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Report of the FAO/CECAF Working Group on the Assessment of Demersal Resources – Subgroup North
Saly, Senegal, 14–23 September 2004

Rapport du Groupe de travail FAO/COPACE sur l´évaluation des ressources démersales – Sous-groupe Nord
Saly, Sénégal, 14-23 septembre 2004

PROGRAMME FOR THE DEVELOPMENT OF FISHERIES
IN THE EASTERN CENTRAL ATLANTIC
FISHERY COMMITTEE FOR THE EASTERN CENTRAL ATLANTIC

PROGRAMME POUR LE DÉVELOPPEMENT DES PÊCHES
DANS L'ATLANTIQUE CENTRE-EST
COMITÉ DES PÊCHES POUR L'ATLANTIQUE CENTRE-EST

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FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
ORGANISATION DES NATIONS UNIES POUR L'ALIMENTATION ET L'AGRICULTURE
Rome, 2006

PREPARATION OF THIS DOCUMENT

The FAO/CECAF Working Group on demersal resources was created during the fifteenth session of the Fishery Committee for the Eastern Central Atlantic (CECAF) which was held in Abuja, Nigeria, from 1 to 3 November 2000 (FAO, 2000).

At the second meeting of the Working Group it was decided to split the group into two subgroups: Subgroup North covering the northern CECAF zone between Cap Spartel and the south of Senegal, and Subgroup South covering the southern CECAF zone between the south of Senegal to the Congo River.

This document reports on the first meeting of Subgroup North which was organized in Saly, Senegal, from 14 to 23 September 2004.

The overall objective of the Group is to contribute to the improvement of the management of demersal resources in Northwest Africa through assessment of the state of stocks and fisheries to ensure the best sustainable use of the resources for the benefit of coastal countries.

In all, 21 researchers from seven different countries participated in the meeting.

The meeting was financed by the Netherlands Institute for Fisheries Research (RIVO) and by the FAO Marine Resources Service (FIRM).

FAO wishes to thank the participants of the Working Group who contributed towards this report. Our special thanks go to Stephen Cofield, Marie-Thérèse Magnan, Françoise Schatto and Luigia Sforza for their assistance with the final preparation of this document. Pedro Barros, Ana Maria Caramelo and Merete Tandstad were responsible for the final technical editing of this document.

PRÉPARATION DE CE DOCUMENT

Le Groupe de travail FAO/COPACE sur les ressources démersales a été créé au cours de la quinzième session du Comité des pêches pour l'Atlantique Centre-Est (COPACE) qui s'est tenue à Abuja (Nigéria) du 1er au 3 novembre 2000 (FAO, 2000).

A la deuxième réunion du Groupe de travail, il a été décidé de diviser le Groupe en deux sous-groupes: le Sous-groupe Nord couvrant la zone nord du CECAF entre le Cap Spartel et le sud du Sénégal, et le Sous-groupe Sud couvrant la zone sud du CECAF entre le sud du Sénégal et le fleuve Congo.

Ce document est le compte-rendu de la première réunion du Sous-groupe Nord qui a été organisée à Saly, Sénégal, du 14 au 23 septembre 2004.

L'objectif général du Groupe est de contribuer à l'amélioration de l'aménagement des ressources démersales en Afrique du nord-ouest par l'évaluation de l'état des stocks et des pêcheries afin d'assurer la meilleure utilisation durable de ces ressources pour le bénéfice des pays côtiers.

En tout 21 chercheurs de sept pays différents ont participé à la réunion.

La réunion a été financée par l'Institut néerlandais de recherche halieutique (Netherlands Institute for Fisheries Research [RIVO]) et par le Service des ressources marines de la FAO (FIRM).

La FAO est reconnaissante aux participants au Groupe de travail qui ont contribué à la réalisation du présent rapport. Nos vifs remerciements vont à Stephen Cofield, Marie-Thérèse Magnan, Françoise Schatto et Luigia Sforza pour l'assistance apportée à l'édition finale de ce document. Pedro Barros, Ana Maria Caramelo et Merete Tandstad étaient responsables de l'édition technique finale de ce document.

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ABSTRACT

A permanent FAO/CECAF Working Group composed of scientists from the coastal countries and from those countries or organizations playing an active role in demersal fisheries in Central-West Africa, was created by CECAF in 2000. The first meeting of Subgroup North was organized in Saly, Senegal, from 14 to 23 September 2004.

The overall objective of the Group is to contribute to the improvement of the management of demersal resources in Northwest Africa through assessment of the state of stocks and fisheries to ensure the best sustainable use of the resources for the benefit of coastal countries. The study zone for the Working Group is the CECAF zone of the Central-East Atlantic Ocean between Cap Spartel and the south of Senegal.

For reasons of heterogeneity, the species and stocks of the demersal Working Group were divided into four groups: hake, other demersals, shrimps and cephalopods. For each of these groups information is provided on the fisheries: sampling schemes and sampling intensity, biological characteristics, stock identity, trends (catch, effort, biological data and abundance indices), assessment, management recommendations and future research.

Approximately 22 different stocks-units were analysed and the results discussed. The quality and trends in basic data (catch, effort, length distribution) collected by each different country and the sampling system, represented some of the main discussion topics of the second meeting 2004 of this Working Group.

The Working Group decided that the majority of the demersal stocks were fully exploited and that, for some of them, the fishing effort should be heavily reduced. A summary of the assessments and management measures is given at the end of this report.

RÉSUMÉ

Un groupe de travail permanent FAO/COPACE, composé de scientifiques des Etats côtiers et des pays ou organisations qui jouent un rôle actif dans les pêcheries démersales de l'Afrique centre-occidentale a été créé par le COPACE en 2000. La première réunion du Sous-groupe Nord a été organisée à Saly, Sénégal, du 14 au 23 septembre 2004.

L'objectif général du Groupe est de contribuer à l'amélioration de l'aménagement des ressources démersales en Afrique du nord-ouest par l'évaluation de l'état des stocks et des pêcheries afin d'assurer la meilleure utilisation durable de ces ressources pour le bénéfice des pays côtiers. La zone d'étude pour le groupe de travail est la zone COPACE de l'océan Atlantique Centre-Est, entre le Cap Spartel et le sud du Sénégal.

En raison de l'hétérogénéité des espèces et des stocks, le Groupe de travail sur les démersaux a été divisé en quatre groupes: merlus, autres démersaux, crevettes et céphalopodes. Pour chacun de ces groupes, des informations sont données sur les pêcheries: système et intensité d'échantillonnage, caractéristiques biologiques, identité du stock, tendances (capture, effort, données biologiques et indices d'abondance), évaluation, recommandations d'aménagement et de recherche future.

Environ 22 stocks-unités différents ont été analysés et les résultats discutés. La qualité et les tendances des données de base (captures, effort et distribution de taille) collectées par chaque pays et le système d'échantillonnage étaient certains des principaux thèmes de discussion de la deuxième réunion 2004 de ce Groupe de travail.

Le Groupe de travail a conclu que la plus grande partie des stocks démersaux étaient pleinement exploités et que pour certains d'entre eux l'effort de pêche devrait être fortement réduit. Le résumé des évaluations et des mesures de gestion est présenté dans les tableaux à la fin de ce rapport.

Distribution :
Working Group participants/Participants au Groupe de travail
Fishery Officers, FAO Regional Offices/Fonctionnaires des pêches des Bureaux régionaux de la FAO
FAO Fisheries Department/Département des pêches de la FAO

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1. INTRODUCTION

The FAO/CECAF Working Group on demersal resources in the northern zone met in Saly, Senegal, from 14 to 23 September 2004.

The overall objective of the Group is to contribute to the improvement of the management of demersal resources in Northwest Africa through assessment of the state of the stocks and the fisheries to ensure the best sustainable use of the resources for the benefit of the coastal countries.

The Group is chaired by Mr Mika Diop of the Mauritanian Oceanographic and Fishery Research Institute (IMROP), Mauritania.

In all 21 researchers from seven different countries and from FAO participated in the meeting.

The meeting was organized by FAO and financed by the General Secretariat of Maritime Fisheries of the Spanish Ministry of Agriculture, Fisheries and Food and by the Netherlands Institute of Fishery Research (RIVO), the Netherlands. It was a follow-up to the second meeting, financed by the Netherlands, which took place in Conakry, Guinea, from 19 to 29 September 2003.

1.1 Terms of reference

The terms of reference of the Working Group which were adopted by the CECAF sub-committee (FAO, 2001) were:

1. To update (to 2003) the catch and effort statistics by country and by species.
2. To consolidate and update biological information on catches, in particular length and age, if available. To proceed with a review of the trends and quality of the available data.
3. To select the most reliable data sources and assessment methods.
4. To assess the current state of the different stocks in the subregion using the available catch and effort information, the biological data and the data from the research surveys.
5. To present the different stock management options for the various stocks, pointing out the long and short-term effects.
6. To identify gaps in the data which need to be remedied during future Working Group meetings.

1.2 Participants

Eduardo	Balguerias	Spain
Pedro	Barros	FAO/Rome
Mariama	Barry	Senegal
Said	Benchoucha	Morocco
Ana Maria	Caramelo	FAO/Rome
Ad	Corten	Netherlands
Famara	Darboe	The Gambia
Mika	Diop (President)	Mauritania
Lourdes	Fernández Peralta	Spain
Eva	García Isarch	Spain
Cheikh (part time)	Inejih	Mauritania
Beyah	Meissa	Mauritania
Asberr	Mendy	The Gambia
Amina	Najd	Morocco
Ana	Ramos	Spain
Pedro	Pascual Alayon	Spain
Birane	Samb	Senegal
Ibrahima	Sow	Senegal
Ignacio	Sobrino	Spain
Merete	Tandstad	FAO/Rome
Djiga	Thiao	Senegal

1.3 Definition of working area

The assessment area of the Working Group is the northern CECAF zone of the Centre–East Atlantic Ocean, between Cap Spartel and the south of Senegal.

1.4 Data quality

Trends and quality of the basic data (catch, effort and length frequencies) collected by each country, as well as the sampling system, were the main topics of discussion during the 2004 Working Group meeting.

For data analysis, the Group envisaged the long term application of analytical assessment methods for all of the stocks. These are methods based on virtual population analysis (VPA) such as ICA, XSA or others. However, in order to use such methods the availability and consistency of catch at age statistics is indispensable as is the possibility of following the different cohorts by age and year through the data series. There are though still problems with the sampling of catches and with the basic data and uncertainties surrounding stock definition which prevent the use of these analytical methods. The Group is aiming to improve the quality of the data series by organizing age reading workshops and carrying out studies on the stocks of each country. The quality of the data series could therefore be improved in the future.

1.4.1 Sampling schemes and sampling intensity

Sampling of the biological parameters (including length and weight) is mostly carried out during the research surveys (Table 1.4.1). Morocco and Mauritania carry out several surveys a year. During these surveys, all the demersal fish species, shrimps and cephalopods are sampled. In 2003 Spain conducted several research surveys on hake in Mauritanian and Spanish waters, using commercial vessels.

As for landings (Table 1.4.2), several problems arise. The landings of black hake by the Spanish fleet are done at Vigo where there is no sampling scheme in place. Thus there are no data on landings. On the other hand, the landings of the ice trawlers in Cadiz are thoroughly sampled by the IEO.

For octopus, data from the commercial fisheries of Morocco and Mauritania are used. In Morocco these data are supplied by the ministry and in Mauritania by the producers' organization, Mauritanian Commercial Fish Company (SMCP). However there is still a lack of information about the Spanish freezer trawlers in Mauritania and the artisanal fishery of Mauritania.

Shrimp are always frozen on board. In theory the data from the landings of the different commercial categories could be used. However, these commercial categories are not standardized, so till now this data is not used to estimate length composition of the landings.

The landings of demersal fish are sampled in Morocco and for the artisanal fishery, in Senegal. In Mauritania no sampling is carried out on the landings of the national fleet, or on the catches of the foreign fleet.

1.5 Methodology and software

For reasons of heterogeneity the species and stocks of the Working Group were divided into four subsets: Hake, Other demersal fish, Shrimps and Cephalopods.

After reviewing the available data, the Working Group decided that the surplus production models should be used to assess all stocks–units (Appendix 2). For one of these stocks (white hake) information is available on the length frequencies of the landings. It is therefore possible to apply models based on length composition.

1.6 Structure of the report

Separate sections have been devoted to each of the four groups: Hake, Other demersal fish, Shrimps and Cephalopods. For each of these groups information is given on the fisheries, sampling schemes and sampling intensity, biological characteristics, stock identity, trends (catch, effort, biological data and abundance indices), assessment, management recommendations and future research. Table 1.6.1 provides the definition of the units analysed by group.

1.7 Follow up of the research recommendations

The Working Group assessed the research recommendations of the last Working Group meeting (2003). The actions adopted for the realization of these recommendations are presented in Table 1.7.1. The Group noted that work has been started to improve the systems for collecting statistics in the countries of the subregion as well as on biological aspects

of certain species studied within the framework of the Working Group. Some recommendations, for various reasons, were not taken into consideration but several will be fulfilled during the present meeting.

1.8 Recent developments in the landings in the northern region

Total catch of demersal resources in the region was estimated at 308 000 tonnes in 2003. Total landings of demersal resources for the period 1990 to 2003 fluctuated around 350 000 tonnes with periods of greater landings of more than 400 000 tonnes, in 1990–1994 and 1999–2000. A decreasing trend has been seen since 2000 (Figure 1.8.1).

The most important demersal resource in the region is the octopus (*Octopus vulgaris*) which makes up on average around 30 percent of the catches of demersal resources during the period being studied. Total catches of octopus have seen a decreasing trend over the last five years going from 150 000 tonnes in 1999 to 60 000 tonnes in 2003 (Figure 1.8.1). Total annual cuttlefish (*Sepia* spp.) landings varied around 28 000 tonnes for the period 1990–1999 followed by a peak of 41 000 tonnes in 2000, then a decrease to 14 000 tonnes in 2003.

Annual average catches of demersal fish (excluding hake) over the last five years have been estimated at around 36 000 tonnes. The red pandora (*Pagellus bellottii*), widely distributed in the West African zone, is the most important species of demersal fish studied by the Working Group. Average landings of this species over the last five years have been around 12 000 tonnes.

Landings of hake (*Merluccius merluccius, M. senegalensis* and *M. polli*) during the last five years have been between 15 000 and 26 000 tonnes, averaging 22 000 tonnes (Figure 1.8.1).

The deepwater rose shrimp (*Parapenaeus longirostris)* and the Southern pink shrimp (*Penaeus notialis*) are considered to be important in the region. Annual average landings over the last five years of *P. longirostris* are estimated at 16 000 tonnes and of *P. notialis* at around 5 000 tonnes.

Other demersal resources not analysed by the Working Group are classified under “Diverse demersal fish” and “Others”. “Diverse demersal fish” includes the demersal fish that are landed but not studied by the Working Group, while “others” includes those species of shrimps and cephalopods that are not studied by the Working Group and other crustaceans and molluscs etc. Landings of these species reach almost 40 percent of the total landings of demersal resources in the region, with an average landing, over the last five years, of 150 000 tonnes/year.

2. HAKE

2.1 Fisheries

The hake fisheries in the region vary considerably between the various countries.

In Morocco hake are targeted by the Moroccan coastal trawler fleet, of approximately 450 vessels, and by the longliner fleet which has been operating in Morocco within the framework of Spanish–Moroccan joint ventures since the end of 2001, and which includes around 20 vessels. The European Union fleet ceased activity in Moroccan waters in 1999.

The only merluccidae species targeted by the coastal Moroccan fishery is the white hake (*Merluccius merluccius*). The longliner fleet exploits both white hake and Senegalese hake (*Merluccius senegalensis*).

In Mauritania, hake fishing is concentrated on black hakes (*Merluccius senegalensis and M. polli*). These are targeted by the Mauritanian and Spanish fleets that practice fresh fishing as well as the bottom longliners. During certain periods the Spanish freezer trawlers also catch large amounts of black hake. These species also make up a non-negligible part of the bycatch of the cephalopod, shrimp and pelagic trawlers.

Since the last few years, the Spanish hake trawlers operate more and more in deeper zones reaching up to 1 000 m in depth.

In Senegal, the Spanish trawlers are the only fleet that targets black hake.

2.2 Sampling schemes and sampling intensity

2.2.1 Catch and effort

Since 2001, the National Fisheries Office of Morocco (ONP) has established a system of daily landings recording in the main ports (the MAIA system). The landings are recorded every day by boat and by species in each port and are then sent to the head office of the ONP in Casablanca. Because of this, a database of data on landings and fishing effort, until 2003, is available to the INRH.

Catch and effort data of the Spanish trawlers and longliners which target black hake in Mauritanian and Senegalese waters are available until 2002. In view of the difficulty in obtaining data from the Spanish longliner fleet, a sampling system was set up in the port of Vigo in January 2004.

In spite of the fact that the two species of black hake are not separated in the fisheries statistics, their proportions in the Spanish hake trawler catches have been calculated based on the results of six research surveys which the Spanish Oceanographic Institute (IEO) carried out on board this fleet in 2002 and 2003.

A summary of the historical data on bycatch in the landings of the Spanish hake trawlers had been prepared before the meeting (Diop *et al.*, 2004). The 1984–2002 time series of total bycatch in the landings of the Spanish hake trawler fleets in the three fishing zones is also available.

