CECAF/ECAF SERIES 10/71
COPACE/PACE SÉRIES 10/71

Report of the FAO/CECAF Working Group on the Assessment of Demersal Resources – Subgroup North
Banjul, the Gambia, 6–14 November 2007

Rapport du Groupe de travail FAO/COPACE sur l'évaluation des ressources démersales – Sous-groupe Nord
Banjul, Gambie, 6-14 novembre 2007

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

CECAF/ECAF SERIES 10/71
COPACE/PACE SERIES 10/71

Report of the FAO/CECAF Working Group on the Assessment of Demersal Resources – Subgroup North Banjul, the Gambia, 6–14 November 2007

Rapport du Groupe de travail FAO/COPACE sur l'évaluation des ressources démersales – Sous-groupe Nord Banjul, Gambie, 6-14 novembre 2007

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS
ORGANISATION DES NATIONS UNIES POUR L'ALIMENTATION ET L'AGRICULTURE
Rome, 2012

The designations employed and the presentation of material in this information product do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations concerning the legal or development status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

Les appellations employées dans ce produit d'information et la présentation des données qui y figurent n'impliquent de la part de l'Organisation des Nations Unies pour l'alimentation et l'agriculture aucune prise de position quant au statut juridique ou au stade de développement des pays, territoires, villes ou zones ou de leurs autorités, ni quant au tracé de leurs frontières ou limites.

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 Cape 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 meeting of Subgroup North which was organized in Banjul, the Gambia, from 6 to 14 November 2007.

The overall objective of the Group is to contribute to the improved 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.

In all, 18 researchers from seven different countries participated in the meeting.

The meeting was funded by the FAO Project GCP/RAF/397/SWE: “Assistance in the Management and development of the fisheries of the Eastern Central Atlantic Area – CECAF” and organized by FAO in collaboration with the Fisheries Department of the Gambia.

FAO wishes to thank the participants of the Working Group who contributed towards this report. Our special thanks go to Stephen Cofield, Sacha Lomnitz, Marie-Thérèse Magnan and Françoise Schatto 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 réunion du Sous-groupe Nord qui a été organisée à Banjul, Gambie, du 6 au 14 novembre 2007.

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.

Au total, 18 chercheurs de sept pays différents ont participé à la réunion.

La réunion a été financée par le Projet FAO GCP/RAF/397/SWE: «Assistance pour la gestion et la mise en valeur des pêches dans la région du comité des pêches pour l’Atlantique Centre-Est – COPACE» et organisée par la FAO en collaboration avec le Département des pêches de Gambie.

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, Sacha Lomnitz, Marie-Thérèse Magnan et Françoise Schatto 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.FAO Fishery Committee for the Eastern Central Atlantic/Comité des pêches pour l’Atlantique Centre-Est.

Report of the FAO/CECAF Working Group on the Assessment of Demersal Resources – Subgroup North. Banjul, the Gambia, 6–14 November 2007.
Rapport du Groupe de travail FAO/COPACE sur l'évaluation des ressources démersales – Sous-groupe Nord. Banjul, Gambie, 6-14 novembre 2007.
CECAF/ECAF Series/COPACE/PACE Séries. No. 10/71. Rome, FAO. 2012. 302 p.

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 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. This report refers to the second meeting of Subgroup North which was organized in Banjul, the Gambia, from 6 to 14 November 2007.

The overall objective of the Group is to contribute to the improved 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 Cape Spartel and the south of Senegal.

For reasons of heterogeneity, the species and stocks assessed by the Working Group were divided into four groups: hake, other demersal fish, 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 this Working Group.

The results of the assessments confirm the conclusion reached at the last meeting in 2004 that most of the stocks assessed are overexploited. 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 États côtiers et des pays ou organisations qui jouent un rôle actif dans les pêcheries démersales de l'Afrique 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. Ceci est le rapport de la deuxième réunion du Sous-groupe Nord a été organisée à Banjul, Gambie, du 6 au 14 novembre 2007.

L'objectif général du Groupe est de contribuer à améliorer l'aménagement des ressources démersales en Afrique du nord-ouest par l'évaluation de l'état des stocks et des pêcheries afin d'assurer une meilleure utilisation de ces ressources au 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 ont été 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 parmi les principaux thèmes de discussion de ce Groupe de travail.

Les résultats des évaluations confirment les conclusions de la réunion 2004, à savoir que la plupart des stocks évalués sont surexploités. Le résumé des évaluations et des mesures de gestion est présenté dans les tableaux à la fin de ce rapport.

CONTENTS

TABLE DES MATIÈRES

1. INTRODUCTION

The FAO/CECAF Working Group on the assessment of demersal resources, Subgroup North met in Banjul, the Gambia, from 6 to 14 November 2007.

The overall objective of the Group is to contribute to improved 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.

For reasons of heterogeneity of the species and stocks, the Working Group decided to divide the resources in four subgroups: Hake, Other demersal fish, Shrimps and Cephalopods. A total of 22 species/species groups were analysed by the Working Group.

The meeting was funded by the FAO Project GCP/RAF/397/SWE: "Assistance in the Management and development of the fisheries of the Eastern Central Atlantic Area – CECAF" and organized by FAO in collaboration with the Fisheries Department of the Gambia.

In all, 18 researchers from seven different countries, SRFC[1] and FAO participated at this meeting. The Working Group is chaired by Said Benchoucha of the National Institute for Fisheries Research (INRH) in Morocco.

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 2006) 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 (10–14 Nov.)	Spain
Pedro	Barros	FAO/Rome
Said	Benchoucha (Chairman)	Morocco
Ana Maria	Caramelo	FAO/Rome
Famara	Darboe	The Gambia
Jessica	Olaussen (6–10 Nov.)	FAO/Ghana
Lourdes	Fernández Peralta	Spain
Hammou	El Habouz	Morocco
Mohamed Moustapha	Ould Bouzouma	Mauritania
Khallahi	Ould Brahim	Mauritania
Asberr	Mendy	The Gambia
Amina	Najd	Morocco

[1] Subregional Fisheries Commission (SRFC)/Commission sous-regionale des pêches (CSRP).

Ana	Ramos	Spain
Pedro	Pascual (6–10 Nov.)	Spain
Birane	Samb	Senegal
Aboubacar	Sidibé	SRFC
Abdellatif	Boumaaz	Morocco
Merete	Tandstad	FAO/Rome
Djiga	Thiao	Senegal

Names and full addresses of all participants are given in Appendix 1.

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 Structure of the report

Separate sections have been devoted to each of the four groups: hake, other demersal fish, shrimps and cephalopods. Table 1.4.1 provides the definition of the units analysed by group.

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.

1.5 Follow-up on research recommendations

Several recommendations were made by the 2003 and 2004 sessions of the Working Group with respect to research to be pursued. The actions adopted for the realization of these recommendations are presented in Table 1.5.1. The Group noted that work has been started to improve the statistical and biological sampling systems in the countries of the subregion. Studies on biological aspects of certain species analysed within the framework of the Working Group had also been initiated. Some recommendations, for various reasons, were not taken into consideration.

For most recommendations follow-up activities had been initiated, although many of them require continuation to be useful for the assessments.

1.6 Trends in catches

Total catch of the demersal resources analysed in this Working Group was 155 000 tonnes in 2006. Total catches of these resources for the period 1990 to 2006 fluctuated with an average of around 220 000 and an average of 167 000 tonnes over the last 5 years. A general decreasing trend has been seen since 1999 (Figure 1.6.1).

In 2006, the most important group of species in the region is cephalopods (with 58 percent of total) and the octopus (*Octopus vulgaris*) represents 42 percent of the total catches of demersal resources in 2006. Total catches of octopus have seen a decreasing trend over the last years going from 159 000 tonnes in 1999 to 65 000 tonnes in 2006 (Figure 1.6.1). Total annual cuttlefish (*Sepia* spp.) catches varied around 29 000 tonnes for the period 1990–1999 followed by a peak of 40 000 tonnes in 2000, then a decrease to 22 000 tonnes in 2006.

The average catches of demersal fish (excluding hake) over the last five years have been estimated at around 25 000 tonnes. The red pandora (*Pagellus bellottii*), widely distributed in the West African zone, was the most important species in terms of catches of the demersal fish studied by the Working Group until 2003. After this year catfish (*Arius* spp.) starts to be the most important of the species analysed. Average landings of catfish over the last five years have been around 11 000 tonnes (Figure 3.1.1a).

Catches of hake (*Merluccius merluccius*, *M. senegalensis* and *M. polli*) during the last five years have been between 13 000 and 23 000 tonnes, with an average of 19 000 tonnes.

The deepwater rose shrimp (*Parapenaeus longirostris*) and the Southern pink shrimp (*Penaeus notialis*) are considered to be important in the region. The average catch over the last five years of *P. longirostris* was estimated at 15 000 tonnes and of *P. notialis* at around 5 000 tonnes.

1.7 Demersal surveys

From September 2004 to November 2007, 25 scientific surveys were carried out in the study area. Morocco and Mauritania carry out several demersal surveys each year. Morocco has carried out six surveys targeting hake and shrimps in the area between Tangiers to the south of Agadir since the last FAO/CECAF Working Group meeting in 2004 (2005:2, 2006:2 and 2007:2). These surveys covered the area from the coast to 1 000 m depth. In the area between Cape Bojador and Lagouira, nine surveys targeting cephalopods were undertaken (2005:3, 2006:3 and 2007:3). These surveys covered the coastal area, to 100 m depth. All of the above surveys are carried out by the Moroccan R/V CHARIF AL IDRISSI. During these surveys, although targeting specific species groups, all demersal fish species, shrimps and cephalopods were sampled.

Mauritania has carried out a total of seven surveys since the last Working Group meeting using the R/V AL AWAM. Four of these surveys were demersal surveys aimed at studying the distribution and abundance of all demersal groups, covering the shelf and slope from 10 to 700 m depth (2005:1, 2006:1 and 2007:2). Four specialized surveys to monitor the closed season (start and end) for cephalopods were also carried out in the area between 20°N and 20°45'N (10–100 m depth) (2005:1, 2006:1 and 2007:2).

From 2004 to 2006, Spain conducted three deep water research surveys in the northern area of CECAF using the research vessel VIZCONDE DE EZA. In addition one survey is planned for November 2007. The 2004 survey covered the northern area of Morocco between Cap Spartel and Agadir, at depths from 500 to 2 000 m. The 2005 survey covered the same depth zone in the area between Agadir and Cap Juby and the 2006 survey the area from Cape Bojador to Cape Blanc, at depths of 200–2 000 m. The 2007 survey will cover Mauritanian waters from 400 to 2 000 m. All these surveys are multipurpose surveys aimed at mapping the distribution, abundance and biodiversity of demersal fish, cephalopods and shrimps as well as megabenthos. Bathymetric maps were also established using a multibeam echosounder.

The last demersal surveys carried out in Senegal with the R/V ITAF DEME were in 2004.

1.8 Data quality

Trends and quality of the basic data (catch, effort and length frequencies) collected by each country, were one of the main topics of discussion during the 2007 Working Group meeting. Although some improvements have been noted in recent years, there are still problems with the sampling of catches and with the basic data. There are also uncertainties surrounding stock definition. The quality of the data series could therefore be improved in the future.

1.8.1 Sampling schemes and sampling intensity

Sampling of biological parameters (including length and weight) is mostly carried out during the research surveys. Morocco and Mauritania make various surveys during the year and all hauls are sampled. In 2004, Morocco established a sampling plan at landing ports. This plan was specifically targeted at shrimps and hake. Shrimps 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 has not been used to estimate length composition of the landings.

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 Spanish Oceanographic Institute (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.

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.

Specific recommendations for each species are reported in the respective sections.

1.9 Methodology and software

A total of 22 species/species groups were analysed by the Working Group (Table 1.4.1).

After reviewing the available data, the Working Group concluded that the only class of methods that could be applied to all stock units were Production Models. Keeping consistency with the methods used in previous Working Groups, the dynamic version of the Schaefer (1954) model was used. To assess the current state of the stocks and estimate the model parameters, an Excel spreadsheet implementation of the dynamic version of this model, with an observation error estimator (Haddon, 2001), was used (Appendix 2). The model was fitted to the data using the non-linear optimizer built into Excel, solver tool. For some stocks it was possible to use length-based models (see below).

Reference points for management advice
To ensure consistency in the management advice, the 2007 Working Group decided to use the same Biological Reference Points (BRPs) as those adopted by the FAO Working Group on the Assessment of Small Pelagic Fish off Northwest Africa. Hence the indices B/B_{MSY} and F/F_{MSY} were used as Limit Reference Points, while the indices $B/B_{0.1}$ and $F/F_{0.1}$ were chosen as Target Reference Points. A more detailed explanation of these reference points and of their use in fisheries management is given in the 2006 Report of the FAO Working Group on the Assessment of Small Pelagic Fish off Northwest Africa (FAO, 2006).

Projections
Simple medium-term projections of future yields and stock development were made according to predefined scenarios using the Schaefer model fitted to the historical data, using a spreadsheet implementation that allowed uniform input and output for all stocks (Appendix 3). A time horizon of five years was used for the projections.

All projections took as their departure point the estimated stock status at the last year of data available. Future management strategies were defined as changes in fishing mortality and/or catch relative to those estimated for the last year of data available.

For each stock, two scenarios where analysed. The first was *status quo* considering future yields and stock development if the current fishing mortality in the fishery is continued. The second scenario considered constant fishing mortality level, corresponding to the catch level recommended for next year for each stock.

Length structured methods
For some of the stocks, like the white hake (*Merluccius merluccius*) and the deepwater rose shrimp (*Parapenaeus longirostris*) of Morocco, the Cassava croaker (*Pseudotolithus senegalensis*) and the catfish (*Arius* spp.) of Mauritania, Senegal and the Gambia, some data on catch length distributions and

growth parameters were available. Therefore, a Length Cohort Analysis (LCA) (Jones, 1984) was applied to these stocks, in order to estimate the fishing mortality level (F-level) in the fishery, and the relative exploitation pattern in the last few years. A length-based Yield per Recruit Analysis was then run on these estimates, to estimate the Biological Reference Points F_{Max} and $F_{0.1}$. Both the LCA and the Yield-per-Recruit Analysis were implemented in Excel spreadsheets. For more information on these methods, readers are referred to Sparre and Venema (1998).

