
Emmelichthyidae	0,00%
Istiophoridae	0,00%
ommastrephidae	0,00%