A study of the percentage of discards of the Spanish hake trawlers in Mauritania in 2002 and 2003 (IMROP/IEO, 2003) has concluded that there is an average of 45–50 percent discards in this fishery.

2.2.2 Biological parameters

Sampling of landings of the commercial fishery in Morocco for biological characteristics of the catches is only done at certain “reference” ports.

The sampling carried out during the surveys conducted by the National Fisheries Research Institute (INRH) provides supplementary information on the demographic structure as well as the biological characteristics of the white hake (sex–ratio, sexual maturity, length–weight relationship, growth... etc.) for the whole distribution area. In total, 36 research surveys were carried out by the INRH using their two research vessels, the IBNOU SINA from 1982 to 1986 and the CHARIF AL IDRISSI from 1987 to 2004. These surveys covered the trawlable zones between Tangiers and Agadir. Generally 80 to 90 trawls were carried out over the course of each survey, following a stratified random sampling. For each trawl the whole catch was sorted and weighed and a species table was made. A sample was then taken of the white hake to study its demographic structure and biological characteristics.

In Morocco, sampling intensity of white hake during the research surveys is high, between 58 and 72 percent, and the level of coverage is 100 percent (all trawls are surveyed). On the other hand, the sampling intensity of the landings of the coastal fishery is very low, between just 0.001 and 0.01 percent. Furthermore, only certain ports are covered by the sampling.

In Mauritania, IMROP undertook four assessment surveys between 2000 and 2001, on board the R/V AL-AWAM, within the framework of the joint IMROP-JICA project. These surveys were carried out at depths of between 30 and 400 m during the cold and warm seasons in the Northern, Central and Southern zones. During the surveys data on yields, length frequencies (LF) and other biological data were collected for the black hakes *Merluccius senegalensis* and *Merluccius polli*. In total, 5 241 individuals were measured.

In 2002, IEO began a programme of embarking scientists on board the Spanish hake trawlers operating in Mauritania. This programme is to be extended subsequently to the hake trawlers operating in Senegalese waters. Two surveys were carried out in 2002 and four in 2003, covering the four hydrological seasons. A number of 1 994 *M. senegalensis* individuals and 19 260 *M. polli* were measured.

During these surveys, data were collected on abundance distribution of the two hake species, the species composition of the catch, length frequencies, discards by zone, the bathymetry and the biological characteristics (length–weight relationship by sex, sex–ratio, breeding grounds and seasons, growth, fertility and genetics).

In October 2003 a joint IEO/IMROP scientific programme was set up. This programme aims at surveying the Mauritanian EEZ with a Spanish commercial longliner. Five surveys will be carried out for a total of 200 days at sea during the four seasons with fixed transects and stations. The CTD will also be used. The deeper zones will be surveyed by longliners for the hake fishery and by pots for the lobster and deep sea crab fisheries. The coastal zone south of Cape

Timiris will also be surveyed for the possible presence of octopus, coastal shrimp and other fish resources. The complete results of these surveys will be presented to the next Working Group.

There is no hake biological sampling programme in Senegal or The Gambia.

2.3 White hake (*Merluccius merluccius*)

2.3.1 Biological characteristics

The white hake is a temperate water species, present along the Atlantic coasts of Europe and Northwest Africa (from Iceland/Norway in the north to Mauritania in the south), in the Mediterranean and along the southern coasts of the Black Sea. The white hake has a relatively long lifespan and moderate growth. Sexual maturity is attained at around the fifth year of life. The females produce between 2 million and 7 million eggs. The intrinsic growth rate is moderate. As for their feeding, the white hake adults generally eat fish (young hake, anchovies, sardines and gadid species) and squid; the young eat crustaceans (especially euphausids and amphipods).

The bathymetric distribution of hake is strongly related to the phases of the biological cycle (Figure 2.3.1).

Spawning generally takes place between the 150 and 200 metre isobaths. The eggs are then carried by the current towards the surface. While they are growing, the larvae are carried towards the coast until the juvenile stage. The adults on the other hand return to the deeper waters after spawning.

2.3.2 Stock identity

The white hake (*Merluccius merluccius*) population of Morocco is considered as a single stock. This species can be found on all types of bottoms from the Straits of Gibraltar to 21° N and from the coast to a depth of 1 000 m.

2.3.3 Data trends

Catch

The annual registered catch by the Moroccan trawler fleet has seen a continual increase since 1998 (Table and Figure 2.3.3a). Landings in 2003 reached 11 600 tonnes, or twice the landings registered in 2002.

Catches by the Spanish trawlers, gillnet fishing vessels and longliners saw a decrease from 1991 until the withdrawal of these fleets in 1999.

Effort

The number of coastal Moroccan trawlers targeting white hake has remained stable since 1992 at 450 units.

The effort of these trawlers has not seen any notable changes since 2001 (Table and Figure 2.3.3b), remaining stable at around 40 000 fishing days during 2001–2003.

The number of European Union vessels saw a progressive decline from 1992 to 1999 when they withdrew from Moroccan waters.

Abundance indices

CPUE

The CPUEs (catches per unit of effort) of the Moroccan trawlers, expressed in kilograms per fishing day (Figure 2.3.3c) show an increasing trend from 1999. The highest recorded CPUE value since 1995 is in 2003 (290kg/fishing day).

The CPUEs of the Spanish vessels showed a decreasing trend from 1996 until the end of the fishing agreement in 1999.

Research surveys

The white hake abundance indices from the surveys (Figure 2.3.3d) show a decreasing trend from 1982 to 2004. The abundance of white hake in 2004 fell by 24 percent compared to that of 2003.

The distribution maps of the white hake abundance indices (Figure 2.3.3e) show a shrinking of the observed areas of concentration of this species. The high densities detected in 2002, which were between 53 and 85 kg/h, completely disappeared in 2004.

Biological data

The surveys have provided some very detailed data on the biological characteristics of the white hake (Table 2.3.3c). Studies of the sex–ratio of this species show a slight female dominance, 56 percent of the sample against 44 percent for the males. The length at first sexual maturity for the females is 34.56 cm. The length–weight relationship equation is $P = 0{,}010494 \times L^{2{,}903268}$ (Table 2.3.3c and Figure 2.3.3f).

Length composition and other information

Analysis of the length distributions in the white hake landings shows that the main mode varied between 16 and 20 cm from 1988 to 1997. From 1998 the mode began to increase, reaching 28 cm in 2000. It then decreased to 22 cm in 2003. On the other hand, the variation in the average length in the landings (Table 2.3.3d and Figure 2.3.3g) has shown a stable trend since 1997.

Analysis of the length distributions obtained during the surveys carried out by the INRH show on the other hand that the average length of the stock has decreased between 1982 and 2004 (Figure 2.3.3h). The percentage of juveniles has increased continually since the beginning of the series, reaching values of 74 percent in November 1999 and 72 percent in June 2003 (Figure 2.3.3i).

Current management measures

In Morocco, the management measures applied to the coastal fishery targeting white hake are limited to regulating the mesh size at 50 mm and the ban on fishing within three miles of the coastline. The closed season was only applied to the European Union vessels operating in Moroccan waters under a fishing agreement that ended at the end of 1999.

2.3.4 Assessment

Methods

The Schaefer dynamic production model implemented in an excel spreadsheet was used to assess the state of stock and fisheries of white hake (see Appendix 2).

A Length Cohort Analysis (LCA) model was also used in the assessment of the white hake stock in Morocco.

Data

To use the production model for the assessment, the series of abundance indices of white hake (*Merluccius merluccius*) obtained during the research surveys was adopted by the Working Group and used with the series of total catch of the stock. The catch statistics of the coastal fishery are underestimated as the longliner catches from the Moroccan–Spanish joint ventures are not available. The Working Group believes that the abundance indices from the surveys better reflect the real stock situation. As opposed to the previous year, a global abundance index was used, corresponding to the stratified average of the observed yields in the two zones surveyed and all the depth strata.

For the LCA, data on length frequencies from the coastal fishery targeting white hake as well as growth parameters and the length–weight relationship were used to assess the stock of white hake.

Results

The model provides a fairly good fit to the adopted series of abundance indices (Figure 2.3.4).

The results of the assessments obtained using this series indicate that the white hake stock is overexploited, with catches that are too high for the natural production of the stock (Table 2.3.4). The current fishing effort is above that of the sustainable fishing effort at current stock biomass levels.

Table 2.3.4: Indicators on the state of the stock and the fishery of *Merluccius merluccius* in the Northern subregion of CECAF

Management unit/Stock	Abundance index	B/B_{MSY}	F_{cur}/F_{SYcurB}
Morocco	Abundance indices of the INRH surveys	119%	115%

B/B_{MSY} : Biomass of the stock in the last year of data as a percentage of the biomass that would produce the Maximum Sustainable Yield. F/F_{SYcurB}: Fishing mortality by fishery in the last year as a percentage of the fishing mortality by fishery necessary to extract the sustainable yield from the current biomass level estimated for the last year of data.

The results obtained using the LCA method also show that the white hake stock is overexploited. Fishing mortality is very high for smaller sizes. The most exploited sizes are between 22 and 36 cm total length. The average weight of the individuals caught is 200g.

Discussion

The results obtained in the assessments show that the stock is overexploited. Fishing effort is 15 percent greater than that producing MSY. Catches are higher than the sustainable production at current biomass levels.The results of the LCA also show that the stock is overexploited. Recruit survival is so weak that the stock could collapse at any moment.

The results of the production model and LCA assessments give consistent indications on trends in stock evolution.

2.3.5 Management recommendations

Taking into account the assessment results, the Working Group decided to recommend the following management measures:

- To reduce fishing effort by about 15 percent.
- To stop fishing in the Larache–El Jadida zone in order to protect white hake recruitment.
- To carry out studies on the possibility of using separator trawls to separate white hake catches from shrimp catches.
- To convert certain vessels to a fishery of less exploited resources.
- To strictly control and apply the current regulations regarding trawl mesh size.

2.3.6 Future research

Updating basic data quality for assessment needs to reduce uncertainties surrounding the results requires additional research to be carried out. The Working Group therefore recommends the following:

- Assessment of the selectivity of the fishing gears.
- Assessment of bycatch and discards of hake in the other fisheries.
- Surveys of hard bottoms and of deep waters to assess the abundance of fishery resources.
- Conduct regular demersal trawl surveys during the same seasons and periods.
- The rapid resumption of biological sampling and of fishing effort in the commercial fishery catches.
- Data collection (catch and effort) of longliners which have been operating in Moroccan waters since the end of 2001 under Moroccan–Spanish joint ventures.

2.4 Black hake (*Merluccius polli* and *Merluccius senegalensis*)

2.4.1 Biological characteristics

Two species of black hake, both exclusive to the centre-east Atlantic, are found on the Moroccan, Mauritanian and Senegalese coasts. The Senegalese hake (*Merluccius senegalensis* – Cadenat, 1950) is found between 33 °N and 10 °N, whereas the Benguela hake (*Merluccius polli* – Cadenat, 1950) is fished between 20 °N and 18.5 °S (Lloris , Matallana and Oliver, 2005).

Taxonomically it is very difficult to distinguish between the two species and for this reason they are normally not separated in commercial statistics. The maximum length is different for the two species, 80 cm for the Senegalese hake and 70 cm for the Benguela hake (Ramos *et al*., in preparation).

According to studies by Boukatine (1986) and Overko, Boukatine and Ly (1986), the most abundant species on the Mauritanian coast is the Senegalese hake, but studies carried out during the IMROP surveys in 2000 and 2001, as well as the results of the scientific observations on board the Spanish hake trawlers in 2002–2003 show that *M. senegalensis* is found at depths of between 150 and 450 m with a maximum abundance in the 200–400 m strata (Table 2.4.1a). After this depth and up to the 1 000 m isobath, *M. polli* is the most abundant (IMROP/IEO, 2002, 2003). This is agreement with observations from Senegal where *M. senegalensis* were found to occupy the more coastal waters and *M. polli* the deeper waters (Caverivière *et al*., 1986; FAO, 1986).

The Senegalese hake breeding grounds are centred around the south of Morocco, the north of Mauritania and to a smaller degree, the north of Cape Verde, whereas the Benguela hake appears to spawn in two different zones, Mauritanian waters and the Gulf of Guinea (García, 1982; Wysokinski, 1986). Both species spawn during the cold season, between October and March (Wysokinski, 1986; Sobrino *et al*., 1990). It would appear as well that both species migrate latitudinally (García, 1982).

During the cold season, both in 2000 and 2001, *M. senegalensis* yields were high over the whole Mauritanian EEZ and particularly in the central zone (Table 2.4.1a). During the warm season, it is the northern and central zones that provide the highest yields, with the central zone still being the area of highest concentration and a low abundance in the southern zone. During these two years, the highest yields were observed at depths of between 200–400 m in the sectors surveyed.

For *M. polli*, during the cold season, the highest yields are observed in the central and southern zones respectively, over all the depths surveyed. The greatest abundance observed was at depths of 200–400 m. During the warm season, the highest concentrations were found in the central zone. In the northern zone, *Merluccius polli* was only found at depths of between 200 and 400 m and in the southern zone at depths of between 80 and 200 m.

2.4.2 Stock identity

No detailed studies on black hake stock identity have been carried out.

Genetic studies will be carried out on samples taken on board the Spanish hake trawlers. These studies should contribute to the confirmation of the stock identity of the two species in Mauritanian waters.

2.4.3 Data trends

Catch

Globally, catches of black hake reached a maximum in 1993 with 20 251 tonnes. After this they stabilised at between 14 500–18 500 tonnes during 1994–2002 (Table and Figure 2.4.3a).

Since 1998, catches of black hake have been increasing in Mauritania. They have comprised 90 percent of the total declared catch of black hake in the CECAF zone since 2000 (96 percent in 2002). In 2002, at the same time as the landings of the Spanish hake trawlers decreased, those of the demersal freezer trawlers increased. Very high catches of black hake can be seen between 2002 and 2004 in the landings of other trawlers, especially the pelagic trawlers (Table 2.4.3a and Figures 2.4.3b and 2.4.3c). In 2002, these catches were at the same level of those of the Spanish hake trawlers.

In Senegal (Figure 2.4.3d), since the peak in 1992 (6 000 tonnes), landings of the Spanish trawlers have shown a decreasing trend.

For the Spanish hake trawlers fishing in Mauritanian waters, 85 percent of landings are composed of *M. polli*. This is due to deep water fishery, the average depth fished between 2002 and 2003 being 557 m. The aim of fishing in deeper waters is to catch *Merluccius polli* which has a higher commercial value and also to avoid catching individuals with a length of less than 30 cm. The species composition of the discards of the Spanish hake trawlers in Mauritania in 2002 is shown in Figure 2.4.3e.

Effort

In Mauritania, Spanish trawler fishing effort decreased between 1990 and 1999, going from 5 000 to 1 423 fishing days (Table 2.4.3b and Figure 2.4.3f). Subsequently however, the trend increased over the rest of the period. The effort of the

Spanish longliners shows the opposite trend, increasing between 1993 and 1999, then slowly decreasing till the end of the series. The effort of the Spanish freezer demersal trawlers was also considered, as these, over recent years, have targeted hake and exerted an almost identical effort on the species as that of the hake trawlers during certain periods.

In Senegal, the effort of the Spanish hake trawlers has shown a decreasing trend since the two peaks observed in 1984 (1 256 fishing days) and 1993 (940 fishing days), stabilizing at around 200 days over the last four years (Figure 2.4.3g).

Abundance indices

CPUE

In Mauritania, after a continual increase from 1991 to 2000, the yields of the Spanish trawler fleet fell drastically from 5 000 kg/fishing day in 2000 to 2 000 kg/fishing day in 2002, a decrease of 60 percent in two years (Figure 2.4.3h). This drastic reduction can also be seen in the demersal trawlers. The CPUEs of the longliners, on the other hand, are quite stable. Those of the Mauritanian hake trawlers have shown a rapid decrease since 2002. In 2002 the CPUE values of the three fleets are at the same level (1 500–2 100 kg/fishing day).

The CPUEs of the Spanish trawlers in Senegal show a continued increase from 1991 until 2001 (Figure 2.4.3i).

Biological data

Length composition

Analysis of the length frequency histograms (Figure 2.4.3j) obtained during the IMROP surveys highlights a plurimodal length distribution of *Merluccius senegalensis* during the 2000 cold season over a length interval of between 7 and 64 cm. During the warm season of the same year, a unimodal distribution can be noted, with a length range between 12 and 56 cm.

For the year 2001, the length distribution is equally unimodal for both seasons, with modes at 27 cm and 35 cm respectively. The length intervals are centred between 10–59 cm and 11–56 cm for the warm and cold seasons respectively.

Sex-ratio

Figures 2.4.3k and 2.4.3l show the proportion of both sexes of *Merluccius polli* and *Merluccius senegalensis* obtained from the scientists embarked on board the Spanish hake trawlers in 2002 and 2003. A sex-ratio of 69 and 72 percent female can be seen in the population of both species. The proportion of females is high in both seasons. The same results were obtained by IMROP for *M. senegalensis*. For *M. polli*, the sex-ratio is higher for the males in the cold season, and balanced during the warm season. The males are smaller than the females for both species. The male proportion is higher among the smaller individuals.

Sexual maturity

During the IMROP surveys no *Merluccius senegalensis* Stage IV females were observed.