2. HAKE

2.1 Fisheries

The geographic and bathymetric distributions of the different hake species as well as their corresponding fisheries differ from one country to another in the subregion.

In Morocco, the only hake species caught by the coastal fishery is the white hake (*Merluccius merluccius*). The number of coastal Moroccan trawlers targeting this species is 300 units. They generally operate to the north of Morocco. This species is also caught by about twenty longliners belonging to joint Hispano-Moroccan companies operating in Morocco since the end of 2001, by a fleet of Moroccan longliners and by 200 coastal trawlers operating to the south of Morocco and catching very small quantities of this species. European Union activity in Moroccan waters ceased at the end of 1999. It should be noted that a new fishing agreement between the European Union and Morocco was signed, but this agreement forbids the fishing of white hake and only allows black hake to be caught after the summer of 2007.

In Mauritania, the hake fishery concentrates on black hake (*Merluccius senegalensis* and *M. polli*). Black hake is targeted by Spanish and Mauritanian fresh fish trawler fleets, as well as Spanish bottom longliners. At some periods in the year, Spanish freezer-trawlers catch large amounts of black hake under different licences (black hake fishery and demersal fishery), but it is difficult to determine the actual composition of these catches. Some fresh fish hake trawlers from other countries also take small quantities of catch. This species also makes up a non-negligible part of bycatch from the cephalopod, shrimp and pelagic trawlers.

Over the last few years, Spanish hake trawlers have been operating more and more in deep Mauritanian waters, reaching depths of 1 000 m. In 2005 and 2006, only a few longliners were active.

In Senegal, the Spanish trawlers are the only fleet targeting black hake. In 2006, this fleet remained inactive as the fishing agreement between the European Union and Senegal came to an end in July and has not been renewed.

2.2 Sampling intensity

Table 2.2.1 shows sampling intensity of white hake.

2.2.1 Catch and effort

In Morocco, since 2001, the National Fisheries Office (NFO) has installed a system of daily sampling of landings at the main ports. The landings are registered by day, vessel, occupation and species at each port and transmitted daily to the NFO headquarters in Casablanca. In 2003, the system was operational in all Moroccan ports. Thus data concerning landings and effort since 2003 are available to the INRH in a database of basic data. Effort for the period 1990–2002 was estimated from that of the ocean-going shrimpers or by examining a sample taken from the sales records of a single port (Larache). A correction factor for effort during this period was calculated by taking the average variation between the actual effort aimed at this species between 2003 and 2006 and the estimated effort for the same period then multiplying this factor by the effort of the same series (1990–2002). The corresponding catches per unit of effort (CPUEs) were thus recalculated for the whole data series.

Catch and effort data from the Spanish trawlers and longliners targeting black hake in Mauritanian and Senegalese waters are available until 2006 in the IEO database. Sampling from the landing ports and effort from the logbooks are compared in order to obtain a control figure for total landings. It should be highlighted that these are fresh fish fleets which carry out many trips which makes following them up difficult. In addition several effort data are missing compared to registered catches over the last few years. Effort is estimated from monthly CPUEs obtained from actual data from each fleet. From the work carried out by the Working Group to validate black hake statistics in the CECAF zone (see Appendix 4), the IEO detected an overestimation of the trips of the trawlers for the years 1990, 1991 and 1992. The effort data relative to these years has been corrected based on the CPUEs of typical vessels chosen for their fishing strategy and regularity. This series was then used as an abundance index to carry out the assessment.

As the two black hake species are not separated in the catch statistics, the proportions of the two species in the Spanish hake trawler catches were calculated based on the results from several trips on board this fleet between 2002 and 2007 by scientific observers from the IEO.

Mauritania does not carry out catch and effort sampling in its ports, but since 1990, it has been obligatory for vessel captains to keep a logbook which provides information on effort deployed by their vessels as well as the quantities of catch in the Mauritanian Exclusive Economic Zone (EEZ). The data collected by this system are stored in a database managed by the Mauritanian maritime surveillance organisation. A copy of this database is sent to IMROP (Institut mauritanien des recherches océanographiques et des pêches) for its use. This database has been particularly useful to the Working Group in its assessment of black hake (see Appendix 4).

A study of the percentage of discards on the Spanish hake trawlers in Mauritania in 2002 and 2003 (IMROP/IEO, 2003) concluded that there are, on average, between 45 and 50 percent of discards in this fishery. The IEO is continuing its studies into the discards of this fleet with the goal of obtaining correct weighting processes for catch and effort and to obtain definitive results by analysing their variability.

2.2.2 Biological parameters

In Morocco, sampling of landings of the commercial fishery to study the biological characteristics of white hake has been carried out in some ports since 1989. Since 2002, sampling has been done regularly in the ports of Larache and Agadir which are considered to be reference ports for landings of this species.

As well as sampling the landings of the commercial fishery, scientific surveys carried out by INRH allow data to be obtained on the demographic structure and biology of white hake (sex-ratio, first sexual maturity, length-weight relationship, growth, etc.). Distribution maps of abundance indices and the percentage of juveniles in the white hake population are also provided by these surveys. In all, 43 surveys have been carried out by INRH from 1987 to 2007 using two research vessels, the IBN SINA from 1982 to 1986 and the R/V CHARIF AL IDRISSI. These surveys covered the trawlable zones between Tangiers and Agadir. In general, 80 to 90 trawls are carried out during each survey following a stratified random sampling plan.

Sampling intensity of white hake in Morocco during the surveys is high at 51 to 77 percent of total catch whilst coverage is 100 percent (all the trawls are sampled). In contrast sampling intensity of landings of the coastal fishery is weak at only 0.01 percent of total catch.

Between 2003 and 2007, IMROP carried out several surveys using the R/V AL AWAM, as part of its mandate to study demersal resources in the Mauritanian EEZ. These surveys were carried out at depths of between 10 and 700 m during the cold and warm seasons. The surveys covered the entire EEZ. Data on catch rates and length frequencies were collected for a variety of species of which black hake *Merluccius senegalensis* and *Merluccius polli* were included.

Since 2002, IEO has put into place a programme of embarking scientists on board the Spanish trawlers working in Mauritania to study the demographic structure and the biology of black hake. During these surveys data on the distribution of abundances of the two hake species, the specific composition of the catch, the length-frequencies, the discards by zone, the bathymetry and the biology (length-weight relationship by sex, sex-ratio, spawning grounds and seasons, growth, fertility and genetics) were collected. It should be pointed out that the largest individuals are gutted so that it is not possible to carry out biological sampling of landings. This programme should eventually be extended to the hake trawlers operating in Senegalese waters, but, for the moment, only one survey has been carried out in this country in 2004. In Mauritania, two surveys were carried out in 2004, four in 2005, three in 2006 and ten in 2007. Data from these last surveys when *M. senegalensis* and *M. polli* individuals were measured is not yet available. During these surveys, between 3 and 12 percent of the total weight of the catch was sampled.

The surveys carried out by the IEO and INRH in 2004, 2005 and 2006 with the Spanish R/V VIZCONDE DE EZA collected a large amount of data on catch rates, distribution and biology of the three hake species (*M. merluccius*, *M. senegalensis* and *M. polli*) in the northern CECAF zone.

There is no biological sampling programme targeting hake in Senegal.

2.3 White hake (*Merluccius merluccius*)

2.3.1 Biological characteristics

White hake is a temperate water species of moderate growth that lives a relatively long time (12–13 years). The first sexual maturity is generally reached around the fifth year of life. Fertility is between two and seven million eggs per female. As for feeding, the adults generally eat fish (young hake, anchovy, sardine, gadids) and squid whereas the young eat crustaceans (mainly euphausiacs and amphipods). Spawning takes place all year round with two peaks, the first in summer and the second in winter. Recruitment takes place in spring and autumn. After spawning, which usually takes place at depths of between 150 and 200 m, the eggs are carried to the surface by the current. The larvae hatch four days later and are carried towards the coast during their period of growth until reaching the juvenile stage. The adults return to deeper waters after spawning.

The bathymetric distribution of this species is strictly tied to the phases of its biological cycle (Figure 2.3.1).

2.3.2 Stock identity

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

2.3.3 Data trends

Catch

Annual registered catch of the coastal Moroccan fleet shows a continual increase from 1998 to 2003. Production reached 11 300 tonnes in 2003, almost twice the recorded landings of 2002. Since 2003, a notable decrease in catch has been observed (Figure and Table 2.3.3a).

The trend of the catches from Portugal longliners declined from 1991 to 1999.

For the Spanish fleet, catches from the trawlers, gillnetters and longliners show a fluctuation from 1991 to 1996. A decline was observed for these fisheries from 1997 up until these fleets withdrew in 1999.

Effort

Overall fishing effort on white hake increased in a continual fashion from 1997, reaching a maximum of about 169 000 fishing days in 2004. A decrease was subsequently observed for the remainder of the period (Table and Figure 2.3.3b).

The number of European Union vessels progressively decreased between 1992 and 1999, the year in which they withdrew from Moroccan waters.

Abundance indices

CPUE

The catches per unit of effort (CPUE) of the Moroccan coastal fleet show that the CPUE (expressed in kg/fishing day) registered their highest level in 1995 at 96 kg/fishing day. Since then there was a drop in catch rates until 1998, followed by a period of progressively increasing catch rates. Catch rates improved in 2003 (77 kg/fishing day) before progressively dropping again to reach 43 kg/fishing day in 2006 (Table and Figure 2.3.3c).

The CPUEs of the Spanish vessels showed a decreasing trend between 1995 and 1999 when the fishing agreement came to and end.

Scientific surveys

The abundance indices of white hake from the scientific surveys (Figure 2.3.3d) show a general decreasing trend between 1982 and 2006. White hake abundance fell 36 percent in 2006 compared to 2005.

The abundance indices distribution maps of white hake (Figure 2.3.3e) show continual shrinkage of the high concentrations observed of this species. The observed densities are composed mainly of adults between Essaouira and Agadir and juveniles between Larache and El Jadida. The percentage of juveniles in this zone is constantly increasing, going from 53 percent in April 2006 to 83 percent in June 2007.

Biological data

Sampling of white hake landings of the coastal fishery and the scientific surveys have provided detailed information on the biology of white hake. The sex-ratio study of this species shows that there is a slight predominance of females, representing 51 percent of the sample compared to 49 percent for males. Total length at first sexual maturity is 35 cm for females and 29.20 cm for males. The length-weight relationship equations are as follows:

$W = 3 \times 10^{(-5)} \times L^{2.73}$ for males
$W = 2 \times 10^{(-5)} \times L^{2.81}$ for females
$W = 8 \times 10^{(-6)} \times L^{2.98}$ overall

Growth parameters are estimated for the whole population at 101.3 cm total length for $L\infty$, 0.096 $year^{1}$ for K and -1.05 $year^{-1}$ for t_o.

Length composition and other information

Analysis of the length structures of the white hake landings of the coastal fishery show that the average total length has progressively decreased since 2001 (27 cm) reaching 22 cm in 2007 (Table 2.3.3d). The percentage of juveniles in the catches of the coastal fishery has been continually increasing since 2000 (Figure 2.3.3f).

Analysis of the length distributions for the scientific surveys carried out by INRH show a stable trend in average length between 1995 and 2004. This subsequently fell, going from 26.91 cm in April 2005 to 21.38 cm in December 2006.

Current management measures

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

2.3.4 Assessment

Methods

The dynamic Schaefer production model implemented on an Excel spreadsheet was used to assess the state of the white hake (*M. merluccius*) stock (Appendix 2). Given the availability of length compositions between 1989 and 2006, LCA and a yield per recruit model were also used to assess the stock of this species.

Data

For the assessment using the production model, the white hake abundance series from the scientific surveys and the CPUEs of the coastal fishery were adopted by the Working Group along with a series of total catch of the stock between 1995 and 2006. The model was fitted taking into account an environmental factor in 1998, 1999 and 2002 on stock abundance. Two studies carried out by the IEO team on the influence of the North Atlantic Oscillation (NAO) on hake abundance justify this decision (Meiners, 2007; Meiners *et al*., 2007).

For the LCA analytical model, the average of the length frequencies in 2004, 2005 and 2006 was used given that this series is the most regular and complete.

Results

The model fits the two abundance indices series well, the fit with the abundance indices from the scientific surveys is slightly better than that of the coastal fleet. The Group therefore decided to adopt the results of the model fitted to the abundance indices of the surveys as they better reflect the actual abundance of the stock (Figure 2.3.4a).

The results from the assessment indicate that the white hake stock is overexploited, with catch exceeding the natural production of the stock (Table 2.3.4a). Current fishing effort is greater than that which would maintain the biomass at its current level.

Table 2.3.4a: Summary of results on the state of the *Merluccius merluccius* stock in the northern CECAF zone

Stock/abundance index	F_{cur}/F_{SYcur}	$B_{cur}/B_{0.1}$	$F_{cur}/F_{0.1}$	B_{cur}/B_{MSY}	F_{cur}/F_{MSY}
Merluccius merluccius/surveys	211%	21%	415%	23%	374%

F_{cur}/F_{SYcur}: Ratio between the observed fishing mortality coefficient during the last year of the series and the coefficient that would give a sustainable yield at current biomass levels.
$B_{cur}/B_{0.1}$: Ratio between the estimated biomass for the last year and the biomass corresponding to $F_{0.1}$.
$F_{cur}/F_{0.1}$: Ratio between the observed fishing mortality coefficient during the last year of the series and $F_{0.1}$.
B_{cur}/B_{MSY}: Ratio between the estimated biomass for the last year and the biomass coefficient corresponding to F_{MSY}.
F_{cur}/F_{MSY}: Ratio between the observed fishing mortality coefficient during the last year of the series and the coefficient giving maximum long term sustainable yield.

Table 2.3.4b shows the results obtained using the LCA analytical model. The yield per recruit model shows that there is an overexploitation of growth (Figure 2.3.4b).

Table 2.3.4b: Summary of results of the LCA of *M. merluccius* in the northern CECAF zone

Stock	$F_{cur}/F_{0.1}$	F_{cur}/F_{max}
Merluccius merluccius (Morocco)	833%	312%

$F_{cur}/F_{0.1}$: Ratio between the observed fishing mortality coefficient during the last year of the series and $F_{0.1}$.
F_{cur}/F_{max}: Ratio between the observed fishing mortality coefficient during the last year and the F_{Max} series.