In 2000, during the cold season, Stage I females are dominant (91.5 percent), followed by Stage II females (8.5 percent). Stage III was completely absent. The same situation was observed in the 2001 cold season when Stage III females only made up 5 percent of all the stages.

During the warm season a change in gonad maturity can be seen, the percentage of Stage I females decreases (60 percent) and that of Stages II and III females increases significantly with respect to the cold season, totalling 30 percent and 10 percent respectively.

For *Merluccius polli*, the Stage I females are dominant in both seasons (65–93 percent), Stage II represents 32 percent in the cold season and only 6 percent in the warm season. Stage III is barely present with 3 and 0.9 percent respectively for the cold and warm seasons. Stage IV, as with *Merluccius senegalensis*, is completely absent.

Length–weight relationship

The length–weight relationships of both species of hake (length in millimetres, weight in grams) are given in Figures 2.4.3m and 2.4.3n. The eviscerated length–weight relationship is given as some commercial categories are landed without viscera.

Generally, *M. polli* is heavier than *M. senegalensis* (Figures 2.4.3m and 2.4.3n). However the number of individuals used of this last species to estimate the relationship was quite low.

The length–weight relationship graphs by sex of *M. polli* show that growth in the females, both in terms of length and weight, is higher than that of the males (Figure 2.4.3o).

2.4.4 Assessment

Methods

The Schaefer dynamic production model, implemented in an Excel spreadsheet, was used to assess the state of the stock and fisheries of black hake. The model is described in detail in Appendix 2.

Data

The catch series of black hake estimated by the Working Group for Mauritania and Senegal were used as total catch series. The zone to the north of Mauritania was not considered as there is no black hake fishery in this zone.

The CPUE series of the Spanish fresh hake trawlers for both zones were used as the abundance indices.

Results

For Mauritania the model does not fit the CPUE series of the Spanish fresh fish fleet well. This is probably due to large fluctuations in the observed CPUEs. These fluctuations can be explained by the instability that this fishery has undergone in Mauritania, and not necessarily by fluctuations in stock abundance. With relation to the hake fishery, several events have been noted in Mauritanian waters over the last few years:

- The coming into force of the rule limiting the minimum catch length of hake to 30 cm since 1991 – which has been strictly enforced since 1996 – and the shift of the Spanish fleet towards deeper waters to fish larger individuals (550 m average depth in 2002 and 730 m in 2003).
- The entry into the fishery, since 2001, of two fleets: a Spanish demersal fleet targeting hake, with freezer capabilities, and the pelagic trawler fleets, which catch large quantities of hake as bycatch.

For Senegal, the estimated CPUEs of the model fit the fisheries yields well (Figure 2.4.4). The model suggests that the black hake biomass in the zone is below that producing maximum sustainable yield. Fishing effort is estimated to be weak for the level of biomass; this explains the increase in the stock (Table 2.4.4).

Table 2.4.4: Indicators on the state of the stock and the fishery of *Merluccius polli* and *Merluccius senegalensis* (black hake) in the Northern subregion of CECAF

Management unit/Stock	Abundance index	B/B_{MSY}	F_{cur}/F_{SYcurB}
Senegal	CPUE of the Spanish hake trawlers	76%	37%

B/B_{MSY} : Biomass of the stock in the last year of data as a percentage of the biomass that would produce the Maximum Sustainable Yield. **F/F_{SYcurB}**: Fishing mortality by fishery in the last year as a percentage of the fishing mortality by fishery necessary to extract the sustainable yield from the current biomass level estimated for the last year of data.

Discussion

Generally the model results agree with the history of the fisheries in Senegal.

In the Mauritanian fishing zone a decline in the CPUEs of all the fisheries targeting hake has been observed, with the exception of the longliners. The current level of total fishing effort (targeted effort and not targeted) shows a situation of overfishing.

2.4.5 Management recommendations

For Morocco, no recommendation can be made as the fishery stopped in 1999.

For the Mauritanian stock, despite the fact that the fit of the production model is very poor, taking into account the drastic reduction in yields observed in all the fisheries targeting hake, as well as the targeting of this resource by other

trawlers, and in particular in view of the drop in CPUE in 2001–2002 (60 percent in the case of the Spanish hake trawlers), it is recommended that effort be reduced by the fleets fishing hake, both as target species and as bycatch.

As far as Senegal is concerned, the Working Group recommends not increasing fishing effort (giving no new licences) until the 2002–2004 catch and effort data have been analysed.

2.4.6 Future research

Taking into account the uncertainties and difficulties encountered, the Working Group recommends:

1. Revising and analysing the IEO and IMROP databases before the next Working Group meeting.
2. Obtaining information on fishing strategies, fishing gears used, catch and discards of all fleets fishing hake both as target species and bycatch in Mauritanian waters.
3. Updating the series of fishery statistics of the trawlers targeting hake in Senegal until 2004.

3. DEMERSAL FISH

3.1 Fisheries

In the four countries of the northern CECAF zone (Morocco, Mauritania, Senegal and The Gambia) coastal demersal resources include fish, crustaceans and cephalopods which are fished at depths of between 0 and 200 m. They are exploited by both industrial (national and foreign) and artisanal fleets.

The fisheries are multispecific and the demersal fish species often constitute bycatch of other specialised fisheries such as the cephalopod, hake or shrimp fisheries.

In 2004, the demersal fish species assessed were *Pagellus bellottii*, *Pagellus acarne, Dentex macrophthalmus*, *Pagrus caeruleostictus*, *Sparus* spp., *Arius* spp., *Pseudotholitus* spp. and *Epinephelus aeneus*. The total landings of these species is given in Table and Figure 3.1.1a.

In Morocco, the fleets that exploit demersal resources are mainly the Moroccan cephalopod freezer trawlers (Ceph.N).

In Mauritania, exploitation of demersal resources is carried out by trawlers which include foreign cephalopod trawlers (Ceph.E), national cephalopod trawlers (Ceph.N), foreign and national hake trawlers (Merlu), foreign and national shrimp trawlers (Crevet), foreign pelagic trawlers (Pélagiq) and foreign and national demersal fishers (Poiss).

In Senegal, demersal resources are exploited by the artisanal and industrial fisheries. The main types of artisanal fishery targeting demersal resources are canoes which fish with a line and are either rowed (PVL) or have an engine (PML) some of which are equipped with ice blocks (PG), and set gillnets (FD). These resources are also bycatch for the purse seine (ST), ringnets (FME), beach seines (SP) and other gears (DIV).

The industrial fleets operating in Senegal are all trawlers which are either national (PIS) or foreign, with coastal demersal fishery licences (PIEC) or deep water demersal fishery licences (PIEP). As regards preservation methods, all trawlers can be divided into freezer trawlers (CON) or ice trawlers (GLA).

In Gambia foreign freezer trawlers (PI) and canoes exploit demersal species. The effort series of these fleets are given in Table and Figure 3.1.1b.

3.2 Sampling schemes and sampling intensity

3.2.1 Catch and effort

The systems of fishery data collection and the biological parameters of demersal fish were described in the last Working Group report (FAO, 2006).

During the 2004 Working Group, a complete update of the Senegalese and Mauritanian data series with regard to the previous Working Group was made, due to the restructuring of the databases of the two countries. Morocco and The Gambia updated their series to 2003. The catch data provided by Mauritania for 1990 are incomplete.

In Senegal's case, floating average estimates were made for the last years given that the industrial fishery data were not completely available. For the Senegalese industrial fishery (PIS), this estimation applies to the years 2002 and 2003,

and for the foreign fishery (PIEC and PIEP), estimates were made for 2001, 2002 and 2003. For the artisanal fishery, only the year 2003 was estimated.

As regards the Senegalese artisanal fishing effort, the data series appears to be inconsistent between 1996 and 1999. Consequently these data should be considered provisional.

For The Gambia, it should be highlighted that only catch estimates for the artisanal fishery have been provided as effort data is not available.

3.2.2 Biological parameters

For most of the countries, biological sampling of demersal fish only takes place during surveys by the research vessels.

In Morocco, lengths are measured and weights of landings are recorded from the coastal fishery in the ports where there is an INRH sampling station.

In Senegal length frequency samples are regularly taken of the landings of the artisanal fishery by CRODT samplers. A summary of sampling intensity in 2002 is given in Table 3.2.1a.

3.3 Red pandora (*Pagellus bellottii*)

3.3.1 Biological characteristics

The red pandora occurs in schools over hard as well as sandy bottoms, especially in the upper 100 m. The species is omnivorous with a predominantly carnivorous diet (including crustaceans, cephalopods, small fish, amphioxus and worms). In the Eastern Atlantic, it is distributed from the Straits of Gibraltar to Angola, including the south-western Mediterranean and the Canary Islands.

3.3.2 Stock identity

It appears to be a single stock that is exploited by the same types of fishery, industrial and artisanal, in the whole subregion. However, taking into account its relative importance to each country, the Working Group decided to analyse each management unit separately (Morocco, Mauritania, Senegal and The Gambia).

3.3.3 Data trends

Catch

Total catch of *Pagellus bellottii* (Figure 3.3.3a) has seen an increase since 1990, reaching a new historic level of around 14 000 tonnes in 1999. Subsequently the catches have tended to fluctuate, with a decreasing trend.

Effort

The fishing effort series shows slight differences between the zones of Morocco, Mauritania and The Gambia (Figure 3.3.3b). In Morocco and Mauritania, the national cephalopod trawler fleets dominate the fishery, but the effort decreases from 1996. The same trend is observed in the industrial fishery of The Gambia. In the Senegalese zone, the fishery is dominated, in terms of effort, by the artisanal fishery. Here, strong growth in effort can be seen between 1996 and 1999, returning to earlier levels from 2000. The other fleets do not show clear trends in effort.

Abundance indices

CPUE

The CPUE series of *Pagellus bellottii* of the Moroccan, Mauritanian and Gambian industrial fleets fluctuated over the period of analysis (1990–2003) in a very marked fashion. The pelagic fleet that operates in Mauritania shows a peak in 1998 (Figure 3.3.3c) The CPUE series of the artisanal Senegalese fleet fluctuates around 330 kg per trip. The CPUE of the ice canoes shows a decreasing trend from 1990 to 1997, followed by a slight increase.

Research surveys

Abundance indices of the AL-AWAM surveys

The series of abundance indices (in kilograms/30 minutes) obtained in Mauritania for *Pagellus bellottii* from the assessment surveys of the R/V AL-AWAM is given in Table 3.3.3a and shown in Figure 3.3.3d. The data trend both in the cold and warm seasons is to decrease, with a slight increase in 2003.

Biological data

Length composition and other information

Several research surveys were carried out in 2000 and 2001 with the R/V AL-AWAM under the joint IMROP-JICA project in Mauritania. In 2000, the sex-ratio of the species was in favour of the males. In the cold season Stage I was dominant with more than 70 percent females, whereas in the warm season it is Stage II that dominates with more than 51 percent; Stage III is also well represented in the warm season with more than 11 percent, though it is completely absent in the cold season.

In 2001, the sex-ratio is in favour of the males during the cold season, whereas it is balanced in the warm season. Gonad maturity also increases from one season to another: Stage III which only amounted to 11 percent during the cold season is observed in more than 31 percent of females during the warm season. The warm season is therefore the spawning season.

3.3.4 Assessment

Methods

The Schaefer dynamic production model, implemented in an Excel spreadsheet, was used to assess the state of the stock and fisheries of *Pagellus bellottii*. The model is described in detail in Appendix 2.

Data

The total catch series of *Pagellus bellottii* for the northern CECAF zone (Morocco, Mauritania, Senegal and The Gambia) were used. For the abundance indices series, the Working Group decided to use the CPUE series of the motorised line fishing canoes from the Senegalese artisanal fishery.

Results

The model provides a satisfactory fit to the data (Figure 3.3.4).

The current biomass is estimated at 50 percent of that producing maximum sustainable yield. Current fishing mortality is 10 percent greater than that which would produce a sustainable yield at the current biomass level (Table 3.3.4).

Table 3.3.4: Indicators on the state of the stock and the fishery of *Pagellus bellottii* in the Northern subregionof CECAF

Management unit/Stock	Abundance index	B/B_{MSY}	F_{cur}/F_{SYcurB}
Northern subregion CECAF	CPUE motorized line canoes Senegal	54%	111%

B/B_{MSY}: Biomass of the stock in the last year of data as a percentage of the biomass that would produce the maximum sustainable yield. **F/F_{SYcurB}**: Fishing mortality by fishery in the last year as a percentage of the fishing mortality by fishery necessary to extract the sustainable yield from the current biomass level estimated for the last year of data.

Discussion

The model provides a reasonable fit to the data series. The current estimated biomass is below that producing maximum sustainable yield. The current estimated fishing mortality is more than 10 percent higher than that which would produce a sustainable yield at current biomass levels. This indicates that the stock is to be considered overexploited.

3.3.5 Management recommendations

The Working Group recommends that fishing effort in this fishery be reduced by 10 percent. Taking into consideration that this species also represents a large bycatch for the other fisheries, it is also necessary to ensure that catches of *Pagellus bellottii* are controlled.

3.4 Axillary seabream (*Pagellus acarne*)

3.4.1 Biological characteristics

Due to the lack of biological sampling of the axillary seabream in Morocco, and apart from some very old studies, no information is available on the present state of the biology of this species.

3.4.2 Stock identity

The axillary seabream (*Pagellus acarne*) population is considered to be a single stock. This species is found on all types of bottom from the Straits of Gibraltar to 21° N.

3.4.3 Data trends

Catch

Annual registered catches of axillary seabream by the Moroccan ocean going cephalopod fleet (Figure 3.4.3a) show an increasing trend between 1999 and 2001. After this the production drops greatly, reaching its lowest value in 2003 (2 178 tonnes).

Effort

Fishing effort on axillary seabream generally shows a declining trend from the beginning of the series (Figure 3.4.3b). This effort decreased regularly from 1990 to 2003 going from 71 189 to 41 782 fishing days.

Abundance indices

CPUE

The CPUEs (catches per unit of effort) of axillary seabream by the Moroccan cephalopod trawlers, expressed in kilograms per fishing day (Figure 3.4.3c), show an increasing trend between 1990 and 1998. A decline is seen in 1999, followed by an increase until 2001. A decrease in CPUEs is again observed for 2002 and 2003.

Research surveys

The axillary seabream was caught both during the surveys carried out in the Atlantic south of Morocco (Bojador–Lagouira) and those done in the Atlantic North Morocco (Tangiers–Agadir). This species is however more abundant in the south. The observed abundance indices show a stable trend in the south of Morocco whereas they fall drastically in the north of Morocco reaching a minimum value of 0.36 kg/h in 2004 (Figure 3.4.3d).

Biological data

Length composition and other information

Currently there is no sampling plan in Morocco to allow the study of the demographic structure of the landings of this species. No biological sampling was carried out on this species during the research surveys due to its low abundance.

Current management measures

The axillary seabream is exploited by the high-sea cephalopod fishery, as well as the coastal and artisanal fisheries. The management measures applied to this species are the same as those applied to all fisheries (see chapters on cephalopods and hake).

3.4.4 Assessment

Methods

The Schaefer dynamic production model, implemented in an Excel spreadsheet, was used to assess the state of the stock and fisheries of *Pagellus acarne*. The model is described in detail in Appendix 2 of this report.

Data

The series of total landings (coastal + cephalopod trawlers) of the axillary seabream (*Pagellus acarne*) estimated by the Working Group was used as the series of total catch of the stock. It should be noted that the low catches over the last few years can be due to the extension of the closed season over the last years.

The Working Group used two different abundance indices series, the CPUEs (tonnes/fishing day) of the Moroccan cephalopod trawlers and the abundance indices (kg/h) of the trawl surveys carried out between Bojador and Lagouira.

Results

The model provides a good fit to the data series of the abundance indices of the surveys (Figure 3.4.4). The Working Group decided therefore to adopt the results of the assessments obtained using these abundance indices.

According to the assessments carried out based on the abundance indices of the surveys (Table 3.4.4), the axillary seabream stock is overexploited, with biomasses below the level producing maximum sustainable yield. Present catches are below the natural production of the stock at current biomass levels.

Table 3.4.4: Indicators on the state of the stock and the fishery of *Pagellus acarne* in the Northern subregion of CECAF

Management unit/Stock	Abundance index	B/B_{MSY}	F_{cur}/F_{SYcurB}
North of 21 ºN	Indices of the INRH trawl surveys	80%	50%

B/B_{MSY} : Biomass of the stock in the last year of data as a percentage of the biomass that would produce the maximum sustainable yield. F/F_{SYcurB}: Fishing mortality by fishery in the last year as a percentage of the fishing mortality by fishery necessary to extract the sustainable yield from the current biomass level estimated for the last year of data.

Discussion

The results of the assessment show that the stock is probably fully exploited, as current catches are below the natural production of the stock at current biomass levels.

3.4.5 Management recommendations

Taking the results of the assessments into account, the Working Group decided to recommend the following management measures:

- Decrease the fishing mortality exercised by the cephalopod trawlers on the axillary seabream stock to allow the stock to recover.
- Encourage the conversion of some vessels towards a fishery of less exploited resources.
- Strictly control and apply the rules governing trawl mesh size.

3.5 Large-eye dentex (*Dentex macrophtalmus*)

3.5.1 Biological characteristics

The large-eye dentex is distributed over the whole subregion. No study of the biological characteristics of this species was provided to the Working Group this year.

3.5.2 Stock identity

Dentex macrophthalus is found in Morocco, Mauritania and Senegal. The Working Group decided to consider a single stock for the whole subregion, in the lack of detailed information.

3.5.3 Data trends

Catch

Total catches of this species are shown in Figure 3.5.3a. In Mauritania the catches are relatively stable during the whole period. In Morocco, an increasing trend is observed from 1990 to 1997 followed by a decrease until 1999 and a new increase in 2001. A substantial drop is visible in 2002 and 2003. In Senegal a decreasing trend is observed from 1990–1994, followed by an increase until 1996. After 1999 a decreasing trend is observed.

Effort

Dentex macrophtalmus is fished by cephalopod trawlers in Morocco and the industrial fishery of Senegal. It is also a bycatch of the cephalopod and pelagic trawlers of Mauritania and of the artisanal fishery in Senegal, particularly by the line fishing motorized canoes and the ice canoes. Fishing effort of all these fleets is shown in Figure 3.5.3b.

Abundance indices

CPUE

The CPUE series of the main fleets fishing *Dentex macrophtalmus* showed different fluctuations over the period under analysis (Figure 3.5.3c). Except for the decreasing CPUE trend in the Senegalese industrial fishery, all the other fleets show fluctuating yields over the whole period.

Research surveys

Data on *Dentex macrophtalmus* from the research surveys were not presented to the Working Group.

Biological data

Length composition and other information

Dentex macrophtalmus length composition data and data on other biological parameters (growth, reproduction, feeding etc.) were not provided to the Working Group.

3.5.4 Assessment

Methods

The Schaefer dynamic production model, implemented in an Excel spreadsheet, was used to assess the state of the stock and fisheries of *Dentex macrophtalmus*. The model is described in detail in Appendix 2 of this report.

Data

The catch series of *Dentex macrophtalmus* for Morocco, Mauritania and Senegal were used.

For assessment needs, the Senegalese industrial fishery CPUE series was used as abundance index as this was the one that seemed to most closely resemble the pattern in stock abundance.

Results

The model provides a reasonable fit to the data (Figure 3.5.4). Results of the assessments using this series indicate that the stock of *Dentex macrophtalmus* is fully exploited as the current biomass is around that producing maximum sustainable yield (Table 3.5.4).

Table 3.5.4: Indicators on the state of the stock and the fishery of *Dentex macrophtalmus* in the Northern subregion of CECAF

Management unit/Stock	Abundance index	B/B_{MSY}	F_{cur}/F_{SYcurB}
Northern Subregion of CECAF	CPUE Industrial fleet Senegal	105%	59%

B/B_{MSY}: Biomass of the stock in the last year of data as a percentage of the biomass that would produce the maximum sustainable yield. **F/F_{SYcurB}**: Fishing mortality by fishery in the last year as a percentage of the fishing mortality by fishery necessary to extract the sustainable yield from the current biomass level estimated for the last year of data.

Discussion

The instability is observed in the CPUE series of Morocco and Mauritania and in the Senegalese artisanal fishery led to the choice of the Senegalese industrial fishery CPUE as abundance index. This choice was not optimal as it is influenced by the method that was used to separate the species from the pink sea bream group, which could be the reason that the fit of the model is only average. Nevertheless the Working Group feels that the assessment results agree with the rest of the information available on this stock. The model results suggest that the stock is fully exploited.

3.5.5 Management recommendations

The quality of the fit did not allow precise conclusions to be drawn on the state of the stock. However, a precautionary approach would consist in not increasing current fishing effort on this species.

3.6 Bluespotted seabream (*Sparus caeruleostictus*)

3.6.1 Biological characteristics

The bioecology of *S. caeruleostictus* in the West African region, has been studied by various authors. The species is found on a large part of the continental shelf, between 10 and 80 m depth. It is most abundant between 15 and 35 m. The species prefers cooler waters (<15°C) and generally lives on hard (rocky) sandy or sandy–muddy bottoms, below the thermocline.

In West Africa, the bluespotted seabream migrates in relation to its life-cycle. Those migrations happen parallel to the coast with greater amplitudes in Mauritania and Senegal. In addition, after having reached a certain size, the more coastal young individuals migrate further offshore where food is more abundant.

3.6.2 Stock identity

The *S. caeruleostictus* species is sold under the name of bluespotted seabream**.** It appears to be a single stock which is exploited by the same types of fishery, industrial and artisanal. The Working Group therefore decided to assess it as a single stock.

3.6.3 Data trends

Catch

Total landings of *S. caeruleostictus* (Figure 3.6.3a) tend to fluctuate with an overall decreasing trend. The landings series of Mauritania and Senegal appear to have opposing fluctuations. The level of total catch has been more or less stable since 1995, around 4 000 tonnes per year.

Effort

In the Senegalese artisanal fishery this species is mainly targeted by the line fishing motorised canoes and ice canoes. It is also caught by Mauritanian and Senegalese trawlers. A general increasing trend in the effort series of these fleets can be seen over the whole period (Figure 3.6.3b). An exception to this is the series of the Senegalese line fishing motorised canoes, which nearly decreased markedly from 1998 to 2001.

However, as previously noted, this could be due to a problem with the database, and should be taken with caution.

Abundance indices

CPUE

The CPUE series of *S. caeruleostictus* for the Mauritanian industrial fleet fluctuated greatly over the period under analysis (1990–2003). Both the Senegalese industrial fleet and the Senegalese ice canoes show decreasing trends in their CPUE (Figure 3.6.3c).

Research surveys

The series of abundance indices of *S. caeruleostictus* in Mauritania estimated by the R/V AL AWAM surveys show fluctuations with no apparent trend (Figure 3.6.3d).

Biological data

Length composition and other information

The biological studies made during the surveys with the R/V AL-AWAM indicate that the reproduction peak must be located during the warm season. Analysis of the length frequency histograms of *S. caeruleostictus* shows a bimodal length distribution in all the R/V AL-AWAM surveys.

3.6.4 Assessment

Methods

The Schaefer dynamic production model, implemented in an Excel spreadsheet, was used to assess the state of the stock and fisheries of *S. caeruleostictus*. The model is described in detail in Appendix 2 of this report.

Data

The catch series of *S. caeruleostictus* for Mauritania and Senegal were used as total catch series. For the abundance indices series, the Working Group decided to use the CPUE series of the Senegalese ice canoes.

Results

The model provides a satisfactory fit to the data (Figure 3.6.4). The results of the model indicate that the stock is overexploited. The present biomass is estimated to be only 36 percent of that producing maximum sustainable yield. The fishing mortality estimated for the last year of data is greater by 16 percent than that which would produce a maximum sustainable yield at current biomass levels (Table 3.6.4).

Table 3.6.4: Indicators on the state of the stock and the fishery of *Sparus caeruleostictus* in the Northern subregion of CECAF

Management Unit/Stock	Abundance index	B/B_{MSY}	F_{cur}/F_{SYcurB}
Mauritania + Senegal	CPUE of the Senegalese ice canoes	36%	116%

B/B_{MSY} : Biomass of the stock in the last year of data as a percentage of the biomass that would produce the maximum sustainable yield. F/F_{SYcurB}: Fishing mortality by fishery in the last year as a percentage of the fishing mortality by fishery necessary to extract the sustainable yield from the current biomass level estimated for the last year of data.

Discussion

The model provides a reasonable fit to the data series. The current biomass is estimated to be below that producing maximum sustainable yield. Current fishing mortality is estimated to be 16 percent greater than that which would produce a sustainable yield at current biomass levels. This indicates that the stock is overexploited.

3.6.5 Management recommendations

The Working Group recommends that fishing effort in this fishery be reduced by at least 20 percent to bring biomass back to a sustainable level. To this end, the catches of *S. caeruleostictus* should be better controlled.

3.7 Seabream (*Sparus aurata* and *Sparus auriga*)

3.7.1 Biological characteristics

Except for some fragmentary information, no biological study has been carried out on these species.

3.7.2 Stock identity

The seabream (*Sparus* spp.) population is considered to be a single stock. This species is found from the extreme north of Morocco to the northern frontier of Mauritania.

3.7.3 Data trends

Catch

Seabream catches by the Moroccan cephalopod trawlers (Figure 3.7.3a) shows an increasing trend from 1998 (215 tonnes) to 2002 (1 092 tonnes). Landings then fell drastically in 2003 to a level of 615 tonnes.

Effort

Fishing effort by the cephalopod trawler fleet has decreased since the beginning of the series (Figure 3.7.3b), going from 71 189 fishing days in 1990 to 41 782 fishing days in 2003.

Abundance indices

CPUE

The CPUEs (expressed in kilograms per fishing day, Figure 3.7.3c) follow the same pattern as that of the catches, increasing from 1998 to 2002, then decreasing to reach a level of 8 kg/fishing day in 2003.

Research surveys

Seabream are generally found during the research surveys carried out in the Atlantic to the south of Morocco. The abundance indices vary between 0 and 0.5 kg/h over the whole period. The overall trend of the surveys' abundance indices is rather similar to the trend of the commercial CPUEs (Figure 3.7.3d).

Biological data

Length composition and other information

No sampling of length composition of sea bream landings is currently carried out. Given their weak abundance indices, sea bream are not sampled during the research surveys.

Current management measures

As with the axillary seabream, sea bream are exploited by the cephalopod trawlers, as well as the coastal and artisanal fisheries. The management measures applied to this species are the same as those applied to all the fisheries (see chapters on cephalopods and hake).

3.7.4 Assessment

Methods

The Schaefer dynamic production model, implemented in an Excel spreadsheet, was used to assess the state of the stock and fisheries of sea bream. The model is described in detail in Appendix 2 of this report.

Data

The series of total sea bream (*Sparus* spp.) landings estimated by the Working Group was used as the total catch series of the stock.

Two abundance indices series were tested, the CPUE series of the Moroccan cephalopod trawlers and the abundance indices series from the surveys. The Working Group decided to adopt the abundance indices of the research surveys carried out in the Atlantic to the south of Morocco between Bojador and Lagouira, this series being the one that more closely followed the stock trends.

Results

The model provides an average fit to the abundance indices series (Figure 3.7.4).

The analysis of the indicators of the state of the stock obtained using the abundance indices of the research surveys carried out to the south of Morocco (Table 3.7.4) indicates that the stock is intensely overexploited, with biomasses well below the level producing maximum sustainable yield. Fishing effort is far greater than the level of effort for a

sustainable fishery at current biomass levels. Current catches surpass by far the natural production of the stock. The present biomass is only 47 percent of the biomass that would produce MSY.

Table 3.7.4: Indicators on the state of the stock and the fishery of *Sparus* spp. in the Northern subregion of CECAF

Management unit/stock	Abundance index	B/B_{MSY}	F_{cur}/F_{SYcurB}
North of 21 ºN	INRH trawl survey	47%	192%

B/B_{MSY} : Biomass of the stock in the last year of data as a percentage of the biomass that would produce the maximum sustainable yield. F/F_{SYcurB}: Fishing mortality by fishery in the last year as a percentage of the fishing mortality by fishery necessary to extract the sustainable yield from the current biomass level estimated for the last year of data.

Discussion

The fit of the production model to the abundance indices series of the surveys is reasonable. The assessments concluded that the stock is heavily overexploited. The present level of fishing effort is greatly above that which would allow biomass stability. A strong decrease in fishing effort will be necessary if the species is to survive.

3.7.5 Management recommendations

The Working Group decided to recommend the following management measures:

- Reduce by over 90 percent the fishing effort exercised by the cephalopod trawler fishery on seabream. This measure is both necessary and urgent to try to save the stock.
- Encourage some vessels to be converted to a fishery of less exploited resources.
- Apply strict and severe controls of the rules governing trawl mesh size.

3.8 Marine catfish (*Arius* spp.)

3.8.1 Biological characteristics

No study of the biological characteristics of these species has been carried out. However they are distributed over the whole region.

3.8.2 Stock identity

The following species are included in *Arius* spp.: *Arius heudolotii*, *Arius gambiensis*, *Arius mercatoris*. Marine catfishes *Arius* spp. are considered as a single stock over the whole of the Senegalese and The Gambian shelf. Thus the Working Group decided to assess the stock located in the southern part of the region (Senegal and The Gambia), and to treat it as a single management unit.

3.8.3 Data trends

Catch

The marine catfish landings in Senegal show large fluctuations, varying between 2 000 and 8 300 tonnes (Figure 3.8.3a). Between 1992 and 1996, a declining trend in catches can be seen, followed by an increase in 1997 and 1998. The landings have shown an increasing trend since 1999. In The Gambia the landings of marine catfish have been fairly stable over the period, with landings of around 1 000 tonnes the last few years.

Effort

Marine catfishes are caught by all the artisanal and industrial fleets in The Gambia and Senegal. They were particularly landed by the Senegalese ice trawlers and the set gillnets of the Senegalese artisanal fishery at the beginning of the 90s. By the end of the 90s they seem to have been targeted by the line fishing motorized canoes and the ice canoes. The effort series of these fleets are given in Figure 3.8.3b. A slight increasing trend can be seen for all the series.

Abundance indices

CPUE

For the industrial fishery of The Gambia, the Senegalese freezer trawlers and the Senegalese artisanal fishery, the CPUEs remain relatively stable at low values until the end of 1998 when they tend to increase sharply (Figure 3.8.3c). The yields of the Senegalese ice trawlers are the only ones to see a decreasing trend with sporadic large fluctuations.

Research surveys

Data from the research surveys of *Arius* spp. were not presented to the Working Group.

Biological data

Length composition and other information

Data on length composition and other biological parameters (growth, reproduction, feeding etc.) of *Arius* spp. were not provided to the Working Group.

3.8.4 Assessment

Methods

The Schaefer dynamic production model, implemented in an Excel spreadsheet, was used to assess the state of the stock and fisheries of *Arius* spp. The model is described in detail in Appendix 2 of this report.

Data

For catch data, the Working Group collated the total catches of Senegal and The Gambia. To fit the model, the CPUEs of the Mbour ice canoes (Senegal) were used as abundance indices.

Results

The available data were not sufficient to obtain conclusive results for assessment of marine catfishes. The model gives inconsistent results.

Discussion

The poor fit of the model could be explained by the fact that the CPUEs are not a true reflection of stock abundance. Marine catfishes appear to be targeted when other more sought-after species are unavailable.

3.8.5 Management recommendations

Taking into account the large catches recorded from 1998 onwards, all increase in fishing effort should be avoided until better assessments are available.

3.9 Croakers (*Pseudotolithus* spp.)

3.9.1 Biological characteristics

Croakers or *Pseudotolithus* spp. include the following species: *P. elongatus*, *P. typus*, *P. senegalensis* and *P. brachygnatus*. *Pseudotolithus* spp. are coastal species distributed over the whole region. They are found on muddy, sandy and rocky bottoms. Smaller individuals can be found along the coast, but rarely in estuaries. The species feeds mainly on fish, shrimp and crabs.

3.9.2 Stock identity

Croakers are mainly distributed and exploited in the southern part of the region, that is Senegal and The Gambia. Consequently, the Working Group decided to consider them as a shared stock between The Gambia and Senegal and to assess them as a single stock for both countries.

3.9.3 Data trends

Catch

Pseudotolithus spp. are caught by the artisanal and industrial fleets. A high level is observed in 1992 (approximately 13 000 tonnes), followed by a decrease until 1995, after which catches stabilized at around 2 000–3 000 tonnes. The high catch registered in 1992 is mainly due to a very large catch by the Senegalese set gillnets (artisanal fishery). From 1999 to 2001 a notable increase can be seen with catches around 6 000 tonnes. Over the last three years, catches have been in the order of 5 000 tonnes (Figure 3.9.3a).

Effort

Pseudotolithus spp. are caught by the multi demersal fleets of both countries, but for most of the fleets it is not an important group.

Among the fleets fishing this species, the effort of the Gambian industrial fishery trawlers shows an increase from 1994 to 2002, followed by a slight decrease in 2003. Efforts of both the main Senegalese industrial fleets (the ice and freezer trawlers) are relatively stable over the latest period (Figure 3.9.3b). For the artisanal Senegalese fishery, the gears that catch this species the most are the set gillnets.

Abundance indices

CPUE

The CPUE of the Gambian industrial fishery shows a strong increase in 2001 and 2002, followed by a decrease in 2003 (Figure 3.9.3c). However, the CPUE of the Senegalese set gillnets shows a decreasing trend from 1992 to 1995. After 1995, the CPUEs are very low.

Research surveys

Data of *Pseudotolithus* spp. from the research surveys were not presented to the Working Group.

Biological data

Length composition and other information

Length composition data for the Senegalese artisanal fishery for the period 1990 to 2003 exist, but they were not analysed by the Working Group.

Data on other biological parameters (growth, reproduction, feeding, etc. of *Pseudotolithus* spp.) were not provided to the Working Group.

3.9.4 Assessment

Methods

The Schaefer dynamic production model, implemented in an Excel spreadsheet, was used to assess the state of the stock and fisheries of *Pseudotholitus* spp. The model is described in detail in Appendix 2 of this report.

Data

Total catch data from The Gambia and Senegal and the CPUEs of the Gambian industrial fishery were used for the assessment.

Results

The model provides a poor fit to the data, probably due to a problem with the basic data. Consequently the Working Group decided not to keep the results of the assessment.