Discussion

The assessment results show that the stock is overexploited. Fishing effort is four times that of the target effort ($F_{0.1}$) and surpasses that which would maintain the biomass at its current level according to the fit with the scientific surveys. It can be seen that the stock situation has degraded compared to the 2004 Working Group results (F_{cur}/F_{SYcurB} = 115%).

The results from the analytical model confirm the overexploitation of the stock. Fishing effort in the last year of analysed data is high among juveniles and young individuals.

2.3.5 Management recommendations

Considering the assessment results, the Working Group decided to recommend the following management measures:

- reduce current fishing effort so that catch levels do not exceed 3 500 tonnes;
- ban fishing during the months of June and July to preserve juvenile stocks.

2.3.6 Future research

The Working Group recommends undertaking the following actions:

- Assess the bycatch and discards of hake in other fisheries.
- Collect data (catch and effort) on the longliners operating in Moroccan waters since the end of 2001 under Spanish-Moroccan joint ventures.
- Carry out studies on the possibility of using trawl separators and grids to separate white hake and shrimp catches.

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

2.4.1 Biological characteristics

Two species of black hake, both found only in the East-Central Atlantic, live along the Moroccan, Mauritanian and Senegalese coasts. The Senegalese hake (*Merluccius senegalensis* – Cadenat, 1950) is found between 33 °N and 10 °N, while the Benguela hake (*Merluccius polli* – Cadenat, 1950) is found between 20 °N and 18.5 °S (Lloris, Mattalana and Oliver, 2005).

At a taxonomic level it is very difficult to differentiate between the two species and for this reason they are not separated in commercial statistics. The maximum length is however different for the two species, 87 cm for the Senegalese hake and 80 cm for the Benguela hake (Lloris *et al*., 2003).

According to studies carried out by Boukatine (1986) and by Overko, Boukatine and Ly (1986), the most abundant species on the Mauritanian coast is the Senegalese hake. Studies carried out during IMROP scientific surveys in 2000 and 2001 (FAO, 2006) as well as results from scientific observer's surveys on board Spanish trawlers and hake longliners between 2003 and 2007, show that *M. senegalensis* is found at depths of less than 500 m whereas *M. polli* is found more at greater depths of up to 1 000 m (see Appendix 4). Observations in Senegal also confirm that *M. senegalensis* is found more in coastal waters and *M. polli* in deeper waters (Caverivière *et al*., 1986; FAO, 1986).

Both species spawn during the cold season, between October and March (Wysokinski, 1986; Sobrino, Cervantes and Ramos, 1990). It would also appear that both species migrate latitudinally (García, 1982).

2.4.2 Stock identity

No detailed studies are available on black hake stock identity.

2.4.3 Data trends

Catch

Black hake catch reached a maximum in 1993 of about 22 000 tonnes. Subsequently it stabilized between 15 000 and 18 000 tonnes over the 1994–2002 period. Since 2002 an important decline is noticeable, which continued until 2006, when the catch decreased to about 7 000 tonnes (Table and Figure 2.4.3a).

In Mauritania, catch of black hake increased between 1998 and 2002. Since 2000, it has made up 90 percent of declared black hake catch in the CECAF zone (96 percent in 2002). In 2002, coinciding

with the decrease in landings by the Spanish hake trawlers, an increase in those of the demersal freezer trawlers can be seen. Large catches of black hake began to appear in 1996, and were especially important from 2002 onwards in landings of other trawlers, notably the pelagic trawlers (Table 2.4.3a and Figure 2.4.3b). Catches over the period 1996–2006 have varied between 1 080 and 3 866 tonnes. Activity by the freezer trawlers from 1992 to 1996 and from 2001 to 2003 under two types of licence ("Black hake fishery" and "Demersal fishery") has probably caused an increase in hake landings, but the exact nature of these catches is subject to caution (see Appendix 4).

In Senegal (Table 2.4.3a and Figure 2.4.3d), after the peak in 1992 (4 400 tonnes), landings by the Spanish trawlers show a decreasing trend which continued, with some fluctuations, until 2006. Some changes were made to this series after the data were revised by the Working Group in Malaga in 2005 (see Appendix 4). The black hake freezer trawler category, which were active some years, was introduced and the remaining catches were grouped under the "Other fisheries" category which includes Spanish freezer shrimp trawlers which were present in the series of the last Working Group in 2004 (FAO, 2006).

For the Spanish hake trawlers active in Mauritanian waters, it can be concluded that nearly 90 percent of landings are made up of *M. polli* (Table 2.4.3b) (see Appendix 4). This is due to a fishery operating in deeper waters, the average depth of which was 542 m between 2003 and 2007. The aim of this fishery in deeper waters is to catch *M. polli* which have a greater commercial value. Table 2.4.3c shows kept and discarded catches of black hake from scientific observers in surveys carried out by the IEO on board the Spanish trawlers in 2005 and 2006.

Effort

In Mauritania, fishing effort by the Spanish trawlers decreased between 1990 and 1999, going from 5 000 to 1 423 fishing days (Table 2.4.3d and Figure 2.4.3e). Subsequently there was an increasing trend until 2002 then another drop. Over the last three years, it has stabilized around the 2 000 fishing days. Effort of the Spanish longliners shows an increasing trend between 1993 and 1999, followed by a progressive decrease until the end of the series. The effort of the Spanish freezer trawler fleet ("black hake" and "demersal fishery" licences) was also taken into account as over the last few years this fleet has targeted hake and its effort has been almost the same as that of the hake trawlers.

In Senegal, effort of the Spanish hake trawlers shows a decreasing trend following two peaks in 1984 (1 256 fishing days) and 1993 (940 fishing days). It subsequently stabilized around 200 fishing days between 1999 and 2002 before increasing slightly in 2003 and 2004 (Figure 2.4.3f).

Abundance indices

CPUE

In Mauritania, following a continual increase between 1991 and 2000, CPUE by the Spanish trawler fleet fell drastically from 5 000 kg/fishing day in 2000 to 2 000 kg/fishing day in 2002 which represents a 60 percent decrease over two years (Figure 2.4.3g). This decline was also observed among the longliners and the Mauritanian hake trawlers. The CPUEs of the Spanish trawlers show the same trend both in Senegal and in Mauritania, with a heavy drop in CPUE in Senegal and a value decreasing by half in one year between 2001 and 2002 (from 8 200 to 3 700 kg/fishing day) (Figure 2.4.3h).

Biological data

Distribution and abundance

The yield distribution of black hake *M. polli* and *M. senegalensis* from the Spanish trawlers and longliners in 2003 and 2004 was mapped in order to analyse the abundance of the two species. As can be observed in Figure 2.4.3i, the highest values of *M. polli* were obtained by the trawlers south of Cape Timiris (an average of 341 kg/h). For the longliners the highest yields of *M. senegalensis* were obtained around 18 ºN (an average of 180 kg/1 000 hooks).

Black hake distribution depends on depth. *M. senegalensis* shows a maximum abundance in the 200–400 m stratum with yields decreasing drastically beyond 500 m (Figure 2.4.3i). *M. polli* constitutes 89.1

percent of catches by the trawlers active in deep waters greater than 900 m between 2002 and 2007. It is the only hake species at depths greater than 550–600 m (Table 2.4.3b). *M. senegalensis* represents 67 percent of longliners catches in less deep waters (see Appendix 4).

During the IMROP surveys in 2000 and 2001, large yields of *M. senegalensis* were detected over the whole Mauritanian EEZ. During the warm season its abundance was very low in the southern zone and was concentrated in the central and northern zones. *M. polli* on the other hand showed greater yields in the central and southern zones at all surveyed depths. The maximum depth surveyed during the surveys was 600 m. Between 2003 and 2007, IMROP carried out a series of surveys which revealed higher yields of *M. polli* in all zones and during all seasons with the exception of the northern zone in 2003 where *M. senegalensis* dominated (Table 2.4.3e).

Length frequency
No information was provided by the IEO on length frequencies in commercial catches of black hake. The length frequency data obtained during the IMROP surveys and provided to the 2004 Working Group highlights a plurimodal distribution in the lengths of *M. senegalensis* during the 2000 cold season and a unimodal distribution during the 2000 and 2001 warm seasons (FAO, 2006).

The bathymetric length distributions of the two species were obtained by the IEO from scientific observer survey data conducted on board the trawler and longliner fleets. For *M. polli*, the length distribution is bimodal between 300 and 600 m, with a length interval that varies between 40 and 50 cm, and unimodal at greater depths (a mode of 55 cm), becoming gradually narrower with depth (Figure 2.4.3j). The modes are also observed in the longliner length distributions (Figure 2.4.3k).

Furthermore greater mean lengths are observed in the longliner fleet compared to the trawler fleet which is probably due to the selective nature of this gear.

Length-weight relationship
The length-weight relationship parameters for *M. polli* and *M. senegalensis* (length in centimetres, weight in grammes) for both sexes and the total Mauritanian population are given in Table 2.4.3f.

A total of 11 710 *M. polli* individuals and 5 521 *M. senegalensis* were sampled on board the trawlers in 2003 and 2004. Generally, *M. polli* has superior weight growth to *M. senegalensis.*

Sex-ratio
Figure 2.4.3l shows the proportion of both sexes of *M. polli* and *M. senegalensis* obtained from scientists on board the Spanish hake trawlers and longliners in 2003 and 2004. For both species a similar sex-ratio is observed with 71.5 and 76.5 percent of females. In both species, the males are of inferior length to the females. Although the proportion of males is large in individuals of smaller lengths (up to 45 cm), practically only females are found in lengths greater than 55 cm.

Sexual maturity
The IEO monthly series of black hake gonads (both species combined) originating from catches landed by all fresh fish trawler and longliner fleets targeting black hake in Mauritanian and Senegalese waters between 1984 and 2006 was analysed. Seasonality was studied along with trends in the series using the X-12 ARIMA (autoregressive-integrated-moving-averages) routine. It can be seen that the seasonal component in the series is very strong between November and February, with a marked signal in December and January (Figure 2.4.3m). This means that spawning takes place during these months for both species. On another hand, the trend shows no clear pattern.

Individuals of both sexes (Stages II and III) of *M. polli* are concentrated around 16 º and 18 ºN during spawning whereas those of *M. senegalensis* are found more to the north between 18 º and 19 ºN (Figure 2.4.3n). Males reach first sexual maturity before females. Length at first sexual maturity is approximately the same for both species: around 35.4 cm for males and 37.0 cm for females (Table 2.4.3g and Figure 2.4.3o).

These parameters were calculated based on a macroscopic analysis of the gonad state (a scale of four states, Lucio *et al.*, 1998) of individuals sampled during the spawning period between the months of November and February (Figure 2.4.3i). Maturity data were fitted to a logistic curve using the INBIO 1.2.1 package developed in R, and applying a generalized linear model (GLM) with binomial errors and a non-parametric bootstrap to estimate the covariation coefficient of the function parameters. The least square parameters were also calculated for comparison.

Data collected during the scientific surveys by the IEO on board the trawlers and longliners provide new results on spawning areas which appear to be located to the south of Cape Timiris during the cold season, and avoid the permanent upwelling of Cape Blanc. Mature spawning individuals of both sexes (Stage III) of *M. polli* are concentrated between 16º and 18 ºN, at depths of 500–700 m, whereas those of *M. senegalensis* are concentrade more at north between 18º and 19 ºN, at depths of 200–350 m.

M. polli females are found mainly to the south of 17.5 ºN, peaking between 16º and 17 ºN. In February their distribution stretches to Cape Timiris (19.5 ºN), but in very weak proportions. They are concentrated above all at depths of between 500 and 800 m, but with reasonably large concentrations between 200 to 500 m. For *M. senegalensis*, mature females are distributed between 19.5º and 16 ºN, in two groups, one to the south of Cape Timiris (December to February) and one towards 17 ºN (November). Mature females occur at depths between 100 and 500 m, and extremely rarely beyond 500 m.

2.4.4 Assessment

Methods

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

Data

Catch and effort series for black hake from the IEO, IMROP and CRODT (Centre de Recherches Océanographiques Dakar–Thiaroye) databases were used to analyse the Mauritanian and Senegalese stocks.

The Spanish hake trawler CPUE series from the IEO for both zones were used as an abundance indice.

Furthermore, the model was adjusted to take into account catches by Spanish freezer trawlers.

Results

For both stocks (Mauritania and Senegal), the production model fits the CPUE series of the Spanish fleet quite well (Figures 2.4.4a and 2.4.4b). The results show that both stocks are overexploited. The biomass of black hake in both zones is below that producing maximum sustainable yield. Current fishing effort is 26 percent greater than the $F_{0.1}$ level (Table 2.4.4a).

Table 2.4.4a: Summary of the results on the state of the *Merluccius* spp. stock in the northern CECAF zone

Stock/abundance index	F_{cur}/F_{SYcur}	$B_{cur}/B_{0.1}$	$F_{cur}/F_{0.1}$	B_{cur}/B_{MSY}	F_{cur}/F_{MSY}
Merluccius ssp. (Mauritania)/ Spanish fresh fish trawlers	73%	40%	126%	45%	114%
Merluccius ssp. (Senegal)/ Spanish fresh fish trawlers	41%	43%	69%	47%	63%

F_{cur}/F_{SYcur}: Ratio between the observed fishing mortality coefficient during the last year of the series and the coefficient that would give a sustainable yield at current biomass levels.
$B_{cur}/B_{0.1}$: Ratio between the estimated biomass for the last year and the biomass corresponding to $F_{0.1.}$
$F_{cur}/F_{0.1}$: Ratio between the observed fishing mortality coefficient during the last year of the series and $F_{0.1.}$
B_{cur}/B_{MSY}: Ratio between the estimated biomass for the last year and the biomass coefficient corresponding to F_{MSY}.
F_{cur}/F_{MSY}: Ratio between the observed fishing mortality coefficient during the last year of the series and the coefficient giving maximum long term sustainable yield.

Discussion
The results of the assessment show that both stocks are overexploited. In Mauritania, current biomass is below the $B_{0.1}$ target biomass and current fishing effort is around 25 percent above the effort corresponding to the target biomass. In Senegal biomass is also below the target biomass. Current effort is however below the effort corresponding to the target biomass.

2.4.5 Management recommendations
The Working Group recommends not increasing current effort for both stocks. Catch of both stocks should not exceed 7 000 tonnes in Mauritania and 600 tonnes in Senegal.