Discussion

Even though the fit was poor, observations of the fishery indicate that the effort of the fleets that land this species is increasing due to the existence of a market. The Working Group also noted that in spite of uncertainties relating to the yields of these species, the general trend in catch of demersal species is decreasing.

3.9.5 Management recommendations

Taking into account the history of the fishery and the uncertainties surrounding the true catches of these species, the Working Group considers there to be a high risk that they are overexploited. Consequently, adopting a precautionary approach, the Working Group recommends reducing fishing morality or fishing effort on *Pseudotolithus* spp.

3. 10 White grouper (*Epinephelus aeneus*)

3.10.1 Biological characteristics

The white grouper (*Epinephelus aeneus*) is a coastal demersal species belonging to the Serranid family which is found in all the subregion. Its bathymetric distribution goes from 20 to 200 m in depth, but it is mainly fished at depths of between 30 and 60 m. The species is found on the rocky bottoms of the continental shelf.

The two main spawning areas are the Petite Côte of Senegal and the south of the Baie du Lévrier in Mauritania. The main concentration of juveniles is found in the mangrove estuary of the Sine Saloum delta in Senegal.

The species feeds on fish, stomatopods, crabs and cephalopods.

3.10.2 Stock identity

For *Epinephelus aeneus*, a single management unit was identified for the three countries (Mauritania, Senegal and The Gambia).

3.10.3 Data trends

Catch

Landings of white grouper show a decreasing trend over the period under analysis (Table 3.1.1a and Figure 3.10.3a). Current landings in 2003 were 50 percent lower than those of 1990. A slight increase in landings was noted in Senegal in 2003, whereas a decrease can be seen in The Gambia and Mauritania. Most of the fish landed in Senegal is from the artisanal fishery, in particular the ice canoes.

Effort

The white grouper (*Epinephelus aeneus*) is targeted by the artisanal and industrial fleets of all the countries.

The ice and freezer trawler effort of the Senegalese industrial fishery shows an increasing trend for the period 1990–2003 (Figure 3.10.3b). Effort of the Gambian industrial fishery trawlers shows an increase from 1994 to 2001, followed by a decrease in 2002 and 2003.

Effort of the Mauritanian fish trawlers remained relatively stable between 1997 and 2001, peaking in 2002, before falling again in 2003 to 2001 levels. In Mauritania, national cephalopod trawlers and pelagic trawlers also catch this species as bycatch. Catches of *Epinephelus aeneus* by these three fleets in Mauritania are low. The Senegalese ice canoe effort shows a general increasing trend between 1990 and 2003.

Abundance indices

CPUE

In general, the CPUEs of *Epinephelus aeneus* show a decreasing trend throughout the study period (Figure 3.10.3c). The Mauritanian fish trawler CPUEs have been particularly low in recent years.

Research surveys

Abundance indices from the IMROP R/V surveys decreased between 1982 and 2003 (Figure 3.10.3d). It is important to note that the surveys were carried out by two different vessels, but with the same characteristics. The first operated from 1982 to 1996 and the second (AL-AWAM) from 1997.

Biological data

Length composition and other information

The length frequencies of white groupers caught by the Senegalese artisanal fishery are available from 1990 to 2003, but were not analysed by the Working Group.

IMROP carried out a joint project with JICA to study the biology of demersal fish using the Mauritanian research vessel AL-AWAM in 2000 and 2001. The length frequencies collected by these surveys were taken into consideration, but the small amount of samples made their utilisation difficult.

3.10.4 Assessment

Methods

The Schaefer dynamic production model, implemented in an Excel spreadsheet, was used to assess the state of the stock and fisheries of *Epinephelus aeneus*. The model is described in detail in Appendix 2 of this report.

Data

For catch data the Working Group collated total catches of all the fleets of the three countries (Mauritania, Senegal and The Gambia). The Working Group decided to use the CPUE series of the Senegalese ice trawlers and the CPUE of the Senegalese ice canoes (artisanal fishery) as abundance indices.

Results

Using the CPUE of the ice canoes, the model did not provide a satisfactory fit. With the CPUE of the Senegalese ice trawlers, the model generally provided an acceptable fit to the data, though the fit at the beginning of the series is weak (Figure 3.10.4).

The results from the fit indicate that the stock is heavily overexploited. The current biomass is much below that producing maximum sustainable yield and fishing mortality is above that necessary to extract the natural production of the stock (Table 3.10.4).

Table 3.10.4: Indicators on the state of the stock and the fishery of *Epinephelus aeneus* in the northern subregion of CECAF

Management unit/Stock	Abundance index	B/B_{MSY}	F_{cur}/F_{SYcurB}
Mauritania, Senegal, The Gambia	CPUE ice trawlers/Senegal	7%	344%

B/B_{MSY}: Biomass of the stock in the last year of data as a percentage of the biomass that would produce the maximum sustainable yield. **F/F_{SYcurB}**: Fishing mortality by fishery in the last year as a percentage of the fishing mortality by fishery necessary to extract the sustainable yield from the current biomass level estimated for the last year of data.

Discussion

The model provides an acceptable fit to the data. The results indicate that the stock of *Epinephelus aeneus* in the region is heavily overexploited with a probable risk of extinction. These results are in line with the trends observed from the abundance indices of the Mauritanian research surveys and the results obtained last year.

3.10.5 Management recommendations

Taking into consideration the results of the assessment and the CPUE trends, as well as the abundance indices obtained from the surveys, the Working Group believes that the stock risks extinction and reiterates its recommendation that the fishery directed at this species be stopped.

3.11 Future Research

The research recommendations that were made for demersal finfish can be summarized as follows;

- Strengthen and improve the collection of statistical information for the demersal fisheries.
- Obtain biological information of catches (length frequencies, sex ratio, age, zone and period of reproduction).
- Further analysis and exploration of the scientific survey data.
- Develop foras for exchange of information between regional scientists and scientists from fishing nations.

More detailed information on future research recommendations for demersal finfish can be found in Table 6.1b.

4. SHRIMPS

4.1 Fisheries

The exploitation of crustaceans in the western coastal states of Africa has a relatively long history (Thiam *et al.*, 1981). Two main groups of shrimps are commercially important in the region from Morocco to Guinea Bissau, the coastal shrimps represented principally by the Southern pink shrimp, *Penaeus notialis*, and the deepwater shrimps, of which deepwater rose shrimp *Parapenaeus longirostris* is the most important. Other less abundant shrimp species are also caught in the area: *Melicertus kerathurus*, *Aristeus antennatus*, *Aristeus varidens*, *Plesionika heterocarpus*, *Plesiopenaeus edwardsianus* and *Aristeomorpha foliacea.*

In Morocco, shrimps are exploited by the national fleet, composed of coastal trawlers which operate on the continental shelf at depths shallower than 150 m and deep sea trawlers, with a larger area of activity. The coastal trawler fleet includes approximately 300 units. This fleet operates near their home ports and carry out short duration fishing trips. The deep sea trawlers started operation in 1985 with units of less than 200 GRT, carrying out fishing trips of between 45 and 50 days. In 2004, the fleet comprised 59 units (Table 4.1a)

The Spanish fleet in Morocco ceased operating on 30 November 1999 with the expiry of the Morocco–European Union Fishing Access Agreement. The Spanish fleet was comprised mainly of fresh and frozen fish trawler units authorized in accordance with the fishing agreement. Their zone of activity was limited to the North of Tarfaya (28°44'N) to the exterior of the 12 nm contour.

In Mauritania, exploitation of shrimp started in the 1960s with a Spanish industrial fleet (Savini, 1982; Sobrino and García, 1992). In the period 1985–1990, the presence of fleets of other nationalities was observed but the fishery was dominated by the Spanish fleet (Diop, 1989).

The shrimping fleet operating in Mauritania in 2004 was composed of 81 vessels of different nationalities. With 32 units the Spanish fleet was the most important in terms of exploitation of *P. longirostris* (46 percent) and *P. notialis* (40 percent). This was followed by a grouping of Mauritanian and/or joint-ventures vessels, with a total of 27 units. Italy ranks third with 7 vessels. Senegal, Portugal and Cameroon are also present with 5, 3 and 2 units respectively. Five vessels are operated by other nationalities with one vessel each.

In Senegal, the industrial exploitation of the shrimp resources started in 1960. Until 1981, these were exploited almost exclusively by the Spanish trawlers. From 1982, a certain number of Spanish vessels took Senegalese nationality, giving rise to a national fleet exploiting the deep waters. With about 80 percent of the total landing of crustaceans, the deepwater rose shrimp *Parapenaeus longirostris* constitute the main target species.

The crustacean fishery targeting coastal shrimps, *P. notialis* in particular, is highly developed in Senegal and The Gambia. Two fleets, industrial and artisanal, target this species.

The industrial shrimp fleet in the Senegal–The Gambia area in 2004 was composed of 61 vessels, 16 Senegalese freezer trawlers, 20 Spanish freezer trawlers and 25 industrial vessels targeting coastal shrimp (Table 4.1a). The artisanal fleet includes a large number of units, but their total number is not known.

Incidental landings of an uncommon species, *Penaeus monodon*, were observed in the landings of artisanal fishers in the Senegal–The Gambia area. Unfortunately, not enough information on the distribution and abundance of this species is available, despite the fact that the landings of this species are on the increase.

4.1.1 Management measures for shrimps

Countries in the region are striving to regulate the shrimp fishery and in so doing, have already established some management regulations. Current measures in place in most of the countries included in this assessment are related to the control of sizes captured, and include both minimum landing sizes, and mesh size regulations.

A summary of these technical measures is given in Table 4.1.1a and Table 4.1.1b.

Besides this, Mauritania observes a two month closed season for the fishery from September to October each year.

It is important to note that no restrictions are placed on total fishing effort or landings in any of the countries. There exists only a restriction on effort of the foreign fleets contained as conditions in respective fishing agreements.

The Subregional Fisheries Commission, a regional body, has been working towards the harmonization of various management measures used in its member countries.

4.2 Sampling schemes and sampling intensity

4.2.1 Catch and effort

There are no sampling schemes in the region for catch and effort and hence there are no estimates to calculate sampling intensity for catch and effort for shrimps.

4.2.2 Length frequencies

For *Parapenaeus longirostris*, length sampling data in 2003 were available from Moroccan and Mauritanian research vessels. In Morocco, commercial landings are not being sampled directly by the research institute. Instead, information on commercial size categories is available from a number of companies. However, due to different classification systems used by different companies, data on size categories cannot be converted easily into length distributions.

Sampling intensity analysis for *Parapenaeus longirostris* and *Penaeus notialis* was carried out for the Spanish fleet operating in Mauritania by the Spanish Institute of Oceanography (IEO, Cádiz) as part of the project "National Program for data collection and management for a common fishing policy" of the European Union and also by the Mauritanian Institute of Oceanographic and Fisheries Research (IMROP). The Spanish samples were provided by the National Association of Shrimp Freezer Vessel Ship owners (ANAMAR) based in the Port of Huelva, Spain, while the samples for the same analysis in Mauritania were taken on board Spanish fishing vessels by Mauritanian observers. For the period 2003, an estimated 10 samples per 1 000 tonnes of *Parapenaeus longirostris* and 16 samples per 1 000 tonnes of *Penaeus notialis* were taken by IEO from ANAMAR.

An average of 300 *P. longirostris* per sample were measured while 120 *P. notialis* per sample were measured by the IEO.

Sampling carried out by Mauritanians observers on Spanish vessels in 2003 was done in the second quarter for *Parapenaeus longirostris* and in the third and fourth quarters for *Penaeus notialis.* It was estimated that 15 and 22 samples per 1 000 tonnes of shrimp caught were taken for each of the two species respectively.

For the Senegalese and The Gambian deepwater shrimp fishery exploited by the Spanish fleet, samples were obtained from ANAMAR for 2003. The number of samples per 1 000 tonnes of *P. longirostris* was estimated at 24 with an average of 240 shrimps per sample.

4.2.3 Biological parameters

The IEO was engaged in biological sampling of both deepwater shrimp, *P. longirostris*, and coastal shrimp, *P. notialis*, as part of a planned routine biological and length sampling of these species for a four year period (2002–2006). The Cádiz Unit of the IEO started work on these species in March 2003. The task of the Unit was to carry out monthly biological sampling of *Parapenaeus longirostris* from Mauritania, and quarterly biological sampling of *P. longirostris* and *P. notialis* from Senegal–The Gambia and Mauritania respectively. No data on the number or characteristics of the samples taken has yet been presented to the Working Group.

4.3 Deepwater rose shrimp (*Parapenaeus longirostris*)

4.3.1 Biological characteristics

The results of the biological sampling survey by INRH, Morocco, show that in this zone female *Parapenaeus longirostris* dominated the population in all seasons and depth strata. Length at first sexual maturity is estimated to be 27.6 mm carapace length (CL). For the same length, the shrimps in the Northern area, Larache–El Jadida are a point heavier than those in the South, Essaouira–Agadir.

The results of the biological sampling show that the period in which the samples were collected coincided with the time this species reproduce in the region, mainly during the autumn and winter months. The studies also revealed that males mature at smaller sizes (length at 1st maturity is 16.44 and 18.35 mm of CL in Mauritania and Senegal, respectively), than females (length at 1st maturity 24–27.8 mm in Morocco and Mauritania).

The main biological characteristics of the stock in this area are presented in previous reports of the CECAF Demersal Working Group.

Environmental effects

A first analysis of the possible effects of the different environmental parameters of the medium (water) and the abundance of *P. longirostris* in Mauritanian waters conducted by IEO using available Sea Surface Temperature (SST) and North Atlantic Oscillation (NAO) indices (García and Sobrino, submitted) suggest that there is no correlation between stock abundance/yields and global SST, but that there is a correlation between yields and NAO indices.

4.3.2 Stock identity

The deepwater rose shrimp (*Parapenaeus longirostris*) in Morocco lives on sandy and muddy bottoms at depths of 50 to 500 m. This species is found between the Northern limit of Cap Spartel (35° 47’ N) and the Southern region of Sidi Ifni (29° 22’ N) (Figure 4.3.2a).

There is no fishery targeting *P. longirostris* between Agadir and Cap Blanc. Figure 4.3.2a shows the distribution of this species in Moroccan waters. For this reason it is suggested that there are two stocks of this species, one in Morocco and another in Mauritania.

In the waters of Mauritania, the *P.* longirostris fishery is carried out mainly between 21° and 19° N. A new fishery targeting *P. longirostris* in Senegalese waters from 16°N is being developed.

Considering the fact that *P. longirostris* is found in geographically different areas, the Working Group adopted three fishery units: Morocco, Mauritania and Senegal–The Gambia.

4.3.3 Data trends

Catch

The global trend of landings of *P. longirostris* in the region during the period (1980–2003) was that of a gradual increase from the beginning of the time series until 1994 when landings were around 15 000 tonnes (Table and Figure 4.3.3a). The highest landings were registered in 1999 (around 18 000 tonnes). The largest part of the landings originates from waters off Morocco.

In Morocco a decrease in the freezer fleet landings and an increase in the fresh fleet landings during the last four years were observed (Figure 4.3.3b).

There has been a gradual increase of landings from Mauritanian waters since 1996, reaching the maximum value in 2003 (4 300 tonnes). The high value recorded in 2003 corresponded to landings of the Spanish and Mauritanian fleets (Figure 4.3.3b).

In the last ten years, the total landings of Senegal–The Gambia have been oscillating, with a minimum of 969 tonnes in 2000 and a maximum of 3 895 tonnes in 1993 (Figure 4.3.3b). A decreasing trend in landings was observed in the last three years of the time series.

Effort

In Moroccan waters, fishing for *P. longirostris* is carried out by the Moroccan freezer and fresh shrimp trawling fleet. Effort being exerted on this species by the freezer trawler fleet stabilized at around 40 000 fishing days in the last three years, after an important increase from 1995 to 2001 (Table 4.3.3b and Figure 4.3.3c).

Although there was an important increase in effort of the Moroccan fresh fleet, it also tends to be stable in the last three years at approximately 18 000 fishing days. As regards the Spanish fleet, the effort decreased until it ceased operation in the waters of Morocco due to the expiry of the Morocco–EU fishing agreement in 1999.

Fishing effort of the Spanish fleet operating in Mauritanian waters showed a large increase from 1987 to 1989 when it peaked and started to decrease until 1992 (Figure 4.3.3c). The fishing effort exerted on this stock by the Spanish fleet has stabilised at around 4 600 fishing days over the last four years. On the other hand, the Mauritanian fleet showed an increasing trend from 1997 (234 fishing days) to 2002 (5 404 fishing days). Even though the effort figure for the Mauritanian fleet for 2003 is provisional, the Working Group is of the opinion that data was grossly underestimated. Total effort has more than doubled in the period from 1999 to 2002.

The industrial fishing fleet fishing off Senegal displayed a high variation in effort along the period concerned (Figure 4.3.3c). This is probably due to the presence of variable numbers of foreign vessels operating in the area. The Spanish freezer fleet showed a stable effort pattern from 1998 to 2003 with about 1 400 fishing days per year.

Abundance indices

CPUE

Catch per unit effort (CPUE) for Morocco showed a gradual decrease for the Moroccan freezer fleet over the last four years while its fresh fish fleet showed stable CPUE values for the same period (Table 4.3.3c and Figure 4.3.3d). Only a small increase in 2003 was observed.

In the case of Mauritania, the CPUEs showed a variable pattern with high and low values during the last ten years (Table 4.3.3c and Figure 4.3.3d). In 2003, the three fleets operating in the area showed the highest values of CPUEs in the time series. This must be interpreted carefully, however, because of the more than likely underestimation of the effort figures for the Mauritanian fleet.

In Senegal–The Gambia, the two main fleets (Senegalese and Spanish fleet) showed fluctuating CPUE patterns, but with an overall declining trend. The yields in the last two years, estimated at around 4 000 kg/day for both fleets, are the lowest in the time-series, and less than half those calculated for the period 1992–1995 (Table 4.3.3c and Figure 4.3.3d).

Research surveys

Morocco

The evolution of indices of abundance of deepwater rose shrimp, *P. longirostris* estimated during the INRH scientific resources survey in the same area have shown an important decrease in the abundance indices in the last five years in the following zones, Larache–El Jadida and Essaouira–Agadir (Table 4.3.3d).

Mauritania

Abundance indices estimated during a research survey conducted by IMROP indicated a relatively stable situation for the two years presented (Table 4.3.3e).

The results of analysis of the sex-ratio from the same surveys for *Parapenaeus longirostris* caught within the EEZ of Mauritania indicate that the sex-ratio is largely in favour of the females in both seasons.

Biological data

Length composition and other information

Morocco

A study of the evolution of the mean length of the deep water rose shrimp (carapace length in millimetres) was carried out on data from the INRH research survey series (1998–2004). It was shown that mean length increases with depth. Young individuals are found near the coast while the adults are abundant beyond the 200 m isobath.

Mauritania

The length frequency distributions of the samples from the resource surveys conducted jointly by IMROP-JICA, using R/V AL-AWAM, indicate a plurimodal length frequency distribution. The lengths ranged from 9 to 46 mm CL for the cold and warm seasons.

Spanish fleet

The length distribution of *Parapenaeus longirostris* from the samples taken from the Spanish fleet catches in Mauritanian waters showed a different size distribution of male and females. Males are smaller in size than females (15.5–32.5 mm of cephalothorax length, with a mode of 22 mm for males and 15–38.5 mm with a mode in 24 mm for females).

In the case of shrimps caught in Senegalese waters by the Spanish fleet, size distributions ranges from 17.5 to 34 mm and from 17 to 36.5 mm for males and females respectively. Male samples show a unimodal distribution with a mode of 22.5 mm, while females have a bimodal distribution, with a main mode at 23.5 mm and a second one at 31 mm.

4.3.4 Assessment

Methods

The Schaefer dynamic production model, implemented in an Excel spreadsheet, was used to assess the state of the stock and fisheries of *Parapenaeus longirostris*. The model is described in Appendix 2 of this report.

Data

A time series of total landing of deepwater rose shrimp *Parapenaeus longirostris* by fishing zones was used by the Working Group.

For Morocco, the abundance index used was the CPUE time series calculated from the Moroccan freezer trawler fleet.

For Mauritania, the CPUE series calculated from the Spanish freezer trawlers operating in Mauritania were used.

And finally, the CPUE of the Spanish freezer trawlers was also used for the assessment of *P. longirostris* in the Senegalese and the Gambian fishing zone.

Results

The model gave acceptable fits to the data for the Moroccan and Mauritanian stocks (Figure 4.3.4), but not for the Senegalese and the Gambian stock. Therefore, it was not possible to assess this latter stock.

In Morocco, the deepwater rose shrimp stock is overexploited (Table 4.3.4). This result was confirmed by the 2003 survey of this stock by the INRH. Compared with the 2003 assessment, the situation has deteriorated further, as the ratio B/B_{MSY} has decreased from 48 to 39 percent. It was also observed that the current fishing mortality rate is now higher than the fishing mortality necessary to extract the sustainable yield from the current biomass level.

The model showed that the *Parapenaeus longirostris* stock in Mauritanian waters is fully exploited. The biomass level is close to that which would produce the maximum sustainable yield, but the current exploitation level is about twice as high as the one the stock can stand on a sustainable basis (Table 4.3.4).

Table 4.3.4: Indicators on the state of the stock and the fishery of *Parapenaeus longirostris* in the northern subregion of CECAF

Management unit/Stock	Abundance index	B/B_{MSY}	F_{cur}/F_{SYcurB}
Morocco	Moroccan freezer trawlers	39%	143%
Mauritania	Spanish freezer trawlers	100%	211%
Senegal–The Gambia	-	-	-

B/B_{MSY}: Biomass of the stock in the last year of data as a percentage of the biomass that would produce the maximum sustainable yield. **F/F_{SYcurB}**: Fishing mortality by fishery in the last year as a percentage of the fishing mortality by fishery necessary to extract the sustainable yield from the current biomass level estimated for the last year of data.

Discussion

The difficulty experienced in adjusting the fit to the CPUE data could be due to the lack of contrast in the data and probably also to erratic fluctuations in the abundance of *P. longirostris.* In view of the difficulties in fitting the models, the results should be interpreted with caution. However, the results are in agreement with other indicators of fishing in the area thus reinforcing confidence in the results as a whole.

For Morocco, the results obtained are similar to those obtained last year. The recommendation for reduction of effort made, based on the 2003 assessment, was largely ignored thus resulting in a further decrease in the biomass of the species. It is therefore imperative that strict management measures be put in place, with strict observance of mesh size regulation to allow the stock to recover.

For Mauritania, the results of the assessment of the deepwater shrimp obtained in 2004 are different from those of the preceding year. The assessment of 2003 clearly showed that this stock was fully exploited with biomass and landings close to B_{MSY} and MSY respectively. This year, there is an indication that landings are exceeding the sustainable production of the stock, i.e. a worsening of the situation from last year. Even if some uncertainty remains, prudence must be the guiding factor in advancing any management recommendation. Like the year before, effort should not be increased for this stock.

The models fitted for Senegal–The Gambia were not acceptable and were therefore rejected.

4.3.5 Management recommendations

Taking into consideration the results of the assessments, the Working Group made the following recommendations for the three stocks:

Morocco:

- Reduce current catch and effort (2003) by 40%.
- Encourage the use of separators in the trawl for separating hake from shrimp.
- Regulations concerning trawl mesh size should be strictly enforced.

Mauritania:

- Do not increase the current level of fishing effort.

Senegal–The Gambia:

- Do not increase the current level of fishing effort until a new assessment is available.

4.3.6 Future research

The Working Group made the following recommendations for future research on *Parapenaeus longirostris*:

- Establish biological sampling programmes for coastal trawler and industrial shrimper landings at the port level in Morocco.
- Carry out an analysis of the evolution of the CPUE series for certain Moroccan freezer shrimpers which have been operating since the start of the fishery.
- Improve knowledge of the biology of this species.
- Carry out selectivity studies to reduce bycatches.

4.4 Southern pink shrimp (*Penaeus notialis*)

4.4.1 Biological characteristics

For *Penaeus notialis*, data were available from research vessel cruises in Mauritania in 2000 and 2001. No sampling of commercial landings for biological purposes has been done in Mauritania in recent years.

P. notialis in Mauritania have a long reproduction period (mature females were found in the catches of the Spanish fleet from July to April). Length at first maturity for males and females is estimated at 17.75 mm (CL) and 38.46–46.14 mm, respectively.

The main biological characteristics of the stock in this area are presented in the previous reports of the CECAF demersal working group.

Penaeus notialis attains a length of 1.8 cm (TL) at the age of 3–4 months. At this age it migrates from the estuarine environment to the sea where it grows until the age of 22 months when it attains maximum length (about 20 cm TL) (Garcia, 1976).

Environmental effects

Studies carried out by the IEO (Garcia and Sobrino, submitted) showed a strong correlation between abundance/yields and surface temperature and NAO indices. These may thus need to be taken into account when analyzing the stock dynamics in future work.

4.4.2 Stock identity

Two different units of *P. notialis* have been identified in this area. A reproduction and nursery area is situated in the Banc d'Arguin (Mauritania) and another at the mouth of the Senegal River. The unit associated with the Senegal River is considered to be composed of four sub-units associated with the Senegal River, Saloum, Gambia and Casamance. However, it is not possible to obtain disaggregated information (landing and effort) for the different sub-units defined here. For this reason, the Working Group has decided to carry out an assessment for two units, one in Mauritania and the other in Senegal–The Gambia.

4.4.3 Data trends

Catch

Total landings in the region showed a variable trend in the last few years with a maximum of around 6 000 tonnes in 2002 followed by a decrease in 2003 (Table and Figure 4.4.3a). The landings in Senegal–The Gambia were stable in the last two years at around 3 500 tonnes while landings in Mauritania decreased from 2 571 tonnes in 2002 to 1 573 tonnes in 2003.

Landings of *P. notialis* in Mauritanian waters by the Spanish freezer fleet showed a gradual decrease from 1999 to the present (Figure 4.4.3b). On the other hand, the Mauritanian freezer fleet showed a gradual increase from 1999 to 2002 followed by a slight decrease in 2003. The landings of other freezer fleets operating in the area showed a fluctuating trend while attaining a maximum in 2002 followed by a decrease in 2003.

In the Senegalese and The Gambian waters, landings from the Senegalese industrial that were at the lowest level in 2000, followed by a gradual increase (Figure 4.4.3b). Landings stabilized at around 3 000 tonnes in the last two years. The Senegalese artisanal fleet showed quite low and stable values over the whole series with a maximum value of 208 tonnes in 1995 and a minimum of 7 tonnes in 1998. Gambian industrial and artisanal landings were quite low, with values between 350 and 500 tonnes for the industrial fleet and 98–213 tonnes for the artisanal fleet over the last three years.

Effort

Fishing effort on *P. notialis* by the Spanish freezer fleet operating in Mauritanian waters has tended to stabilize in the last ten years with some fluctuation in the last years. There was an increase from 2 395 fishing days in 2001 to 3 879 fishing days in 2002. This was then followed by a decrease in 2003 to 3 262 fishing days (Table 4.4.3b and Figure 4.4.3c). On the other hand, the Mauritanian freezer fleet showed a gradual and important increase of effort from 1997, reaching a maximum of 5 404 fishing days in 2002 (Table 4.4.3b and Figure 4.4.3c). This too was followed by a decrease of effort to 2 842 fishing days in 2003. The effort of other fleets operating in Mauritanian waters was quite variable as could be seen in the time series with a maximum of 1 991 fishing days in 2002 followed by a decrease to 776 fishing days in 2003.

The fishing effort of the Senegalese industrial fleet was quite stable over the last four years with values of between 30 000 and 35 000 days at sea (Table 4.4.3b and Figure 4.4.3c). On the other hand, the estimated effort of the artisanal fleet showed a strong decrease from a maximum of 683 010 trips in 2000 to 314 196 trips in 2001. Fishing effort of the Gambian industrial fleet has increased steadily throughout the series, with a larger increase from 1999 to 2000, and a relatively stable pattern over the last three years at around 4 700 fishing days.

Abundance indices

CPUE

The CPUE calculated for the Spanish freezer fleet operating in Mauritanian waters showed a fluctuating trend over the last eight years with the highest values in 1999 and 2001 of approximately 490 kg/fishing day (Table 4.4.3c and

Figure 4.3.3d). CPUEs were stable in 2002 and 2003 with an estimated value of around 250 kg/fishing day. On the other hand, the yields of the Mauritanian freezer fleet have fluctuated without trend from 1999 to present. The CPUE for the Mauritanian freezer fleet declined in 2002 to a minimum of 149 kg/fishing day but increased again in 2002 to 231 kg/fishing day in 2003. Lastly, the yield of the other fleets operating in the area was very variable. A maximum of 391 kg/fishing days in 2002 and a minimum of 171 kg/fishing days in 2003 were recorded.

Regarding the yields of the different fleets operating in waters off Senegal–The Gambia, the trends of both the Senegalese industrial and artisanal fleets are quite stable. A slight increase in CPUE (93 kg/fishing days) was observed in the last year of the time series in the case of the industrial fleet. The CPUE for the artisanal fleet stabilized at 0.83 kg/trip during the last two years. The CPUE of the Gambian industrial fleet showed a fluctuating trend during the period 1994–1999. Since 1999, the CPUEs have taken a downward trend to a minimum of 75 kg/fishing days in 2001, followed by an increase to 107 kg/fishing days in 2002 and then a decrease in 2003 to the same value as in 2001.

Research surveys

Mauritania

The abundance indices estimated by IMROP during research surveys, have remained stable for the period 2000, 2001 and 2002 with 0.66, 0.63 and 0.62 kg per 30 minute trawl, respectively.

The sex-ratio for *Penaeus notialis*, in the samples from the research survey, was found to be around 1.

Biological data

Length composition and other information

Mauritania

For *P. notialis* a plurimodal distribution was observed in the survey samples in 2000 and 2001. Lengths ranged from 20 to 44 mm and from 17 to 61 mm CL for 2000 for the cold and warm seasons respectively. In 2001, the lengths ranged from 17 to 61 mm CL and 17 to 54 mm for the cold and warm seasons respectively.

Samples of *P. notialis* from the Spanish freezer fleet in Mauritania, showed a different size distribution for males and females. Male sizes ranged from 20 to 31.5 mm CL while the females showed a wider range from 20 to 44 mm. On the other hand, males have one mode (26 mm of CL) and females have two modes at 28.5 and 40.5 mm.

4.4.4 Assessment

Methods

The Schaefer dynamic production model implemented in an excel spreadsheet was used to assess the state of stock and fisheries of *Parapenaeus longirostris*. The model is described in Appendix 2 of this report.

Data

The total landing time series of *P. notialis* for the Mauritanian, Senegalese and the Gambian fishing zones respectively were used in the assessment of these stocks. For the Mauritanian stock, the CPUE of the Spanish freezer trawlers was used as an abundance index. For the Senegalese and Gambian stock, the series used was that of the CPUE from the Senegalese industrial fishery.

Results

The dynamic production model fits relatively well the data from both stocks (Figure 4.4.4).

The Mauritanian stock of southern pink shrimp, *P. notialis* is moderately to fully exploited. The biomass has slightly surpassed the level that will produce maximum sustainable yield while current landings are below the sustainable production of the stock (Table 4.4.4).

For Senegal–The Gambia, the results show that the southern pink shrimp stock is overexploited (Table 4.4.4). Current biomass is only about 60 percent of the level that would produce the maximum sustainable yield, while current landings exceed the production of the stock by 24 percent.

Table 4.4.4: Indicators on the state of the stock and the fishery of *Penaeus notialis* in the Northern subregion of CECAF

Management unit/Stock	Abundance index	B/B_{MSY}	F_{cur}/F_{SYcurB}
Mauritania	Spanish freezer trawlers	129%	72%
Senegal–The Gambia	Senegal Industrial trawlers	63%	124%

B/B_{MSY}: Biomass of the stock in the last year of data as a percentage of the biomass that would produce the maximum sustainable yield. **F/F_{SYcurB}**: Fishing mortality by fishery in the last year as a percentage of the fishing mortality by fishery necessary to extract the sustainable yield from the current biomass level estimated for the last year of data.

Discussion

All the series for *P. notialis* show a very low level of contrast in the abundance and catch data. This situation makes it more difficult to fit the model to the fisheries data, and reduces the reliability of the model estimates. Under these circumstances, the results should be interpreted with caution. However, the results are in agreement with other fishing indicators, thus reinforcing confidence in the results as a whole.

For Mauritania, the landings and the abundance indices in recent years have shown significant variation that cannot easily be explained by the model. This may indicate either that environmental factors play a major role in the dynamics of the stock, or that the CPUEs are not appropriate indices of stock abundance. The results obtained from the models should be interpreted with prudence.

In the case of Senegal–The Gambia, the model shows a good fit, indicating a situation of overexploitation. If this situation is not attended to, a serious overexploitation of this stock could occur.

4.4.5 Management recommendations

Taking into consideration the results of the assessments and the associated uncertainties, the Working Groups recommend not to increase the current level (2003) of fishing effort in Mauritania and reduce current fishing effort (2003) with about 25% for the unit Senegal–The Gambia.

4.4.6 Future research

The Working Group made the following recommendations for future research on *Penaeus notialis*:

- improve knowledge of the biology of this species;
- improve information on catch and fishing effort by fishing zone (Senegalese and The Gambian fleets);
- stock Identity studies;
- study the possible relationships between environmental factors (SST, rain, …) and the abundance of the species;
- carry out selectivity studies to reduce bycatches.

5. CEPHALOPODS

5.1 Fisheries

Cephalopods in Northwest Africa (CECAF north subregion) are caught both as target species in specific directed fisheries and as bycatch in non-directed fisheries. These fisheries are conducted by a heterogeneous fleet of vessels ranging from small canoes to bottom trawlers, using a number of fishing gears such as pots, jigs and bottom trawls. The fishery has been divided, for statistical purposes, into three major components, according to the flag of the vessels and their characteristics: i) artisanal, ii) industrial conducted by nationals and iii) industrial conducted by third countries within the framework of fishing agreements, the most important being those signed between the European Union and almost all coastal countries in Northwest Africa.