2.4.6 Future research
The Working Group gives priority to the following recommendations:

- Improve the follow up of bycatch of black hake by other fleets in Senegal.
- Establish a programme of observation at sea in order to break down catches of black hake by species in Senegal and Morocco and to continue with the current IEO programme in Mauritania.
- Study in greater depth the influence of environmental parameters on the abundance of resources in the subregion.

3. DEMERSAL FISH

The distribution of the demersal fishes varies according to the nature of the sea bed and to the depth. Some demersal species are associated with a sandy and muddy sea bed in estauaries at less than 30 metres depth. The distribution of these species is also influenced by seasonal changes in the water masses and their abundance depends on the presence of warm water masses. It is in this biologically highly productive environment with variable physic-chemical characteristics that the eurybath and eurytherm species belonging to the families of Sciaenidae (*Pseudotolithus* spp.) and Ariidae (*Arius* spp.) can be found.

Other demersal species can be found on sediments of a diverse nature, from muddy to rocky, and at depths between 30 and 100 metres. The distribution of these species depends on the presence of cold water masses. On the rocky sea bed, the Sparidae belonging to the *Dentex* spp. and the serranidae belonging to the grouper (*Epinephelus* spp.) are encountered, whereas the species observed on muddy and sandy sea beds are represented by the Sparidae (*Pagellus* spp. and *Sparus* spp.). Beyond 200 metres deep, we find the large-eye dentex (*Dentex macrophthalmus*).

3.1 Fisheries

Due to their generally elevated market value, coastal demersal resources are very sought after in all four of the northern CECAF zone countries (Mauritania, Morocco, Senegal and the Gambia). They are exploited by artisanal and industrial fleets (national and foreign). The fisheries are multi-purpose and demersal fish species often represent bycatch of other specialized fisheries such as the cephalopod, hake or shrimp fisheries.

The demersal fish to be assessed this year are the *Pagellus bellottii*, *Pagellus acarne*, *Pagellus* spp., *Dentex macrophthalmus*, *Pagrus caeruleostictus*, *Sparus* spp., *Arius* spp., *Pseudotholitus* spp. and *Epinephelus aeneus*. Table 3.1.1a and Figure 3.1.1a show annual catches and trends in landings respectively. Overall catch for these species fluctuates between around 20 000 and 37 000 tonnes.

Demersal fish resources in Morocco are exploited by a heterogeneous fleet of Moroccan cephalopod freezer trawlers (Ceph. N), coastal fishing vessels: trawlers and longliners (coastal), artisanal boats (artisanal), leased boats and Russian vessels operating under the Morocco–Russia fishing agreement. Only the longliner and some of the artisanal boats target demersal fish, other vessels catch them as bycatch.

In Mauritania, exploitation of demersal resources is carried out by various types of trawler: foreign cephalopod (Ceph. E), national cephalopod (Ceph. N), foreign and national hake (Hake), foreign and national shrimp (Shrimp), foreign pelagic trawlers (Pelagic) and foreign and national demersal fish trawlers (Fish).

In Senegal, demersal resources are mainly caught by artisanal boats using fishing lines. Two categories exist: motorized line canoes (MLC) carrying out daily trips and ice canoes (IC) equipped with ice that do trips lasting several days. These resources are also caught by Senegalese and foreign trawlers fishing under fishing agreements. Each of these fleets is made up of freezer and ice trawlers. The artisanal fleet is currently composed of 12 619 canoes and the number of Senegalese trawlers was 100 in 2005.

In the Gambia, it is foreign freezer trawlers (PI) and artisanal canoes that exploit demersal resources.

Effort series for these fleets are given in Table and Figure 3.1.1b.

3.2 Sampling systems and intensity

3.2.1 Catch and effort

The systems for collecting fisheries statistics and biological parameters of demersal fish were described in the previous Working Group report (FAO, 2006).

Given that data on the *Pagellus bellottii* species in Morocco are mixed with statistics for other red pandora species, that is to say *Pagellus erythrinus*, it was decided to group both into a single group of *Pagellus* spp. A large quantity of demersal resources, mainly the Dentex family, caught by vessels working under the Morocco–Russia fishing agreement are not broken down by species. It is important to calculate the proportion of *Dentex macrophthalmus* in this group of species.

Nearly all the Senegalese data have been updated since the report of the last Working Group in 2004 following the restructuring of the database. A document (Appendix 3) has been elaborated to provide thorough explanations. For 2006, catch is estimated by floating average.

In Mauritania, demersal species are also caught by the artisanal fishery. The Working Group did not have any data available for this fishery.

In the Gambia, it should be noted that estimates of catch by the artisanal fishery were provided whereas effort data are not available.

3.2.2 Biological parameters

For most of the countries biological sampling of demersal fish is mainly carried out during the scientific surveys of the research vessels.

In Morocco, lengths and weights of the main demersal species are recorded at landings for the coastal fishery in the ports where there are sampling INRH stations and for the artisanal fishery at INRH regional centres (Dakhla and Laâyoune).

In Senegal, length frequency samples are regularly taken at the artisanal fishery landing sizes by CRODT samplers.

3.3 Red pandora (*Pagellus bellottii*)

3.3.1 Biological characteristics

Red pandora is found both on hard and sandy bottoms, in particular in depths of more than 100 m. They are omnivores with a mainly carnivore diet including crustaceans, cephalopods, small fish, amphioxus and worms. In the East Atlantic the species is distributed from the Straits of Gibraltar to Angola, including the southwest Mediterranean and Canary Islands.

3.3.2 Stock identity

The Working Group considered a single stock exploited by the industrial and artisanal fisheries over the whole zone. However, given its importance in each country, the Working Group decided to carry out an analysis by management unit (Mauritania, Senegal and the Gambia).

3.3.3 Data trends

Catch

Total catch of *Pagellus bellottii* (Table 3.1.1a and Figure 3.3.3a) fluctuated between 1990 and 1999 with an average value of around 8 100 tonnes. After 1999, the total catch fell from 9 500 to 5 600 tonnes. The largest catches in the northern CECAF region are carried out by Senegal.

Effort

The fishing effort series shows small differences in the study zones (Figure 3.1.1b). There is no clear effort aimed at this species in the industrial fishery, especially in Morocco and Mauritania. This species is mainly targeted by the artisanal sector in Senegal with the largest catches being carried out by the motorized line canoes (MLC) and the ice canoes (IC). MLC effort has been increasing since 2001 whereas that of the IC is more or less stable.

Abundance indices

CPUE

The *Pagellus bellottii* CPUE series for the Moroccan, Mauritanian and Gambian industrial fleets fluctuated greatly over the period under analysis (1990–2006). From 1996 to 2004, the highest yields were obtained in Mauritania by the pelagic trawlers with a peak in 1998 (Table 3.3.3a and Figure 3.3.3b). In Senegal, where the species is caught most, the ice canoe CPUEs showed an increasing trend from 2000. On the other hand, the motorized line canoes show a decrease in CPUE since 1993 despite a peak in 1999 due to this being a particularly cold year.

Scientific surveys

Abundance indices from the R/V AL AWAM surveys

The abundance indices series (in kg/30 minutes) for *Pagellus bellottii* in Mauritania obtained during the assessment surveys of the R/V AL AWAM is given in Table 3.3.3b and shown in Figure 3.3.3c. The trend in the abundance index data is of a continual decline. The last years seem to indicate a collapse in the Mauritanian zone.

Biological data

Length composition and other information

Senegal presented a length frequency series from the artisanal fishery for 1990 to 2007. Analysis of the data shows that the average length of *Pagellus bellottii* remains between 20 and 21 cm for the whole period.

3.3.4 Assessment

Methods

The Schaefer dynamic production model implemented on an Excel spreadsheet was used to assess the state of the *Pagellus bellottii* fishery stock (Appendix 2).

Data

The total catch series of *Pagellus bellottii* over the whole northern CECAF zone (Mauritania, Senegal and the Gambia) was used. For the abundance indices series, after several attempts with various abundance series (ice canoes, Mauritanian national cephalopod trawlers), the Working Group decided to use the CPUE series of the motorized line canoes from the Senegalese artisanal fishery.

Results

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

Current biomass is below that corresponding to the $B_{0.1}$ biomass. Current fishing effort is greatly above that producing a sustainable yield at current biomass levels (Table 3.3.4).

Table 3.3.4: Indicators on the state of the stock for the *Pagellus bellottii* fishery in the northern CECAF zone

Stock/abundance index	$\mathbf{F_{cur}/F_{SYcur}}$	$\mathbf{B_{cur}/B_{0.1}}$	$\mathbf{F_{cur}/F_{0.1}}$	$\mathbf{B_{cur}/B_{MSY}}$	$\mathbf{F_{cur}/F_{MSY}}$
Pagellus bellottii (Mauritania, Senegal and the Gambia)/CPUE motorized line canoes Senegal	177%	17%	361%	17%	325%

F_{cur}/F_{SYcur}: Ratio between the observed fishing mortality coefficient during the last year of the series and the coefficient that would give a sustainable yield at current biomass levels.
$B_{cur}/B_{0.1}$: Ratio between the estimated biomass for the last year and the biomass corresponding to $F_{0.1.}$
$F_{cur}/F_{0.1}$: Ratio between the observed fishing mortality coefficient during the last year of the series and $F_{0.1.}$
B_{cur}/B_{MSY}: Ratio between the estimated biomass for the last year and the biomass coefficient corresponding to F_{MSY}.
F_{cur}/F_{MSY}: Ratio between the observed fishing mortality coefficient during the last year of the series and the coefficient giving maximum long term sustainable yield.

Discussion
The stock is heavily overexploited. This conforms with the drop or even collapse of the abundance indices measured in Mauritania by the R/V AL AWAM. On the other hand, the increase in CPUEs of the ice canoes in Senegal could be explained by the enlargement of their fishing zone outside of Senegal towards countries to the south.

3.3.5 Management recommendations
As during the previous Working Group, it is recommended that fishing effort be reduced for all demersal fisheries targeting this species.

3.4 Axillary seabream (*Pagellus acarne*)

3.4.1 Biological characteristics
This is a benthopelagic species found in depths of up to 500 metres. Axillary seabream are found on hard and sandy bottoms. It lives at depths of 100 metres, the young are coastal. It is an hermaphrodite, omnivorous species, eating molluscs and crustaceans. In the eastern Atlantic, the species is distributed from the Bay of Biscay to Senegal and includes Cape Vert, the Azores, Madeira and the Canary Islands.

3.4.2 Stock identity
The axillary seabream population (*Pagellus acarne*) was considered as a single stock.

3.4.3 Data trends
Catch
The axillary seabream is mainly caught by ocean-going trawler fleets, coastal fishery vessels (longliner and trawler) and artisanal fishery boats. It is not possible to distinguish axillary seabream landings of the coastal and artisanal fisheries from the catch statistics, they are therefore included together in the same coastal category.

An alternation can be seen between the catches of the hake trawlers and the coastal fleet. The catch series of axillary seabream by the freezer cephalopod trawlers shows a decrease since 2001, stabilising over the last three years at around 600 tonnes. As for the coastal fishery, catches fell between 1999 and 2002, then stabilized at average values of around 1 200 tonnes, nearly twice the catch of the ocean-going fishery (Table 3.1.1a and Figure 3.4.3a).

Effort
Only longliners and some other vessels direct effort towards demersal fish. The effort of other vessels is mostly aimed at octopus or hake and shrimp. The only effort series available is that of the ocean-going cephalopod fishery (Table 3.1.1b and Figure 3.1.1b).

Abundance indices

CPUE

The CPUEs of axillary seabream landings by the ocean-going fishery reached its maximum of 77 kg/fishing day in 2001 before falling to 16 kg/fishing day in 2006 (Table 3.4.3a and Figure 3.4.3b).

Scientific surveys

Axillary seabream was caught during both the surveys carried out from Bojador to Lagouira and those between Tangiers and Agadir. The species is most abundant in the south. The abundance indices show a decreasing trend both in the north and the south of Morocco (Figure 3.4.3c).

Biological data

Length composition and other information

Axillary seabream sampling has been carried out by the INRH regional centre in Laâyoune since 2003 as well as on board the R/V CHARIF AL IDRISSI during its bottom trawl surveys.

Current management measures

The axillary seabream is exploited by the ocean-going, coastal and artisanal cephalopod fisheries. This species is subject to the same management measures as that of the ocean-going and coastal fishery.

3.4.4 Assessment

Methods

The Schaefer dynamic production model implemented on an Excel spreadsheet was used to evaluate the state of the stock of the *Pagellus acarne* fisheries (Appendix 2).

Data

The total catches series (coastal + ocean-going cephalopod trawlers) of axillary seabream (*Pagellus acarne*) estimated by the Working Group was used as the series of total stock catch. It should be noted that the weak catches over the last few years of the ocean-going fishery could be due to the biological closed season which has become ever longer.

As an abundance indices series, the Working Group used three different series, the CPUEs (tonnes/fishing day) of the Moroccan ocean-going cephalopod trawlers, the abundance indices (kg/h) of the trawl surveys carried out between Bojador and Lagouira and an average of the survey indices.

Results

The model provided a good fit to the average abundance indices series for each year of the surveys (Figure 3.4.4).

The axillary seabream stock is overexploited (Table 3.4.4) as the current biomass is less than the target biomass, $B_{0.1}$. Actual fishing effort is above the $F_{0.1}$ effort.

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

Stock/abundance index	F_{cur}/F_{SYcur}	$B_{cur}/B_{0.1}$	$F_{cur}/F_{0.1}$	B_{cur}/B_{MSY}	F_{cur}/F_{MSY}
Pagellus acarne/Moroccan surveys	156%	19%	312%	20%	281%

F_{cur}/F_{SYcur}: Ratio between the observed fishing mortality coefficient during the last year of the series and the coefficient that would give a sustainable yield at current biomass levels.
$B_{cur}/B_{0.1}$: Ratio between the estimated biomass for the last year and the biomass corresponding to $F_{0.1.}$
$F_{cur}/F_{0.1}$: Ratio between the observed fishing mortality coefficient during the last year of the series and $F_{0.1.}$
B_{cur}/B_{MSY}: Ratio between the estimated biomass for the last year and the biomass coefficient corresponding to F_{MSY}.
F_{cur}/F_{MSY}: Ratio between the observed fishing mortality coefficient during the last year of the series and the coefficient giving maximum long term sustainable yield.