The main target species in the cephalopod fisheries are octopus (*Octopus vulgaris*), cuttlefish (*Sepia* spp., of which most are *Sepia hierredda* and a southwards decreasing proportion of *Sepia officinalis*) and squid (*Loligo vulgaris*). *Sepia bertheloti* is another rather important cuttlefish species in the subregion which is commercialized under the denomination of “sepiola”. In general terms, octopus is the most abundant and valuable species in the cephalopod fisheries in the subregion, accounting for 65 percent to 75 percent of total landings, but its relative importance decreases going southwards being replaced by increasing proportions of *Sepia hierredda*. Squid virtually disappears from the landings made in southern Senegal.

Three major fishing grounds for cephalopods are found along the Northwest African coast, which more or less coincide with the distributional range of the three octopus stocks considered to occur in the subregion. From north to south these are: i) the zone between Cap Bojador (26º N) and Cap Blanc (21º N), ii) the zone between Cap Blanc (21º N) and the mouth of the Senegal river (16º N) and iii) the zone between the mouth of the Senegal river (16º N) and the border with Guinea Bissau (12º N).

In the zone between Cap Bojador and Cap Blanc, fishing for cephalopods started at the beginning of the 60s by a Japanese fleet targeting octopus. Already in 1963, this fleet was taken over by small Spanish ice trawlers supplying their landings to both Japanese and Spanish motherships where catch was sorted, frozen and packed to be distributed to the international market. These small trawlers were rapidly substituted by other Spanish flagged modern ice trawlers operating autonomously. This eventually caused the motherships to disappear from the region. In 1969 the fleet was composed of 39 vessels that increased progressively in number until a maximum of 279 was reached in 1980, although no more than 126 were ever operating simultaneously. The technical characteristics of these vessels were relatively constant throughout the years, apparently because they were very well adapted to the fishing conditions, mean annual production and type of processing. A standard vessel had a 32 m length overall (LOA), 245 tonnes gross tonnage (GRT) and 900 HP engine power. Fishing agreements signed between Spain and Morocco first and the EU and Morocco later on, imposed a gradual decrease of the Spanish fleet which left the zone when the last fishing agreement came to an end in December 1999.

The development of the Moroccan industrial fleet in the zone between Cap Bojador and Cap Blanc started in 1978, increasing very rapidly in number of units at the time when they replaced the Spanish vessels leaving the fishery.

Currently, the fleet includes 290 freezer trawlers using two main types of gears respectively named “Spanish trawl” and “Korean trawl”. Average trips are of around 50 days at sea and technical characteristics of the vessels are more heterogeneous than those of the Spanish fleet that formerly fished in the zone.

Vessels range from 30 m to 40 m LOA, 200 to 600 GRT and 600 to 2 000 HP. More recently an important part of the Moroccan artisanal fleet formerly fishing for a wide variety of demersal finfish has evolved to a very specialized fishery targeting octopus, using passive gears such as pots and hand jigs. This fleet is made up of wooden open vessels of around 2 tonnes GRT, equipped with outboard engines of 15 to 25 HP. The number of vessels in the fishery has increased dramatically since 1993. It now exceeds 7 000 units, mostly operating in the coastal zone, although they can easily travel to a distance of more than 20 miles from the coast. Ice trawlers constitute the third component of the Moroccan fleet which has also recently joined the cephalopod fishery in the zone between Cap Bojador and Cap Blanc. There are around 100 units with an average of 60 tonnes GRT and 400 HP, mostly using a trawl called the “atomic trawl” and making trips ranging from 6 to 10 days at sea.

Management regulations applying to this fishery during the last years are as follows:

- In 2003 the fishery was closed from 15 March to 15 June, and from 1 September until the end of the year. This closure continued until 15 June, 2004. In September 2004 the fishery was closed again for an indefinite period.
- Separate quotas were set for the freezer trawlers, the fresh fish trawlers, and the artisanal fleet. The artisanal fleet took its quota within a few weeks and fishing was closed for this fleet before the end of the fishing season. The other two fleets did not succeed in filling their quotas within the open periods.
- Landings of size category T9 were forbidden in 2003. As of May 2004, landings of category T8 were also forbidden.
- A minimum mesh size for the freezer trawlers of 60 mm, and for the fresh fish trawlers of 40 mm.
- A limitation of the number of pots per canoe, the total number of canoes and the number of landing sites for the canoes was implemented. The last two measures were introduced in 2004.
- Freezer trawlers are not allowed to fish within a 12 mile limit of the coast. For fresh fish trawlers this limit is 6 miles. All fishing is forbidden in the protected zone between 24 º N and 25 º N.

The cephalopod fishery between Cap Blanc and the mouth of the Senegal river was also developed at the beginning of the 1960s by Japanese vessels to which vessels from different countries joined in subsequent years. In the early 1980s, Mauritania started its industrial fleet composed of both ice and freezer trawlers which exploited the cephalopod resources in exclusivity for more than a decade. The number of each of these fleet components increased steadily until 2003. In 1996 a fishing agreement was signed between Mauritania and the European Union allowing the entry to the fishery of a number of European vessels, most of them Spanish flagged. Currently the number of cephalopod trawlers, all flags and types included, is around 190, a third of them being of foreign origin. Spanish freezer trawlers are dominant among these foreign vessels, having passed from an initial number of 14 in 1995 to 52 in 2003. Their average

characteristics in this latter year were 34 m LOA, 234 tonnes GRT and 896 HP. As in the Cap Bojador–Cap Blanc area, a new artisanal fishery targeting cephalopods has also appeared in the zone since 1989. It is composed of small wooden open vessels of different sizes and types based all along the Mauritanian coast. Vessels from the Nouadhibou region mainly target octopus while those coming from Nouakchott are mostly interested in cuttlefish. Fishing gears used in the fishery have diversified over the course of the years ranging from the original pots for octopus to hand jigs to traps. However, the former are still dominant in the fishery.

Management measures currently in force in the Cap Blanc fishery are:

- A closed season from 1 September to 30 October. This measure has been in force since 1996.
- Since 2003, no new licences for the industrial fishery for octopus have been issued. Units that leave the fleet are not being replaced. There is no restriction on the number of canoes fishing for octopus or the number of pots employed by them.
- A minimum mesh size of 70 mm in the industrial fleet.
- A minimum landing weight of 500 g (eviscerated).
- Trawlers are not allowed to fish within the coastal zone that is reserved for the artisanal fleet.

Fishing for cephalopods in the region between the mouth of the river Senegal and the border with Guinea Bissau is a fairly new activity. It is mostly practised by Spanish freezer trawlers working in the framework of the Senegal–EU fishing agreement. The number of these vessels has fluctuated considerably over the period 1991–2003 ranging from a minimum of 1 and a maximum of 6. Their average technical characteristics in 2003 were 36 m LOA, 244 tonnes GRT and 771 HP. There are also trawlers from other countries fishing with different types of licences both in Senegalese and Gambian waters. Precise information on these vessels was not available to the Working Group. Another important component of the fishery is the Senegalese artisanal fleet, a part of which is increasingly and seasonally targeting cephalopods using hand jigs and traps.

Squid (*Loligo vulgaris*) was not assessed by the Working group, but the catch and CPUE data are shown in Tables 5.1a and 5.1b.

5.2 Sampling schemes and sampling intensity

5.2.1 Catch and effort

Landing and effort statistics from the Moroccan fisheries in the subregion are available by month and port at the "Institut national de recherche halieutique" (INRH) of Morocco. The database contains raw data from all the fisheries. Information from the artisanal fleet fishing for octopus is completed by interviews at the landing sites, freezing plants and elsewhere. The fishing effort deployed by this particular fleet is estimated by interviews at the main ports according to the number of daily trips by vessel and the trip duration.

The Mauritanian, Senegalese and Gambian sampling schemes are extensively described in Sections 2.2 and 3.2.

The Spanish statistical system for cephalopod fisheries was established in 1975 by the "Instituto Español de Oceanografía". Originally, it was composed of a group of scientific samplers based at the port of Las Palmas de Gran Canaria which was the only landing site for cephalopods in the region. A number of changes in the fleet strategy were introduced over the years which forced the whole system to be adapted. Currently this system includes two main sources of information:

1. A network of samplers located at the landing ports in Spain (Las Palmas de Gran Canaria in the Canary Islands and Vigo, Cangas and Marín in Galicia).
2. Copies of logbooks compulsory for every EU vessel over 80 tonnes GRT.

Samplers gather detailed information, by vessel and by trip, on fishing effort (fishing days and days at sea) and landings of the three target species (octopus, cuttlefish and squid) as well as of the general bycatch. Copies of logbooks are used to cross-check and to complete sampling information whenever necessary. Combined analyses of the two sources provide monthly landing and effort statistics which are routinely stored in the IEO institutional database.

5.2.2 Biological parameters

Biological sampling in the region is regularly conducted at the main landing ports of the region.

In Morocco, commercial landings are not being sampled directly by the research institute. Instead, information on commercial size categories (T1–T9) is available from the Ministry. Using information on the average weight per commercial category, the data from the Ministry are converted into weight distributions of the total landing.

In Mauritania, information on commercial size categories is available from the producer's organization, SMCP, for the artisanal fleet and for the ice trawlers. No information is available for the Mauritanian freezer trawlers.

Sampling of octopus, cuttlefish and squid caught by the Spanish fleet operating in the subregion is being carried out by the IEO as part of the project "National programme for data collection and management for a common fishery policy" of the EU. This covers data on biometry and biological parameters which had not yet been analyzed by the time of the Working Group meeting.

Information on length and weight is available for research vessel landings in Morocco and Mauritania.

5.3 Octopus (*Octopus vulgaris*)

5.3.1 Biological characteristics

The biology of the main cephalopod species occurring in the subregion has been studied quite intensively over the years. There is a good knowledge of many aspects of their life cycle and the amount of biological parameters available in the scientific literature is rather abundant. A summary of all this information was already presented at the CECAF ad hoc Working Group on cephalopod resources held in Santa Cruz de Tenerife in 1997 (Lamboeuf, 1997). A number of additional works have appeared in recent years covering a range of biological aspects and fishery related questions mostly related to octopus. An updated list of references will be presented at the next Working Group.

5.3.2 Stock identity

Three different octopus stocks have been identified in the subregion since the first assessment Working Group held in 1978:

Dakhla Stock (26° N – 21° N)
Cap Blanc Stock (21° N – 16° N)
Senegal–The Gambia Stock (16° N – 12° N)

This stock separation was based on fishery data that have recently been confirmed using more accurate fishing information including vessel satellite tracking (VMS) as well as genetic analyses.

In Mauritania studies on octopus distribution have shown a relatively marked spatial separation of the different cohorts that are exploited in two distinct periods of the year. In practice this means that if the catches that are carried out in the zone during the warm season relate solely to the Cap Blanc stock, then in the cold season (December to May) some of the catches carried out in Mauritania will span both this stock and that of the North of Cape Blanc. Interannual fluctuations could reduce or exacerbate these exploitation relationships with the Dakhla stock.

5.3.3 Data trends

Catch

Dakhla Stock (26 °N–21 ° N)

Total landings of octopus have shown marked fluctuations since 1990 with maximums in 1991 (111 623 tonnes) and 2000 (107 373 tonnes) and minimums in 1997 and 2003 of respectively 50 081 tonnes and 24 928 tonnes (Table and Figure 5.3.3a). This latter figure may be underestimated due to incomplete statistics still under preparation. The annual trends in total landings follow more or less periodic cycles which are reflected in the catches of most of the fleets in the fishery that could be related to changes in the productivity of the system or in the availability of octopus, affected by external environmental factors.

Landings of Moroccan freezer trawlers have shown an almost continuous decreasing trend from a maximum of 71 066 tonnes in 1991 (Figure 5.3.3a). This general trend has seen some short recovery periods among which the most important is that of 2000 (55 373 tonnes). The current level of landings is only 12 046 t. This reduction in landings is mostly due to the simultaneous reduction of freezer trawlers operating in the region since 1990. The apparent recovery observed in the period 1998–2001 could be explained by an improvement in the stock following the extension of the closed seasons applied to the fishery. Landings of the Moroccan artisanal fishery has followed a similar trend with landings increasing from 1993 (27 000 tonnes) up to 2000 (45 000 tonnes), followed by a period of continuously

decreasing landings until 2003, when a catch of only 9 885 tonnes was observed. As for the ice trawler fleet, landings have showed similar trends to those of the previous fleets, landings passing from 4 000 tonnes in 1994 to 10 000 tonnes in 2001. During the last year of the series (2003) a very low value was registered (2 997 tonnes). Despite the introduction in 2001 of new management measures (TAC) and the extension up to seven months of the closed season during 2003, fleets have been unable to land during the last two years due to the TAC established by the authorities.

Landings from the Spanish freezer trawlers show a constant decreasing trend from 1991 (40 557 tonnes) until the end of the fishery in 1999 with a minimum in the series (8 703 tonnes) (Figure 5.3.3a). This trend is explained by the constant reduction of vessels allowed to access the fishery in the successive fishing agreements signed between the EU and Morocco. Despite this general trend, the data show some slight recoveries in certain years such as in 1993 and 1998 which are also observed in the landings of other fleets, particularly in that of the Moroccan freezer trawlers.

Cap Blanc stock (21 ° N–16 ° N)

During the period 1990 to 2003, octopus landings have fluctuated between a maximum of 46 000 tonnes in 1992 and a minimum of around 17 000 tonnes in 1998 (Table and Figure 5.3.3a). It should be noted that these catch statistics are based on declared catches from the fishery logbooks. They do not include bycatch of octopus in the demersal fisheries which target species other than octopus. Data from observers on board the European Union fleet show that cephalopods make up between 10 and 15 percent of the catch of finfish vessels, 6 percent for the shrimper catches and 1.4 percent for the catches of hake vessels. It is therefore assumed that total catches of octopus in the Mauritanian EEZ are underestimated. In 2003, the provisional statistics show a slight decrease in the octopus catch, despite the fact that they do not cover all the active fleets. This decrease should however be considered with caution due to the relatively low number of vessels declaring their catch in 2003, especially between May and August.

Senegal–The Gambia stock (16 ° N–12 ° N)

Total landings from the Senegal–The Gambia stock in the period 1990–2003 ranged between a minimum of 884 tonnes in 2002 and an unusual maximum of 40 652 tonnes in 1999. Other annual maximums have been periodically observed in 1991, 1994 and 2002. This general trend is followed by all the fleets participating in the fishery, the Senegalese industrial fleet being the major contributor with landings usually accounting for more than 50 percent of the total (Table and Figure 5.3.3a).

Effort

Dakhla stock

Fishing effort deployed on the Dakhla stock in the period 1990–2003 has been quite stable for most fleets operating in the region (Table and Figure 5.3.3b). Only the Moroccan artisanal fleet, fishing with pots, has dramatically increased its effort, passing from a total of 297 500 fishing days in 1994 up to 833 000 fishing days in 1999, to stabilise around values ranging between 700 000 and 800 000 fishing days in the following years. The reason for this increase is the dramatic increase in the number of artisanal vessels which has gone from around 2 000 in 1994 to more than 7 000 in recent years. The ice trawler fleet has maintained a more or less constant effort except in 2001 and 2002 where it was almost doubled compared to other years. This fishery is currently practiced by more than 200 vessels. As for the Moroccan freezer trawler fleet, effort has seen a general decreasing trend over the years under consideration. Nevertheless, slightly higher effort values were observed during a short period extending from 1994 to 1996. Vessels in this fleet have numbered around 290 units since 1992.

The Spanish freezer trawler fleet left the fishery in 1999. During the period 1990–1999, it saw a continually decreasing effort, passing from 35 261 fishing days in 1990 to 11 921 fishing days in the last year of the series except for 1996 when a slight increase was observed (Table and Figure 5.3.3b).

Cap Blanc stock

Fishing effort on octopus saw marked fluctuations during the study period. The observed trends seem to follow (with a gap of between one and two years) those of the catches (Table and Figure 5.3.3b). These fluctuations are particularly observed in the national and foreign freezer trawler fleets and the artisanal fishery vessels. The ice trawler fleet, which saw a steady increase in their effort beginning in 1990, have seen a very slight increasing trend since 1996, that is to say that it has been practically constant at around 16–17 000 fishing days per year.

The national freezer trawlers, after a noticeable increase, reaching a maximum of nearly 26 000 fishing days in 1996, have seen a considerable decrease since then, coming down to a lower level of number of days than that of the ice trawlers at around 12 000 fishing days.

The effort of the European freezer trawlers, which began operating in Mauritanian waters at the end of 1995, increased steadily until 2001, to a level slightly higher than that of the national fleet. The effort decreased somewhat in 2002. The marked decrease seen in 2003 for all the fleets cannot be taken into consideration due to the problems with the quality of the data provided that year.

Senegal–The Gambia stock

Most of the effort on the Senegal–The Gambia stock is made by the Senegalese artisanal fleet. This effort saw an increasing trend from 1992 until 1999 followed by a sharp decrease in 2000 from which it recovered in subsequent years (Table and Figure 5.3.3b). The effort of the remaining fleets was more or less stable over the whole time series except during the second half of the 90s when an increase was observed, probably as a reaction to the marked increase in octopus abundance.

Abundance indices

CPUE

Dakhla stock

Octopus CPUEs of the Moroccan freezer trawlers have shown a general decreasing trend from a maximum in 1993 (1.2 tonne/fishing day) until the last year of the series in 2003 (0.3 tonnes/fishing day). Nevertheless, several minor peaks were observed in specific years such as 1991, 1995, 1998 and 2000 (Table and Figure 5.3.3c). The trend in CPUE of the Moroccan ice trawlers is very similar, showing maximums and minimums in approximately the same years. In particular, the period 1998–2000 shows very high CPUE values. The CPUEs from the artisanal fleet have evolved differently, showing peaks in 1994 and 2002. In all cases abundance indices saw heavy reductions during the last years of the available series.