Discussion
The assessments show that the stock is overexploited. The stock situation has been aggravated due to the increase in fishing effort.

3.4.5 Management recommendations
Taking note of the results of the assessments, the Working Group decided to recommend the following management measures:

- Reduce the effort carried out on the axillary seabream stock to allow the stock to build itself up.
- Ensure a follow-up of the application of current regulations.

3.5 Large-eye dentex (*Dentex macrophtalmus*)

3.5.1 Biological characteristics
The large-eye dentex is distributed over the whole subregion. The adults are normally found at 100–300 m depth, although juveniles can also be found in shallower waters.

3.5.2 Stock identity
The large-eye dentex (*Dentex macrophthalmus*) is found in Mauritania, Morocco, Senegal and the Gambia. Due to the lack of detailed information the Working Group decided to consider a single stock for the whole subregion.

3.5.3 Data trends
Catch
Catches of this species are shown in Figure 3.5.3a. In Mauritania catches fluctuate between 150 and 500 tonnes until 2003, after which they increase to 2 300 tonnes in 2004. In 2005, the catches decrease again followed by an increase in 2006 to around 1 100 tonnes. In Morocco, an increasing trend is observed from 1990 to 1997 followed by a period of large fluctuations until 2006. A substantial drop is visible from 2005 to 2006 (from 3 800 to 1 900 tonnes). In Senegal, a decreasing trend is observed from 1990 to 1994, followed by an increase until 1996. After 1999, a decreasing trend is observed. In the Gambia this species is not split in the catches of demersal fishes.

Effort
Dentex macrophtalmus is not a targeted species, but it is fished as a bycatch species by several fleets including the Moroccan and Mauritanian cephalopod trawlers and the pelagic and demersal fish trawlers of Mauritania. It is also a bycatch of the artisanal fishery in Senegal, particularly by the motorized line canoes and the ice canoes. Fishing effort of all these fleets is shown in Figure 3.1.1b.

Abundance indices
CPUE
The CPUE series of the main fleets fishing *Dentex macrophtalmus* showed different fluctuations over the period under analysis (Table 3.5.3a and Figure 3.5.3b). Except for the decreasing CPUE trend in the Senegalese artisanal fishery (motorized line canoes and the ice canoes), all the other fleets show fluctuations over the whole period.

Research surveys
The annual mean catch rates (kg/30 minutes) of *Dentex macrophtalmus* from research surveys in Mauritania show a fluctuating trend, with very low catch rates since 1995 (Figure 3.5.3c).

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.

Data

The catch series of *Dentex macrophtalmus* for Morocco, Mauritania and Senegal and the abundance index for the surveys in Mauritania were used as inputs to the model.

Many countries do not separate all the various Dentex species and other Sparidae species in their catch reporting and it could be that what is reported as *Dentex macrophtalmus* is in fact one of the other *Dentex* species, hence causing a mismatch between the reported and true catch of this species.

Several other abundance series were considered by the Working Group, but given that *Dentex macrophtalmus* is not a targeted species and that the species is found principally in deeper waters, it was thought that none of the other abundance indices available to the Group would give a good indication of the abundance of this species. For instance the cephalopod trawlers in Morocco cover mainly the coastal area up to 100 m depth and thus cover mostly the juvenile part of the population, as observed from the length distribution of the catches (not presented to the Working Group).

Results

The available data were not sufficient to obtain conclusive results for the assessment of *Dentex macrophtalmus.*

Discussion

The model did not provide an acceptable fit to the data. The poor fit of the model resulted from the difficulty in explaining the observed high catches given the very low abundance index in recent years.

Although no reliable result was obtained from the model, care should be taken in the management of this species as the survey abundance index from Mauritania indicates very low levels of this species.

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, given the low catch rates observed in recent years in the surveys in Mauritania 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. These 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. However, in Senegal the level of total catch has been more or less stable since 1995, around 4 000 tonnes per year. In each of the last four years (2003 to 2006 inclusive) Senegal registered, on average, more than three times the landings of the species in Mauritania annually.

Effort

In the Senegalese artisanal fishery, this species is mainly targeted by the motorized line 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 3.1.1b). An exception to this is the series of the Senegalese motorized line canoes, which decreased markedly from 1998 to 2001. However, as previously noted, this could be due to a problem with the database. In 2006 Senegalese line fishing and gill net (PML & FD) demonstrate two opposite tendencies, an increase and decrease respectively. The situation should be approached cautiously.

Abundance indices

CPUE

The CPUE series of *S. caeruleostictus* for the Mauritanian industrial fleet fluctuated greatly over the period under analysis (1990–2003). During subsequent years (2004–2006) a general increasing trend is observed with the exception of the Mauritanian pelagic industrial fisheries (pelagic RIM) which reached zero in 2006. Both the Senegalese industrial fleet and the Senegalese ice canoes show decreasing trends in their CPUE (Table 3.6.3a and Figure 3.6.3b).

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 3.6.3c).

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 of *S. caeruleostictus* shows a bimodal length distribution in all the R/V AL AWAM surveys (Figure 3.6.3d).

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 Appendix 2.

Data

The catch series for *S. caeruleostictus* in Mauritania and Senegal were used as a 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 show that the stock is overexploited. Current biomass is below that corresponding to $B_{0.1}$. Current fishing effort is far higher than that which would produce a sustainable yield at the current biomass level (Table 3.6.4).

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

Stock/abundance index	F_{cur}/F_{SYcur}	$B_{cur}/B_{0.1}$	$F_{cur}/F_{0.1}$	B_{cur}/B_{MSY}	F_{cur}/F_{MSY}
Mauritania + Senegal/CPUE Senegalese ice canoes	128%	65%	183%	71%	165%

F_{cur}/F_{SYcur}: Ratio between the observed fishing mortality coefficient during the last year of the series and the coefficient that would give a sustainable yield at current biomass levels.
$B_{cur}/B_{0.1}$: Ratio between the estimated biomass for the last year and the biomass corresponding to $F_{0.1.}$
$F_{cur}/F_{0.1}$: Ratio between the observed fishing mortality coefficient during the last year of the series and $F_{0.1.}$
B_{cur}/B_{MSY}: Ratio between the estimated biomass for the last year and the biomass coefficient corresponding to F_{MSY}.
F_{cur}/F_{MSY}: Ratio between the observed fishing mortality coefficient during the last year of the series and the coefficient giving maximum long term sustainable yield.

3.6.5 Management recommendations

The Working Group recommends that fishing effort in this fishery should be reduced to bring the biomass back to a sustainable level. For this reason, the catches of *S. caeruleostictus* should be monitored more closely.

3.7 Seabreams (*Sparus* spp.)

3.7.1 Biological characteristics

The *Sparus* spp. group comprises the *Sparus auriga* and *Sparus aurata.*

Sparus auriga is a benthopelagic species which lives at average depths of 170 metres. In the east Atlantic, the species is distributed from Portugal to Angola. It is found on rocky bottoms. The young migrate towards the coast. The species feeds on crustaceans and molluscs.

Sparus aurata is a demersal species living in depths up to 150 metres. In the east Atlantic the species is distributed from the Straits of Gibraltar to the Canary Islands. It is found on rocky and sandy bottoms in less deep waters up to 30 metres. The adults migrate to 150 metres depth. It is a sedentary species, living alone or in small groups. In spring, the species migrates towards the coastal zones close to the lagoons and estuaries. It is a carnivorous and occasionally herbivorous species that feeds on molluscs. It lives in both salty and hyper-salty waters.

3.7.2 Stock identity

The species is composed mostly of redbanded seabream, bluespotted seabream and common seabream. They are caught by the ocean-going, coastal and artisanal fleets.

3.7.3 Data trends

Catch

Catch of this species by the freezer cephalopod trawlers shows an increasing trend varying between 200 and 2 300 tonnes (Table 3.1.1a and Figure 3.7.3a).

Effort

Effort is similar to that of other species in Morocco (Table 3.1.1b and Figure 3.1.1b).

Abundance indices

CPUE

The largest seabream CPUEs are those of the cephalopods ocean-going fleet. They have seen an improvement since 2000, recording a maximum in 2004 and 2005 of 53 kg/fishing day (Table 3.7.3a and Figure 3.7.3b).

Scientific surveys
Sparus spp. are found mainly during the scientific surveys carried out in the Atlantic to the south of Morocco. The abundance indices vary between 0.3 in 2003 and 11.3 kg/30 min in 2005 in the autumn surveys (Figure 3.7.3c). The overall trend in the survey abundance indices is fairly similar to that of the commercial CPUEs.

Biological data
Length composition and other information
Sampling of the length composition of landings of *Sparus auriga* was begun by the Laâyoune centre. Given their low abundance indices, *Sparus* spp. are not the object of biological sampling during the scientific surveys.

Current management measures
Like the axillary seabream, seabream are exploited by the ocean-going cephalopod, coastal and artisanal fisheries. The management measures in force for this species are the same for each of the fisheries (see the chapters on cephalopods and hake).

3.7.4 Assessment
Methods
The Schaefer dynamic production model implemented on an Excel spreadsheet was used to assess the state of the stock and the fisheries of *Sparus* spp. (Appendix 2).

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

The CPUE series of the Moroccan ocean-going cephalopod trawlers and the abundance indices from the surveys were tried.

Results
The available data did not permit conclusive results to be obtained for the assessment of *Sparus* spp.

Discussion
The poor fit of the model could be explained by the fact that the CPUEs do not reflect the real stock abundance. *Sparus* spp. seem to become a target when more in demand species, such as cephalopods, are not available.

3.7.5 Management recommendations
Considering the large catches recorded over the last few years, any increase in effort should be avoided until more detailed assessments are available.

3.8 Marine catfish (*Arius* spp.)

3.8.1 Biological characteristics
There are no known studies on the biological characteristics of the marine catfishes in the region. However these species are known to be distributed over the whole region.

3.8.2 Stock identity
The *Arius* spp. group consists of: *Arius heudolotii*, *Arius gambiensis*, and *Arius mercatoris*. The marine catfishes, *Arius* spp. in the shelves of Senegal and the Gambia are considered as a single stock and therefore, the Working Group decided to assess the stock as a single management unit.

3.8.3 Data trends

Catch

Landings of marine catfishes in Senegal show large fluctuations, ranging from just under 1 650 to 12 500 tonnes (Figure 3.8.3a). Landings of the *Arius* spp. are characterized by a downward trend from 1992 to 1996 and an increase in 1997 and 1998. The highest landings of these species were observed in 2005 (over 12 500 tonnes) after which the landings began to decline to about 7 500 tonnes. On the other hand, a less pronounced fluctuation in landings of marine catfish in the Gambia with an overall tendency to increase was observed (Figure 3.8.3a). Landings of the species in the Gambia rose from about 970 tonnes in 2004 to over 2 600 tonnes in 2006.

Effort

Marine catfishes are caught by both the artisanal and industrial fleet in the Gambia and Senegal. The significant part of the landings of *Arius* spp. was by the Senegalese ice trawlers (PIS GLA) during the period 1990 to 1999 (Table 3.1.1.a). Since the year 2000, Senegalese freezer trawlers dominated landings of the species. This phenomenon may be explained by a change in fishing strategy by the two fleets. It is important to note that no significant change in the level of effort employed by the two fleets targeting *Arius* spp. was observed, as shown in Table 3.1.1b.

Abundance indices

CPUE

Marine catfish fishery in Senegal shows similar CPUE trends to those of total catch with PIS GLA, dominating from 1990 to 1999 and PIS CON from 2000 to 2006. The highest CPUE for both fleets was observed in 1997 and 1998 respectively (Figure 3.8.3b). For the industrial fishery of the Gambia, CPUE values were very low but stable throughout the 1990s with a sharp increase in 2004. The increase in the abundance indices was maintained through to 2006. CPUE by Senegalese ice trawlers was characterized by sharp fluctuations in the 1990s before stabilising at lower values from 2002 onwards (Table 3.8.3a).

Research surveys

No research survey data on *Arius* spp. were presented to the Working Group by participating countries in the region.

Biological data

Length composition and other information

Time series data on length composition of *Arius heudelotii* from the Senegalese artisanal fisheries was provided to the Working Group (Table 3.8.3b).

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 the fisheries of *Arius* spp. (Appendix 2). LCA was used with length composition data of the artisanal fisheries in Senegal.

Data

Input data into the model was total catch of marine catfishes in both the Gambia and Senegal, with different abundance indices from the PIS CON, PIS GLA fleets in Senegal and all other fleets operating in the two countries.

Results

Several runs of the model using the above data have revealed that the available data were not sufficient to obtain conclusive results for assessment of marine catfishes in both countries. The model gives inconsistent results.

Discussion

The poor fit of the model could be explained by the fact that the CPUE used are not a true reflection of stock abundance but represent more the fishing strategies employed by the fleet operating in the

continental shelves of the Gambia and Senegal. Marine catfishes are not considered the main high value species targeted by the industrial fleet but are nonetheless landed as bycatch. They are coastal species and are not targeted. The LCA results were also not reliable and could not be used for any management decision.

3.8.5 Management recommendations

With the huge landings of marine catfishes in recent years in the Gambia and Senegal and in the absence of conclusive assessment, as a precautionary approach it is prudent not to increase effort on the stocks until a more reliable assessment is possible.

3.9 Croakers (*Pseudotolithus* spp.)

3.9.1 Biological characteristics

The *Pseudotolithus* spp. consists of *P. elongatus*, *P. typus*, *P. senegalensis* and *P. brachygnatus (*or *P. senegallus)*. These 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 and landed by both the artisanal and industrial fleet operating in the Gambia and Senegal. The highest total landings of croakers for the Senegal-the Gambia subregion of over 6 600 tonnes was recorded in 1990 (Table 3.1.1a), with nearly 3 600 tonnes coming from the industrial fisheries of the Gambia. A fluctuation in total landings of the stock was recorded during the whole period analysed (Figure 3.9.3a). Landings by set gillnets in Senegal indicate a decrease in trend in 2006.

Effort

The *Pseudotolithus* spp. are caught and landed by a multi-demersal fishing fleet of both countries, but for most of the fleet it is not an important group (Table 3.1.1b).