The CPUEs of the Spanish freezer trawler fleet were very similar to those of the Moroccan freezer trawler fleet both in values and trends, until their withdrawal from the fishery in 1999 (Table and Figure 5.3.3c).

Cap Blanc stock

The octopus CPUE of the Cap Blanc zone shows a strongly decreasing trend after the peak of 1992 which continued until 1997 (Table and Figure 5.3.3c). The CPUEs stabilized subsequently at a relatively low level except for a slight improvement in the index in 2000. In 2003 the CPUEs increased again. A certain consistency in the trends can be seen for all the different fleets fishing octopus in this zone.

Senegal–The Gambia stock

Abundance indices of octopus of the Senegal–The Gambia stock have evolved very similarly for all fleets exploiting the fishery with maximums and minimums occurring in the same years (Table and Figure 5.3.3c). CPUEs are relatively stable, with a very high peak in 1999 for all fleets. The highest CPUEs were attained by the Spanish freezer trawlers fleet with values ranging between 0.072 t/fishing day and 2.3 t/fishing day (in the exceptional year 1999). It is followed by the Senegalese industrial fleet, the Gambian industrial fleet and the Senegalese artisanal fleet in descending order of CPUEs.

Research surveys

Dakhla stock

The series of abundance indices of octopus obtained from research surveys carried out by the Institut national de recherches halieutiques (INRH, Morocco) show a general decreasing trend for the period October 1998–December 2003. Maximums are observed in October 1998 (35.45 kg/30 minutes) and October 2000 (35.43 kg/30 minutes) and marked minimums are shown in April 1999 (6.56 kg/0.5 hours) and October 2003 (3.98 kg/30 minutes) (Figure 5.3.3d).

Cap Blanc stock

The research surveys show a slight decreasing trend in the indices, although less noticeable than that of the CPUE (Figure 5.3.3d).

Senegal–The Gambia stock

No research survey results for octopus from Senegal–The Gambia were presented to the Working Group.

Biological data

Length composition and other information

Information on length frequency distribution of octopus from the Dakhla stock as well as data on the sex-ratio and maturity stage of octopus from the Cap Blanc stock were submitted to the Working Group by the INRH (Morocco) and the IMROP (Mauritania). However, this information was not analyzed during the meeting.

5.3.4 Assessment

Methods

The Schaefer dynamic production model, implemented in an Excel spreadsheet, was used to assess the state of the stock and fisheries of *Octopus vulgaris*. The model is described in Appendix 2 of this report.

Dakhla stock

Data

For the assessment, series of total catches in tonnes in the zone between 26 °N and 20 °N, for the three national fleets and the Spanish industrial fleet were used. As an abundance index, and owing to the fact that the CPUE series in tonnes per fishing day for each component showed exactly the same trend, the Working Group used the CPUE of the Moroccan industrial fishery.

Results

The model provides a good fit to the data (Figure 5.3.4a). The results indicate that the current biomass is below that producing maximum sustainable yield (Table 5.3.4a). However, the estimated catch for the last year of the time series (2003) is below the theoretical production of the stock as regards the estimated biomass, which indicates that there is potential for the stock to recuperate. Considering the above, the model shows that the stock is largely overexploited and it is necessary to reduce the fishing effort whilst maintaining catches at their present level

Discussion

The model provides a good fit to the data. The results show that the Dakhla octopus stock is largely overexploited and is in danger of extinction. This situation is confirmed by the results of the last surveys carried out by the research vessel which indicate that the biomass is in continual decline.

Cap Blanc stock

Data

The data series of total catches from 1991 to 2003 recreated over one year going from November to October (instead of the usual calendar year) was used as input into the *Octopus vulgaris* assessment model for the Cap Blanc stock. As an abundance index series the Working Group used the annual CPUE series of the Mauritanian freezer trawlers calculated over the same time period.

Two other data series were also looked at during the octopus analysis. These were the total catch series by cohort which are quite distinct entities and are exploited during different seasons: November to May (so called cold season stocks) and June to October (warm season stocks).

The three data series were based on available monthly catch data for the different fleets targeting octopus.

Results

Running the model on a year going from November to October gives a good fit (Figure 5.3.4b). As in 2002, the current biomass is greatly below that producing maximum sustainable yield, and fishing mortality is very high in relation to that which is necessary to extract the natural production of the stock (Table 5.3.4a). The Cap Blanc octopus stock is heavily overexploited in relation to its biomass and fishing mortality.

Discussion

The model provides a satisfactory fit to the data. The results indicate that the Cap Blanc *Octopus vulgaris* stock is overexploited.

Senegal–The Gambia Stock

Data

Total annual landing data of all fleets exploiting the stock in the period 1991–2003 were used for the analysis. Some changes have been introduced in relation to last year's assessments. They mostly apply to landings from the Senegalese fleets that have been revised according to the new database being established at the "Centre de recherches océanographiques de Dakar–Thiaroye" (CRODT, Senegal). Also total landing data from 1990 has been removed from the analysis since no corresponding CPUE data is available. The very large landing and CPUE observed in 1999 was instead retained, since external information suggests that this is indeed a feature of the fishery and not a sampling artefact. CPUE series from the Spanish freezer trawlers fleet targeting cephalopods was used as abundance indices to fit the model.

Results

The model fit is acceptable. The theoretical curve follows the CPUE trend across the years (Figure 5.4.4c).

The model estimates that current stock biomass is about 47 percent of the biomass producing MSY and the fishing mortality applied during the last year of the series surpasses by 38 percent that needed to keep the stock at its current biomass level.

Discussion

The assessment results look relatively reliable despite the exclusion of some years from the analyses. They suggest that the stock is overexploited both in terms of biomass and fishing mortality.

Table 5.3.4a: Indicators on the state of the stock and the fishery of *Octopus vulgaris* in Mauritania, Senegal and The Gambia

Management unit/Stock	Abundance index	B/B_{MSY}	F_{cur}/F_{SYcurB}
Dakhla stock	CPUE of the Moroccan cephalopod vessels	32%	52%
Cap Blanc stock	CPUE of the Mauritanian cephalopod freezer trawlers	25%	117%
Senegal–The Gambia stock	CPUE of the Spanish freezer trawlers	47%	138%

B/B_{MSY}: Biomass of the stock in the last year of data as a percentage of the biomass that would produce the maximum sustainable yield. **F/F_{SYcurB}**: Fishing mortality by fishery in the last year as a percentage of the fishing mortality by fishery necessary to extract the sustainable yield from the current biomass level estimated for the last year of data.

5.3.5 Management recommendations

The assessment indicates that all the octopus stocks in the subregion are overexploited, albeit at different levels. The Working Group thus recommends that fishing effort should be reduced in all the fisheries targeting this species.

5.4 Cuttlefish (*Sepia* spp.)

5.4.1 Biological characteristics

No new studies on the biology of these species were presented to the Working Group.

5.4.2 Stock identity

The Working Group adopted at the meeting the definition of three administrative stocks which are as follows:

Dakhla stock (26° N – 21° N)

Cap Blanc stock (21° N – 16° N)
Senegal–The Gambia stock (16° N – 12° N)

In the absence of new information on stock structure, the Working Group did not discuss further these stock definitions, and these were thus used.

5.4.3 Data trends

Catch

Total landings of cuttlefish in the subregion have varied between around 11 600 tonnes in 1993 and 33 000 tonnes in 2000. A progressive reduction can be observed over the last years with a slight recovery in 2003 mostly due to an increase in landings from the Cap Blanc Stock (Table and Figure 5.4.3a). In general, all fleets exploiting this resource show a decreasing trend with periodical fluctuations throughout the period which are the same for most of the fleets. A drop in landings can be observed during the last years of the series except for the Cap Blanc stock which experienced a slight recovery in 2003.

Effort

Section 5.3.3 describes the evolution of fishing effort in the subregion. There is no fleet that specifically targets cuttlefish. Therefore the trends in effort are those already described for the octopus fishery.

Abundance indices

CPUE

CPUEs of cuttlefish have fluctuated markedly in all the three stocks considered (Table 5.4.3b and Figure 5.4.3b). All the series show a general decreasing trend from 1990 until now. However, this decrease is not continuous and several cycles which are not always the same for all fleets fishing in the same zone can be observed. This is particularly noticeable in the Senegal–The Gambia stock where the CPUEs of the Gambian industrial fleet and the Senegalese artisanal fleet seem to evolve differently from the remaining two fleets.

Research surveys

Abundance indices of cuttlefish from the Dakhla stock obtained from research surveys carried out by the "Institut national de recherches halieutiques" (INRH, Morocco) show a general decreasing trend in the period October 1998 – December 2003. Maximums are observed in October 1999 and March 2001. Minimums were found in April 1999, October 2000 and October 2003 (Figure 5.4.3c).

Relative abundance indices (CPUEs referred as a percentage of the baseline value in 1982) of cuttlefish from the Cap Blanc stock calculated by the IMROP (Figure 5.4.3c) indicate a general decreasing tendency from 1993 until 2001. However, the worst period was that between 1984 and 1988 where values were around 30 percent lower than the value in 1982.

Biological data

Length composition and other information

No new information was made available to the Working Group regarding these aspects.

5.4.4 Assessment

Methods

The Schaefer dynamic production model, implemented in an Excel spreadsheet, was used to assess the state of the stocks and fisheries of *Sepia* sp. The model is described in Appendix 2 of this report.

Dakhla stock

Data

As a series of total catch, the Working Group used cuttlefish total catch data for the zone between 20 ° N and 26 ° N for the period 1990 to 2003. As an abundance index the Working Group adopted the CPUE series of the Moroccan cephalopod freezer trawlers.

Results

The model provided a good fit to the CPUE series of the Moroccan cephalopod freezer trawlers (Figure 5.4.4a).

The results of the model indicate that the estimated biomass for the 2003 stock is appreciably less than that producing maximum sustainable yield, MSY. However, the level of fishing activity during the last year was also quite below the level required to extract the natural production of the stock.

Discussion

In light of the results obtained, the Dakhla stock of *Sepia*. spp. appears to be overexploited in relation to its biomass, which would agree with the drastic drop in yields observed by the commercial fishery. The level of fishing activity is not deemed to be excessive, which gives hope that the stock can recover, if the pressure by the fishery is reduced. It is therefore necessary to reduce the fishing mortality of this species in order to promote a sustained natural production of the stock.

Cap Blanc stock

Data

The series of total catches estimated by the Working Group for the zone between 21º N and 16º N for the period 1990 to 2003 was used in the assessment model as a series of total catches for the Cap Blanc *Sepia* spp. stock. As an abundance index, the Working Group adopted the CPUE series of the Mauritanian freezer trawlers.

Results

The model gave a good fit to the CPUE series of the Mauritanian freezer trawlers (Figure 5.4.4b).

The results of the model indicate that the estimated biomass for the 2003 stock is well below that producing maximum sustainable yield, MSY. However, the level of fishing activity during the last year is also below the level required to extract the natural production of the stock.

Discussion

In light of the results obtained, the Cap Blanc stock of *Sepia*. spp. appears to be overexploited in relation to its biomass, which would agree with the drastic drop in yields observed by the commercial fishery. The level of fishing activity is not deemed to be excessive, which gives hope that the stock can recover, if the pressure by the fishery is reduced. It is therefore necessary to reduce the fishing mortality of this species in order to promote stock recovery.

Senegal–The Gambia stock

Data

Total annual landing data of all fleets exploiting the stock in the period 1993–2003 were used for the analysis. Some changes were introduced in relation to last year's assessments. They mostly apply to landings from the Senegalese fleets that have been revised according to the new database being established at the CRODT. Also total landings from 1990 to 1992 have been removed from the analysis since no corresponding CPUE data were available. The CPUE series from the Spanish freezer trawlers was used as abundance indices to fit the model. The Working Group keeps in mind, however, that this fleet mainly targets octopus and some doubts may arise as to the reliability of their CPUEs as indicators of the species abundance.

Results

Model fitting is acceptable. The theoretical curve follows the CPUE trend across the years although it does not seem to be very sensitive to changes between consecutive years (Figure 5.4.4c). A constant downward trend in abundance is estimated.

The estimated current stock biomass is very much below the biomass yielding MSY and the fishing mortality applied during the last year of the series is twice the one that the stock could stand while keeping its biomass at the current level.

Discussion

Assessment results look relatively reliable despite the exclusion of some years from the analyses and the doubts about the quality of CPUE indices as indicators of the stock biomass. These results indicate that the stock is overexploited both in terms of biomass and fishing mortality. These results are in agreement with other external information about the stock.

Table 5.4.4: Indicators on the state of the stock and the fishery of *Sepia* spp. in Mauritania, Senegal and The Gambia

Management unit/Stock	Abundance index	B/B_{MSY}	F_{cur}/F_{SYcurB}
Dakhla stock	CPUE of the Moroccan cephalopod vessels	77%	44%
Cap Blanc stock	CPUE of the Mauritanian cephalopod freezer trawlers	16%	77%
Senegal–The Gambia stock	CPUE Spanish ice trawlers	15%	205%

B/B_{MSY}: Biomass of the stock in the last year of data as a percentage of the biomass that would produce the maximum sustainable yield. **F/F_{SYcurB}**: Fishing mortality by fishery in the last year as a percentage of the fishing mortality by fishery necessary to extract the sustainable yield from the current biomass level estimated for the last year of data.

5.4.5 Management recommendations

All the stocks of cuttlefish in the region show signs of overexploitation. The Senegal–The Gambia stock, in particular, shows very clear signs not only of a much reduced biomass, but also of a fishing pressure that clearly exceeds the production capacity of the stock. Simultaneously, in most of the fisheries, the cuttlefish is generally a bycatch of a fishery mostly directed at octopus, so that any recommendation addressing the cuttlefish will have to consider the effect on the octopus stock. With these points in mind, the Working Group makes the following management recommendations:

For the Dakhla stock, fishing effort should not be increased. Catches of cuttlefish should be monitored, as well as the fishery itself, to ensure that effort is not diverted from octopus to cuttlefish. If this does happen, it may be necessary to further reduce the effort in the fishery as a whole.

For the Cap Blanc cuttlefish stock, it would probably be sufficient to ensure that effort is not increased. However, in this fishery, cuttlefish is a bycatch of the main fishery, the octopus fishery. Since effort must be reduced for the octopus fishery, it follows that effort on the cuttlefish stock should also be reduced.

Finally, for the Senegal–The Gambia stock, all indications point to an already overexploited stock, in which removals from the fishery greatly exceed the production capacity of the stock. For this stock, it is imperative that fishing effort be reduced markedly.

5.5 Future research

For the cephalopod stocks, it was found that the availability of monthly landings data and abundance indices allowed for a better assessment of these short-lived species. It was also found that considerable uncertainty remains on the actual separation of the stocks in the area.

The Working Group considers that these must be priority areas for research on cephalopods during the next year, and therefore makes the following research recommendations:

1. All countries should prepare seasonal or (preferably) monthly data on catch, effort and abundance indices for the next Working Group meeting.
2. The studies on cephalopod unit stocks should be continued.

6. CONCLUSIONS

Summary sheets with assessment results and recommendations are presented in Tables 6.1a and 6.1b. The results of the assessments confirm the conclusion reached by last year's meeting that several of the stocks in the region are moderately to severely overexploited. The most overexploited stocks in the region are the thiof (*Epinephelus aeneus*), the octopus (*Octopus vulgaris*), the cuttlefish (*Sepia* spp.), the Moroccan deepwater shrimps (*Parapenaeus longirostris*) and the white hake (*Merluccius merluccius*).

The assessment of black hake gave no clear results for Mauritania, due probably to inconsistencies between the catch and CPUE data for this fishery. For next year's meeting all data must be reviewed and further analyzed. For Senegal and the Gambia the results of the analysis indicated that the stock was moderately exploited. However, only data up to 2001 were used for the analysis. It is known that from 2002 the number of Spanish deep sea trawlers in Senegal increased, so the current situation may have changed in comparison to the earlier years.

Finfish species in the region showed different degrees of overexploitation. The worst situation is that of the thiof for which the estimated current (2003) stock level is less than 10 percent of the biomass that would produce MSY. Catches consist almost exclusively of juveniles, and the stock of thiof in this region is under severe threat.

All of the octopus stocks in the region are seriously depleted. It is therefore necessary to ensure that current restrictions imposed in these fisheries are adhered to. The stocks of cuttlefish in the region are also over exploited, and measures should be taken to avoid further depletion.

Like last year the working group has restricted its assessments to production models, except for the white hake for which length based models were also applied. Production models do not take into account variations in exploitation pattern. However, in the absence of data on the size or age structure of the catch, the working group could not use structural models.

In future years, more data should be made available on size composition of octopus landings in the region as well as on shrimp catches in Morocco. Monthly data of squid (*Loligo vulgaris*) should also be made available for the future.

Catch and effort data, and also biological sampling data, were sometimes incomplete for the last year (2003). This should be improved in future years.

All working group members supported a proposal to exchange scientific observers between countries in order to increase the reliability of the data and optimize available resources (human and financial). A further objective would be to standardize methods used by observers in the various fleets and countries.