Among the fleets fishing this species, the effort of the Gambian industrial fishery trawlers shows a steady increase from 1994 to 2002, followed by a downward trend until 2006. In Senegal, effort of the ice trawler fleet shows a decreasing trend from 2002 to 2005 followed by a sharp increase in 2006, while the freezer trawler effort was relatively stable over the latest period. For the artisanal Senegalese fishery, the gears that catch this species most frequently are set gillnets.

Abundance indices

CPUE

The CPUE of the Gambian industrial fishery shows a decreasing trend with fluctuations throughout the study period with a slight increase in 2006 (Figure 3.9.3b). For Senegal, the CPUE of ice and freezer trawlers tends to stabilize at low values during the last three years.

Research surveys

Research survey data on the *Pseudotolithus* spp. group were not available for use by the Working Group.

Biological data

Length composition and other information

Length composition data on *Pseudotolithus senegalensis* for the Senegalese artisanal fishery for the period 1990 to 2006 was provided to the Working Group for analysis (Table 3.9.3c).

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. (Appendix 2). LCA was used with length composition data of the artisanal fisheries in Senegal.

Data

The input data into the model were total catches of *Pseudotolithus* spp. from the Gambia and Senegal and the CPUE of the Gambian industrial fisheries.

Results

The data used in the model did not provide a good fit. The CPUE could not explain the oscillations in annual catch.

Discussion

Pseudotolithus spp. is caught together with high value fish species targeted by industrial fleets in both countries. The Working Group noted, that in spite of uncertainties relating to the CPUE of this stock, the general trend observed was a gradual increase characterized by oscillations. The LCA on *Pseudotolithus senegalensis* indicated an inconsistency due to length frequency samples not raised to total catch. The results of the LCA are therefore not suitable for management advice.

3.9.5 Management recommendations

Croakers, *Pseudotolithus* spp. are considered to be subject to high fishing pressure as exerted on all demersal fish species. Although the assessment was inconclusive due to inadequate catch and effort data available to the Working Group, it was recommended that, as a precautionary approach, fishing effort should not exceed the current level.

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. Its bathymetric distribution extends from 20 to 200 m in depth, but the main fishing zone is between 30 and 60 m. The species lives on rocky bottoms of the continental shelf.

The young individuals (less than 30 cm) are mainly found in coastal zones, particularly in estuaries. After this they are found at greater depths (between 30 and 100 m) both in rocky zones and above all in very sandy zones.

The two main reproduction zones are the Petite Côte in Senegal and south of the Bay of Lévrier in Mauritania. The highest concentration of juveniles is found in the mangrove estuary of the Sine Saloum central delta in Senegal.

It is a voracious predator feeding on fish, cephalopods and crustaceans.

3.10.2 Stock identity

A single management stock of *Epinephelus aeneus* was considered 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). Catches have declined from around 3 000 tonnes in 1996 to 1 000 tonnes in 2006. The largest catches are in Senegal with 868 tonnes on average over the last five years. The annual averages over the same period are 200 tonnes in the Gambia and 50 tonnes in Mauritania. Most of the catch landed in Senegal is from the artisanal fishery, in particular from the ice canoes.

Effort

White grouper *Epinephelus aeneus* is targeted by the artisanal and industrial fleets of all the countries.

The total effort from the ice and freezer trawlers of the Senegalese industrial fishery shows an overall decreasing trend over the last years except for the ice trawlers of the Senegalese industrial fishery (Figure 3.1.1b).

Fishing effort remained relatively stable in Mauritania with a peak in 2002, before falling to 2001 levels in 2003. Effort then increased until 2006 when it fell drastically. In Mauritania, the national cephalopod trawlers and the pelagic trawlers also catch this species as bycatch.

Abundance indices

CPUE

In general, the CPUEs of *Epinephelus aeneus* show a decreasing trend over the study period (Table 3.10.3a and Figure 3.10.3b). The yields from the trawlers in Mauritania are very low and in the industrial fishery in Senegal have collapsed. A decreasing trend can also be seen for the ice canoe fishery.

Scientific surveys

The abundance indices from the scientific surveys carried out by the IMROP R/V AL AWAM decreased between 1982 and 2006 (Figure 3.10.3c). It should be noted 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 (R/V AL AWAM) from 1997 onwards.

Biological data

Length composition and other information

The white grouper length frequencies from the Senegalese artisanal fishery are available from 1990 to 2006, but were not analysed during the Working Group.

Under a CRODT/JICA project (2006), estimation of white grouper growth was carried out by reading the scales. The following parameters were obtained:

$$L\infty = 99.29 \text{ cm}, \quad K = 0.145 \text{ year}^{-1} \quad \text{and} \quad t_0 = -0.23 \text{ year}.$$

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 the fisheries of *Epinephelus aeneus*. This model is described in detail in Appendix 2.

Data

For catch data, the Working Group combined the total catches of all the fleets from the three countries (Mauritania, Senegal and the Gambia). For the abundance indices' series, the ice canoes CPUE series from the Senegalese artisanal fishery gave the best fit.

Results

The fit of the model using the ice canoe CPUE was judged to be satisfactory (Figure 3.10.4).

The results indicate that the stock is becoming extinct. Current biomass is below that corresponding to the $B_{0.1}$ biomass. Current fishing effort is greatly above that producing maximum sustainable yield at current biomass levels (Table 3.10.4).

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

Stock/abundance index	F_{cur}/F_{SYcur}	$B_{cur}/B_{0.1}$	$F_{cur}/F_{0.1}$	B_{cur}/B_{MSY}	F_{cur}/F_{MSY}
Epinephelus aeneus (Mauritania, Senegal and the Gambia)/CPUE Senegalese ice canoes	48%	5%	970%	5%	873%

F_{cur}/F_{SYcur}: Ratio between the observed fishing mortality coefficient during the last year of the series and the coefficient that would give a sustainable yield at current biomass levels.
$B_{cur}/B_{0.1}$: Ratio between the estimated biomass for the last year and the biomass corresponding to $F_{0.1.}$
$F_{cur}/F_{0.1}$: Ratio between the observed fishing mortality coefficient during the last year of the series and $F_{0.1.}$
B_{cur}/B_{MSY}: Ratio between the estimated biomass for the last year and the biomass coefficient corresponding to F_{MSY}.
F_{cur}/F_{MSY}: Ratio between the observed fishing mortality coefficient during the last year of the series and the coefficient giving maximum long term sustainable yield.

Discussion
The results show that the *Epinephelus aeneus* stock in the region is at risk of extinction. These results agree with the abundance indices from the scientific surveys in Mauritania and the results obtained during the last Working Group. Declared catches in Senegal probably come from neighbouring waters.

3.10.5 Management recommendations
Taking into consideration the results from the assessment and the trends in the CPUEs, as well as those of the abundance indices from the surveys, the Working Group considers the stock to be at risk of extinction and reiterates it recommendation that all fishery directed at this species be halted.

3.11 Pandora (*Pagellus* spp.)

3.11.1 Biological characteristics
This group comprises *Pagellus bellottii* and *Pagellus erythrinus*. *Pagellus erythrinus* is a benthopelagic species which lives at depths of up to 300 metres. In the east Atlantic the species is distributed from Norway to Guinea Bissau. It is found in shallow waters on different types of bottom (rocky, sandy and muddy) and migrates during the winter towards the deeper bottoms.

3.11.2 Stock identity
The pandora (*Pagellus* spp.) is considered as a single stock in Morocco. This species is found on all types of bottoms from the Straits of Gibraltar to Lagouira (20° 50'N).

3.11.3 Data trends
Catch
This group includes the other pandora species, that is to say *Pagellus bellottii* and *Pagellus erythrinus*. Landings of this species by the ocean-going cephalopod fleet are continually increasing, reaching 1 600 tonnes in 2006.

Catch data have risen from 124 tonnes in 2002 to 152 tonnes in 2006 for the artisanal fishery and from 54 tonnes to 149 tonnes for the coastal fishery (Table 3.1.1b and Figure 3.11.3a).

Effort
Only the longliners and some vessels target effort at demersal fish. For the other vessels, effort is mostly aimed at octopus, hake and shrimp. Only the effort of the ocean-going cephalopod fishery is available for this series (Table 3.1.1b and Figure 3.1.1b).

Abundance indices

CPUE

The CPUEs of the ocean-going cephalopod trawler fishery show an increasing trend between 1999 and 2004. A fall is seen in 2005 to half the CPUE recorded in 2004 or 34 kg/fishing day (Table 3.11.3a and Figure 3.11.3b).

Scientific surveys

Pandoras are caught both during the surveys carried out in the south Moroccan Atlantic (Bojador–Lagouira) and during those carried out in the north Moroccan Atlantic (Tangiers–Agadir) (Table 3.11.3b and Figure 3.11.3c).

Biological data

Length composition and other information

In this group of species, only *Pagellus erythrinus* is sampled at the port of Laâyoune.

Current management measures

As with the axillary seabream, the sparids are exploited by the ocean-going cephalopod trawler, coastal and artisanal fisheries. The management measures applied to this species are the same as those applied to each of the fisheries (see the chapters on cephalopods and hake).

3.11.4 Assessment

Methods

The Schaefer dynamic production model implemented in an Excel spreadsheet was used to assess the state of the stock and the fishery of *Pagellus* spp. (Appendix 2).

Data

The total catch series of *Pagellus* spp. estimated by the Working Group was used as the total catch series of the stock.

Two abundance indices series were tried, the CPUE series from the Moroccan ocean-going cephalopod trawlers and the abundance indices of the Morocco surveys.

Results

The available data were not sufficient to obtain conclusive results for the assessment of *Pagellus* spp.

Discussion

The poor fit of the model could be explained by the fact that the CPUEs do not reflect the real abundance of the stock. *Pagellus* spp. appears to be a target species when the more in demand species such as the cephalopods are not available.

3.11.5 Management recommendations

Taking into account the large catches recorded over the last few years, any increase in fishing effort should be avoided until more precise assessments are available.

3.12 Future research

Despite the research effort already undertaken, the same recommendations as in 2004 were made for demersal fish by the Working Group:

- Strengthen and improve the collection of statistical information for the demersal fisheries.
- Improve research in the identification of the species in the group names.
- Obtain biological information on the catches (length frequencies, sex-ratio, age reproduction period and zone).
- Deeper analysis and exploration of the scientific data from the surveys.
- Favour exchanges of information between regional scientists and scientists from the fishing nations.

4. SHRIMP

4.1 Fisheries

The exploitation of crustaceans off the west African coasts is relatively old. From Morocco to Guinea-Bissau, two main groups of shrimp are commercially important. These are the coastal shrimps, mostly made up of southern pink shrimp *Penaeus notialis*, and deep water shrimp, mainly the deep-water rose shrimp *Parapenaeus longirostris*. Other less abundant shrimp are also caught in the zone: *Melicertus kerathurus*, *Aristeus antennatus*, *Aristeus varidens*, *Plesionika heterocarpus*, *Plesiopenaeus edwardsianus* and *Aristeomorpha foliacea*.

In Morocco, shrimp are exploited by the national fleet composed of coastal trawlers which fish the continental shelf at depths of no greater than 150 m and long range ocean-going trawlers. There are around 300 coastal trawlers. They operate close to their home ports and carry out short trips. The ocean-going fleet began operating in 1985 with vessels of a tonnage less than 200 GRT and carry out trips of 45 to 50 days. In 2006, this fleet counted 58 vessels (Table 4.1a).

Spanish fishery activity in Morocco came to an end on 30 November 1999, following the expiry of the Morocco-European Union fishing agreement. The Spanish fleet was made up, above all, of fresh fish and freezer trawlers operating under the fishing agreements. Their zone of activity was limited to the north of Tarfaya (28 °44' N parallel) outside the 12 nautical mile zone. The new fishing agreement between Morocco and the European Union signed in 2006 does not include deep-water rose shrimp.

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

The shrimp fleet operating in Mauritania in 2006 was composed of 81 vessels of different nationalities. With 32 vessels, the Spanish fleet was the largest in terms of exploitation of *P. longirostris* (46 percent) and *P. notialis* (40 percent). In 2005, 29 Spanish vessels were active in the Mauritanian zone. They were 27 in 2006. There was also a group of 27 Mauritanian and/or joint venture vessels. Italy occupied third position with seven vessels and Senegal, Portugal and Cameroon were present with respectively five, three and two vessels each. Lastly there were five other vessels from five different nations.

In Senegal, industrial exploitation of shrimp resources began in 1960. Until 1981, they were exploited almost exclusively by Spanish trawlers. From 1982, some Spanish vessels took Senegalese nationality, giving birth to a national fleet exploiting the deep waters. In 2005, 13 Spanish vessels were active in the Senegalese zone. Their number had reduced to five in 2006. The Spanish fleet activity ceased in the zone with the end of the fishing agreement between Senegal and the European Union in July 2006. With 80 percent of total crustacean catch, the deep-water rose shrimp *Parapenaeus longirostris* constitutes the main target species.
The crustacean fishery targeting coastal shrimp is very developed in Senegal and the Gambia. Two fleets, industrial and artisanal, mainly target *P. notialis*.

In the Senegal–the Gambia zone, the shrimp industrial fleet was composed of 61 vessels in 2006, of which 16 Senegalese freezer trawlers, 20 Spanish freezer trawlers and 25 industrial vessels targeting coastal shrimp (Table 4.1a). The number of vessels of the artisanal fleet reached 12 600 units.

Accidental catches of a less common species, *Penaeus monodon*, have been observed in landings of the artisanal fishers in the Senegal–the Gambia zone. Unfortunately not enough information is available on the distribution and abundance of this species, even though their landings are increasing.

4.1.1 Management measures for shrimp

The countries in the region are making an effort to regulate the shrimp fishery and have already put some management measures in place. In most of the countries, these are presently tied to control of the length of the fish caught. They include minimum landing lengths and rules governing mesh size.

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

Mauritania also observes a biological rest period of two months, September and October, each year.

It is important to note that no restriction is in force on total fishing effort or on the landings in the various countries. There is only one restriction relating to the effort of foreign fleets which is included in the respective fishing agreements.

4.2 Sampling systems and intensity

4.2.1 Catch and effort

There is no sampling system in place in the region for landings or effort. However, in Morocco, all catch and effort data are recorded by the national fisheries office which manages the fish markets in the landing ports.

4.2.2 Length frequencies

In Morocco, a sampling programme of deep-water rose shrimp lengths in coastal trawler commercial catches has been in place in the landing ports since 2002. Since 2004, sampling is regularly carried out in three fishing ports.

The biological sampling data of *Parapenaeus longirostris* come from the ports of Larache for 2006, Agadir for 2002–2005 and Casablanca for 2004–2005. Sampling is carried out once or twice a month. The quantities sampled vary between six and ten kilograms per month. Sixteen sampling operations were carried out in 2005 and 12 others in 2006. The total number of shrimp measured was 13 345 in 2005 and 14 361 in 2006 (Table 4.2.2a).

In Morocco, the deep-water rose shrimp landed by the shrimp freezer trawlers is sorted into several commercial categories and due to different classification systems employed by the various companies, data relative to length composition of the catches cannot be obtained yet.

Analysis of sampling intensity of *Parapenaeus longirostris* (Table 4.2.2a) and *Penaeus notialis* (Table 4.2.2b) was carried out by the Spanish fleet operating in Mauritania by IEO (in Cadiz) and IMROP, under the European Union project “National programme for data collection and management of a common fisheries policy”. The Spanish samples were provided by the National Association of Fishery and Seafood Freezer Trawler Owners (ANAMAR) based in the port of Huelva, Spain, whereas in Mauritania, the samples were collected on board Spanish fishing vessels. In 2005, 26 samples for a total weight of about 996 tonnes of *Parapenaeus longirostris* and 41 samples of around 1 125 tonnes of *Penaeus notialis* were provided by ANAMAR and the IEO. In 2006, 37 samples of *P longirostris* (1 757 tonnes) and 37 samples of *P. notialis* (1 791 tonnes) were carried out.
For the shrimp deep water fishery exploited by the Spanish fleet in the Senegal–the Gambia zone, ANAMAR carried out 19 samples of *P. longirostris* (297 tonnes) in 2005 and seven samples (74 tonnes) in 2006. Shrimp sampling stopped in July 2006 with the end of the fishing agreement.

4.2.3 Biological parameters

In Morocco, studies of the biological cycle of deep-water rose shrimp (*Parapenaeus longirostris*) have been in place in one of the landing ports since 2002. Nowadays collection of the biological parameters of this species takes place regularly in the three main ports of the Moroccan Atlantic zone.

Monthly average lengths for the coastal fishery landings in the ports of Larache, Casablanca and Agadir show variations between 19 and 22 mm in carapace length between 2002 and 2006. The exploited shrimps are therefore of a small size (Table 4.2.3a).

The IEO undertook biological sampling and length measurement of the deep-water rose shrimp *P. longirostris* and the southern pink shrimp *P. notialis* between 2002 and 2006. The Cadiz branch of the IEO also began sampling from March 2003 and carried out monthly biological sampling of *P. longirostris* in Mauritania as well as quarterly sampling of *P. longirostris* and *P. notialis* in Senegal–the Gambia and Mauritania. In 2005 and 2006, the monthly sampling of lengths and biological parameters of *P. longirostris* in Mauritania was carried out during periods of fishing activity and ceased during the biological rest period.

In the Senegalese zone, sampling operations of length and biological parameters of *P. longirostris* were carried out quarterly in 2005 and 2006 (until the end of the fishing agreement).

4.3 Deep-water rose shrimp (*Parapenaeus longirostris*)

4.3.1 Biological characteristics

The linear growth and length-weight relationship parameters of deep-water rose shrimp were estimated from the Moroccan coastal trawler commercial catches in the landing ports.

The length-weight relationship equations obtained from the biological sampling of coastal fishery catches in the port of Casablanca between June 2004 and June 2005 are given in Table 4.3.1.

Table 4.3.1: Length-weight relationship of deep-water rose shrimp by sex

Sex	Ratio equation	No. analysed	R^2	Student test | t |
Females	P = 0.0053 × Lc2.2523	1842	0.932	15.10
Males	P = 0.0067 × Lc2.1517	1082	0.844	15.70
Females+Males	P = 0.0051 × Lc2.2557	2924	0.917	14.36

The Von Bertalanffy growth equations for deep-water rose shrimp (biological sampling in the port of Casablanca) are the following:

Cl = 51.28 (1 – exp-0.827 (t +0.30)) for females.
Cl = 42.51 (1 – exp-0.934 (t+0.33)) for males.
Cl = 49.86 (1 – exp-0.939 (t +0.32)) for both sexes combined.

Cl = carapace length in mm.
t = time in year.

The weight growth equations are the following:

$Wt = 37.64 (1 - \exp-0.8266(t+0.30))^{2.25}$ for females.
$Wt = 21.39 (1 - \exp-0.9336(t+0.33))^{2.15}$ for males.
$Wt = 34.46 (1 - \exp-0.9393(t+0.32))^{2.26}$ for both sexes combined.
The overall sex-ratio for this species is 0.63 for females and 0.37 for males. Of 2 924 individuals examined from the coastal fishery landings in the port of Casablanca during the period 2004–2005, 1 842 were female and 1 082 were male.

Length at first sexual maturity was estimated at 23.44 mm to the carapace, corresponding to a total length of 11.20 cm. Weight at first sexual maturity was 6.41g and the corresponding age was 0.44 years.

Individual absolute fertility varies between 1 100 and 120 100 eggs per female for carapace lengths between 20 and 40 mm (between 9 and 17 cm total length). Relative fertility varies between 151 and 6 191 eggs per gram of shrimp.

The deep-water rose shrimp has a varied diet. The *Foraminifira* are the preferred prey of this species. Plant debris, copepods, *Mysidacea*, amphipods, euphausids, the eggs and larvae of decapods and molluscs, crabs, gastropods, fish scales and eggs, grains of sand, radiolarians and sponges are all an important part of its diet. The biodiversity in the diet seems to increase with age and this increase is more apparent amongst females. The diet does not vary between sexes or season. Natural mortality is very high in deep-water rose shrimp. Fishing mortality is 1.52 per year for both sexes combined, 1.60 per year for males and 1.43 per year for females.

Environmental effects
A first analysis of the possible effects of different environmental parameters and of the abundance of *P. longirostris* in Mauritanian waters carried out by the IEO using the available indices of sea surface temperature (SST) and the north Atlantic oscillation (NAO) (Garcia and Sobrino, submitted), suggests that there is no correlation between stock abundance/yields and the overall SST, but that there is a correlation between yields and the NAO indices.

The level of salinity seems to have a direct effect on deep-water rose shrimp spawning. Recent studies (Benchoucha *et al.* in preparation) have effectively shown that spawning generally takes place at salinity values of between 35.6 and 36.5 psu, both in shallower depths (75–200 m) and in deeper zones (250–500 m). Spawning has been observed both in spring and summer in shallower zones. In winter, spawning takes place in both zones.

4.3.2 Stock identity
The deep-water rose shrimp (*Parapenaeus longirostris*) lives on sandy and muddy bottoms at depths between 20 and 700 m. This species is found between the northern limit of Cape Spartel (35 °47’ N) and the southern region of Sidi Ifni (29 °22’ N).

No fishery targets *P. longirostris* between Agadir and Cape Blanc. Figure 4.3.2a shows the distribution of this species. In Mauritanian waters, *P. longirostris* is targeted mainly between 21 ° and 19 °N. The fishery targeting *P. longirostris* in Senegalese waters from 16 °N is developing.

Considering the fact that *P. longirostris* is found in different geographic zones, the Working Group adopted three stocks: Morocco, Mauritania and Senegal–the Gambia.

4.3.3 Data trends
Catch
Catch of *P. longirostris* in the region over the period 1980–2006 shows a gradually increasing trend from the beginning of the series until 1998, the year in which landings reached a maximum tonnage of 19 000 tonnes (Table 4.3.3a and Figure 4.3.3a). Thereafter catches stabilized until 2003. In general, total catch in the region has followed the same pattern as that of the catch in Moroccan waters where most of the landings take place.

In Morocco, a continual increase in catch with some fluctuations by the shrimp freezer trawlers can be seen until 2001, the year after which a decline is observed. This decrease continued until 2006, going from 8 700 tonnes to 3 600 tonnes (Figure 4.3.3b). Catches by Moroccan fresh shrimp coastal trawlers increased gradually from 1996 to stabilize between 2003 and 2006. During this period the coastal trawler catches were similar to those of the freezer trawlers.

In Mauritania, despite the fluctuation in catch by the Spanish freezer trawlers, landing trend by this fleet is increasing, with a maximum value of 2 574 tonnes in 2003, the year in which the maximum catch was also seen in the Mauritanian shrimp freezer trawler fleet. Catch of other shrimp freezer trawlers has continued to increase slowly reaching a maximum in 2004. Thereafter, a decrease in shrimp landings in

Mauritania is seen. This decrease is very marked for the Spanish shrimp freezer trawlers which subsequently increased their catches in 2006 (Figure 4.3.3b).

In the 1981–2006 time series, total landings in Senegal–the Gambia varied from a minimum of 400 tonnes in 1997 to a maximum of 4 500 tonnes in 1998 (Table 4.3.3a and Figure 4.3.3b). Landings by the Spanish shrimp trawlers show large fluctuations with a general decreasing trend which was very accentuated over the last three years. After a sharp drop to 132 tonnes in 2000, catch of the industrial fishery in Senegal has regularly increased reaching a maximum of 3 000 tonnes in 2003, then stabilising over the last three years (Figure 4.3.3b).

Effort

In Moroccan waters, since the end of the fishing agreement between Morocco and the European Union, the deep-water rose shrimp *P. longirostris* is only targeted by a national fleet comprising coastal trawlers and shrimp freezer trawlers. A strong increase in effort by the Moroccan fresh fish fleet can be seen from 1995. This doubled in 1999. Since then the effort of this segment of the fishery has remained between 110 000 and 120 000 fishing days. Effort of the shrimp freezer trawler fleet stabilized at between 15 000 and 18 000 fishing days from 1998 (Table 4.3.3b and Figure 4.3.3c).

Fishing effort by the Spanish fleet on deep-water rose shrimp in Mauritanian waters shows an increase between 1987 and 1989 going from 4 060 to 10 074 fishing days. This effort has stabilized around 4 600 fishing days over the last few years (Table 4.3.3b and Figure 4.3.3c). The Mauritanian fleet which began fishing shrimp in 2000 shows a variable effort, fluctuating between 1 800 and 5 400 fishing days. The situation is identical for the other shrimp freezer trawlers in Mauritania.

The industrial fishery fleet off the coast of Senegal shows fluctuating effort between 1982–2006, with an overall decreasing trend (Figure 4.3.3c), which is probably due to the presence of a variable number of foreign vessels active in this zone. Effort from the Spanish freezer trawlers has been fluctuating in Senegal. The largest efforts were recorded globally between 1980 and 2001 with values of between 4 515 and 1 434 fishing days, which can be explained by the non-permanent presence of these trawlers in the Senegalese fishery zone. From 2001, Spanish freezer trawlers efforts fell drastically reaching 139 fishing days in 2006.

Abundance indices

CPUE

In Morocco, catches per unit of effort (CPUE) have shown a progressive decrease for the shrimp freezer trawlers since 2000. Their CPUEs went from 522 kg/fishing day in 2000 to 221 kg/fishing day in 2006. Over the last two years, the CPUEs have stabilized at around 220 and 250 kg/day. For the coastal trawlers, the CPUEs are relatively low and stable over the same period (Table 4.3.3c and Figure 4.3.3d).

In Mauritania, the CPUEs of the three shrimp freezer trawler fleets have shown the same trend with fluctuations between 2000 and 2006 (Table 4.3.3c and Figure 4.3.3d). The Spanish and Mauritanian shrimp trawlers showed the highest CPUE values in 2001 and 2003. The situation is the same for the other freezer trawlers fishing in Mauritania with the highest CPUE values in 2004.

In Senegal–the Gambia, the CPUEs of the Spanish shrimp freezer trawlers targeting deep-water rose shrimp show fluctuations from 1986 to 2006. The CPUEs vary between 381 and 972 kg/fishing day with a general decreasing trend (Table 4.3.3c and Figure 4.3.3d).

Scientific surveys

Morocco

Deep-water rose shrimp *P. longirostris* abundance indices estimated from the scientific surveys carried out by INRH in the Moroccan north Atlantic zone show a large decrease over the last three years in the zones of Larache–El Jadida and Essaouira–Agadir (Table 4.3.3d).

Mauritania
The abundance indices estimated during the scientific surveys carried out by IMROP show that the highest yields were obtained in 2004, with 3.25 kg/30 minutes. Over the last two years, the yields dropped, reaching a minimum of 0.46 kg/30 minutes (Table 4.3.3e and Figure 4.3.3f).

Results from the sex-ratio analysis from the surveys in the Mauritanian EEZ indicate that the sex-ratio of *Parapenaeus longirostris* is much higher for females during both seasons.

Biological data
Length composition and other information
Morocco
A study of the average length of deep-water rose shrimp (carapace length in mm) was carried out using data from the INRH scientific survey (1993–2006). It showed that average length increases with depth. One finds young individuals close to the coast whereas adults are abundant below 200 m (Figure 4.3.3e).

Mauritania
Length distributions from the samples of the scientific surveys carried out jointly by IMROP-JICA on board the R/V AL AWAM show a plurimodal distribution. The lengths were between 9 and 46 mm (total length) in both the cold and warm seasons.

Spanish fleet
The length distributions of *Parapenaeus longirostris* in the samples of the Spanish fleet in Mauritanian waters show a different length distribution for males and females. The males are smaller than the females (15.5–32.5 mm cephalothorax length, with a mode of 22 mm for males and 15.0–38.5 mm, with a mode at 24 mm for females).

For shrimp caught in Senegalese waters by the Spanish fleet, the lengths vary between 17.5 and 34.0 mm for males and 17.0 and 36.5 mm for females. The male samples showed a unimodal distribution with a mode of 22.5 mm whereas the females have a bimodal distribution, with a main mode at 23.5 mm and a secondary mode 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 the fisheries of *Parapenaeus longirostris*. The model is described in Appendix 2 to this report. Given the availability of length composition data between 2002 and 2006, the analytical model was also used for the deep-water rose shrimp stock in Morocco.

Data
A time series of total catch of deep-water rose shrimp *Parapenaeus longirostris* by fishing zone was used by the Working Group.

For Morocco, two abundance indices series were adopted, the CPUE series from the shrimp freezer trawlers and the abundance indices series from the surveys. The global model fits both abundance index series. The Working Group decided to retain the abundance indices series from the INRH scientific surveys in Morocco which better reflects the actual abundance of the stock.

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

The CPUEs from the Spanish shrimp freezer trawlers were also used to assess *Parapenaeus longirostris* in the Senegal–the Gambia fishing zone.

Results
The model provided acceptable fits to the data for the Moroccan and Mauritanian stocks (Figure 4.3.4), but not for the Senegal–the Gambia stock.

In Morocco, the deep-water rose shrimp stock is overexploited (Table 4.3.4). Current biomass is below the target biomass $B_{0.1}$. This situation was confirmed by the yields obtained during the INRH scientific surveys in 2006. With respect to the 2004 assessment, the situation has deteriorated. It was also noted that current fishing effort is higher than the target effort $F_{0.1}$.

In Mauritania, the model showed that the *Parapenaeus longirostris* stock is fully exploited. Current biomass is close to the target biomass $B_{0.1}$ (Table 4.3.4).

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

Stock/abundance index	$\mathbf{F_{cur}/F_{SYcur}}$	$\mathbf{B_{cur}/B_{0.1}}$	$\mathbf{F_{cur}/F_{0.1}}$	$\mathbf{B_{cur}/B_{MSY}}$	$\mathbf{F_{cur}/F_{MSY}}$
Morocco/INRH survey index	297%	11%	618%	12%	556%
Mauritania/Spanish freezer trawlers	85%	106%	79%	116%	71%

$\mathbf{F_{cur}/F_{SYcur}}$**:** Ratio between the observed fishing mortality coefficient during the last year of the series and the coefficient that would give a sustainable yield at current biomass levels.
$\mathbf{B_{cur}/B_{0.1}}$**:** Ratio between the estimated biomass for the last year and the biomass corresponding to $F_{0.1.}$
$\mathbf{F_{cur}/F_{0.1}}$**:** Ratio between the observed fishing mortality coefficient during the last year of the series and $F_{0.1.}$
$\mathbf{B_{cur}/B_{MSY}}$**:** Ratio between the estimated biomass for the last year and the biomass coefficient corresponding to F_{MSY}.
$\mathbf{F_{cur}/F_{MSY}}$**:** Ratio between the observed fishing mortality coefficient during the last year of the series and the coefficient giving maximum long term sustainable yield.

Discussion
Taking into account the difficulties encountered in fitting the models due to the random fluctuations in recruitment, the results should be treated with caution for both countries. Nevertheless, the results agree with those from other fishery indicators in the sector (abundance indices from the surveys and commercial vessel yields), which reinforces confidence in the reliability of the results overall.

For Morocco, the results are similar to those obtained during the 2004 assessment (FAO, 2006). The recommendations issued during that assessment regarding a reduction in effort have been largely ignored, which has consequently led to a renewed decrease in the biomass of the species.

For Mauritania, the assessment results show that the stock of deep-water rose shrimp is fully exploited with a biomass close to B_{MSY}.

The fitted models for the Senegal–the Gambia zone were not acceptable and were therefore discarded.

4.3.5 Management recommendations
Taking into account the results from the assessments, the Working Group made the following recommendations for the three stocks:

Morocco
- Strongly reduce current effort (2006) in order to obtain a level of sustainable catch to allow the stock to be rebuilt.
- Encourage the use of separator trawls.

Mauritania
- Do not increase current fishing effort.

Senegal–the Gambia

- Do not increase fishing effort until new assessments are available.

4.3.6 Future research

The Working Group made the following recommendations for future research into *P. longirostris:*

- Strengthen the biological sampling programme in place for landings of coastal trawlers and industrial shrimp trawlers in the Moroccan ports.
- Continue the programme of biological sampling of Mauritanian catches with the support of the Spanish fisheries office in Nouadhibou.
- Improve knowledge on the biology of this species.
- Carry out selectivity studies to reduce bycatch.
- Strengthen the follow-up on exploitation (catch and effort) of the stock in the Senegal–the Gambia zone.

4.4 Southern pink shrimp (*Penaeus notialis*)

4.4.1 Biological characteristics

Data on *Penaeus notialis* were provided by surveys carried out by the research vessels in Mauritania in 2005 and 2006. No sampling of commercial landings for biological study has been carried out in Mauritania over the last few years.

P. notialis has a long reproduction period in Mauritania (mature females have been found by the Spanish fleet from July to April). Length at first maturity is estimated a 17.75 mm (total length) for males and 38.46–46.14 mm for females. It is important to underline that this study is being continued, even if it is not yet conclusive (fertile females were not found either in 2005 or 2006).

The main biological characteristics of this stock have been presented in previous CECAF Working Group reports on demersal fish.

Penaeus notialis reaches a length of 1.8 cm (total length) at the age of 3–4 months. At this age, the species migrates from the fluvial estuaries to the sea where it grows until the age of 22 months, at which age it reaches its maximum length (around 20 cm total length) (Garcia, 1976).

Length sampling of *Penaeus notialis* catches by the Spanish fleet operating in Mauritania were carried out by the IEO, but length composition of this species was not presented to the Working Group. Sampling intensity for *P. notialis* is shown in Table 4.2.2b.

Environmental effects

Studies carried out by the IEO (Garcia and Sobrino, submitted) have highlighted a strong correlation between abundance/yields, the surface temperature and the NAO indices. These data should consequently be taken into consideration when performing an analysis of the stock dynamic in the future.

4.4.2 Stock identity

Two different stock units of *P. notialis* were identified in the zone. One reproduction and breeding zone 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, Saloum, Gambia and Casamance rivers. However, it is not possible to obtain broken down information (landing and effort) on these different sub-units. For this reason the Working Group decided to assess only two units, one in Mauritania and the other in Senegal and the Gambia.

4.4.3 Data trends

Catch

Total catch in the region has shown a variable trend over the last few years with a maximum of around 6 000 tonnes between 1996 and 2002, followed by a decrease in 2003 and 2004 and then an increase over the last two years (Table and Figure 4.4.3a). Catches in Senegal and the Gambia have progressively decreased over the period, going from 3 800 tonnes in 1995 to 2 000 in 2006, whereas catches in Mauritania have continually increased, going from 1 000 tonnes in 1995 to more than 2 700 tonnes in 2006.

P. notialis catch by the Spanish freezer trawler fleet in Mauritanian waters shows large fluctuations between 1987 and 2006 with a peak observed in 1999 (Figure 4.4.3b). On the other hand, the Mauritanian freezer trawler fleet showed a progressive increase in catch from 1999 to 2002, followed by a fluctuating period the last five years. Catches of other freezer trawler fleets operating in the zone have shown a fluctuating trend with a maximum in 2005 followed by a decrease in 2006.

In the Senegalese waters, catch by the Senegalese industrial fleet (less than 250 GRT) have shown a decreasing trend between 1987 and 2006 in spite of the value observed in 1995 (2 300 tonnes). The minimum value (1 100–1 400 tonnes) was recorded over the last three years (Figure 4.4.3b). Catch by the industrial and artisanal Gambian fleets was fairly low, with a decrease from 2001.

Effort

Fishing effort aimed at *P. notialis* by the Spanish freezer trawler fleet operating in Mauritanian waters shows fluctuation during the period of analysis. An increase can be seen from about 2 400 fishing days in 2001 to about 3 900 fishing days in 2002, followed by a decrease until 2005 with 2 500 fishing days and then an increase in 2006 (Table 4.4.3b and Figure 4.4.3c). On the other hand, the Mauritanian freezer trawler fleet has shown a gradual and large increase in effort since 1997, with a maximum of 5 404 fishing days in 2002 (Table 4.4.3b and Figure 4.4.3c). Effort by the other fleets operating in Mauritanian waters was very variable, as can be seen in the time series, with a maximum of nearly 5 000 fishing days in 2004–2005.

Fishing effort by the Senegalese industrial fleet (less than 250 GRT) remained relatively stable between 2000 and 2004 with average values of 26 700 days at sea. It increased greatly in 2005 to more than 50 000 fishing days before decreasing again in 2006 (Table 4.4.3b and Figure 4.4.3c). Estimated effort of the artisanal fleet showed an initially heavy decrease, going from a maximum of 683 010 trips in 2000 to 314 196 trips in 2001, before increasing enormously the following years reaching its maximum values (more than one million trips) between 2004 and 2006. Even if it is a little shifted, the trend follows that of the industrial fleet. Fishing effort by the Gambian industrial fleet increased regularly over the time series, passing from 1 260 days of fishing in 1999 to more than 4 700 days in 2003. But since 2004, this effort knows a decrease with 1 400 days of fishing in 2006.

Abundance indices

CPUE

The calculated CPUEs for the Spanish freezer trawler fleet in Mauritanian waters have shown a fluctuating trend since 1996 with the highest values in 1999 and 2001 of around 490 kg/fishing day. Between 2002 and 2004, the CPUEs remained stable with an estimated value of about 250 kg/fishing day. The last two years have seen another increase (Table 4.4.3c and Figure 4.4.3d). The Mauritanian freezer trawler fleet's CPUEs initially decreased, reaching a minimum of 140 kg/fishing day in 2002 and 2004. They then increase in 2005 and 2006 to around 300 kg/fishing day. Finally, CPUE of the other fleets operating in the zone have been very variable registering a minimum of 20 kg/fishing day in 2004 and a maximum of 300 kg/fishing day in 2006.

As regards CPUE of industrial fleet operating in the waters off Senegal, trend decreases slightly over the series from 121 kg/fishing day in 1987 to 49 kg/fishing day in 2006. The CPUEs of the Gambian industrial fleet showed fluctuations over the period 1994–1999 (between 318 and 277 kg/fishing day).

After 1999, the CPUEs show a decreasing trend until 2004 with only 28 kg/fishing day, followed by a slight increase in 2006 with 91 kg/fishing day (Table 4.4.3c and Figure 4.4.3d).

Scientific surveys
Mauritania
The abundance indices estimated by IMROP during its scientific surveys remained stable between 2000 and 2002 with 0.66, 0.63 and 0.62 kg per 30 minute trawl for the years 2000, 2001 and 2002. A marked improvement was seen in 2004 with an indices of 1.5 kg/30 minutes, followed by another decrease in 2005 to a minimum of 0.5 kg/30 minutes (Table 4.4.3d).

Biological data
Length composition and other information
Mauritania
A plurimodal distribution was observed for *P. notialis* in the survey samples in 2000 and 2001. The lengths in 2000 were between 20 and 44 mm (CL) during the cold season and between 17 and 61 mm during the warm season. In 2001, they were between 17 and 61 mm during the cold season and 17 to 54 mm in the warm season. In 2005 and 2006, length frequency data from the surveys were not exploited.

Samples from the *P. notialis* Spanish freezer trawler fleet catches in Mauritania showed a different length distribution for males and females. Male lengths vary between 20 and 31.5 mm whereas those of the females showed a wider range between 20 and 44 mm. The males only had one mode (26 mm) whereas the females had two (28.5 and 40.5 mm). In 2005 and 2006, length composition data from the Spanish freezer trawler commercial catches were not exploited.

4.4.4 Assessment
Methods
The Schaefer dynamic production model implemented in an Excel spreadsheet was used to assess the state of the stock and the fisheries of *P. notialis*. The model is described in Appendix 2 to this report.

Data
The total landings time series of *P. notialis* in Mauritania, Senegal and the Gambia were used to assess each of the stocks. For the Mauritanian stock, the CPUE of the Spanish freezer trawlers was used as an abundance index. For the Senegal–the Gambia stock the CPUE series of the Senegalese industrial fishery trawlers (less than 250 GRT) was used.

Results
The dynamic production model fits the data of *P. notialis* of both stocks relatively well (Figure 4.4.4).

The Mauritanian stock of Southern pink shrimp *P. notialis* is fully exploited. Current biomass is close to the target biomass $B_{0.1}$ (Table 4.4.4).

For Senegal and the Gambia, the results show that the Southern pink shrimp stock is overexploited (Table 4.4.4). Current biomass is below the target biomass $B_{0.1}$. It was also observed that current fishing effort is above the target effort $F_{0.1}$. With respect to the 2004 assessment, the stock situation has further deteriorated.

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

Stock/abundance index	F_{cur}/F_{SYcur}	$B_{cur}/B_{0.1}$	$F_{cur}/F_{0.1}$	B_{cur}/B_{MSY}	F_{cur}/F_{MSY}
Mauritania/Spanish freezer trawlers	131%	101%	129%	112%	116%
Senegal-Gambia/Senegalese industrial trawlers	116%	30%	215%	34%	194%

F_{cur}/F_{SYcur}: Ratio between the observed fishing mortality coefficient during the last year of the series and the coefficient that would give a sustainable yield at current biomass levels.
$B_{cur}/B_{0.1}$: Ratio between the estimated biomass for the last year and the biomass corresponding to $F_{0.1.}$
$F_{cur}/F_{0.1}$: Ratio between the observed fishing mortality coefficient during the last year of the series and $F_{0.1.}$
B_{cur}/B_{MSY}: Ratio between the estimated biomass for the last year and the biomass coefficient corresponding to F_{MSY}.

Discussion
For Mauritania, the landings' series and the abundance indices show some variation which could be tied to environmental factors which play an important role in the stock dynamic, or to the CPUEs used, which do not represent true abundance indices of the stock. Even if the results from the model are treated with caution, they highlight that the level of current fishing effort is not compatible with the biomass level producing the optimal yield of the stock.

In the case of Senegal and the Gambia, the model provides a good fit, showing a situation of overexploitation. If this situation is not corrected, there is a threat of collapse of the stock.

4.4.5 Management recommendations
Taking into account the results from the assessment, the Working Group recommends decreasing current fishing effort (2006) in Mauritania and drastically reducing current fishing effort (2006) in the Senegal–the Gambia zone.

4.4.6 Future research
The Working group made the following recommendations for future research into *P. notialis:*

- Improve knowledge on the biology of this species.
- Continue the programme of biological sampling of the Mauritanian catches with the support of the Spanish fisheries office in Nouadhibou.
- Improve information on catch and effort by fishing zone (Senegalese and Gambian fleets).
- Study stock identity.
- Study the possible relationship between environmental factors (SST, rain, etc.) and abundance of the species.
- Study selectivity of the trawls to reduce bycatch.

5. CEPHALOPODS

5.1 Fisheries

Cephalopods are caught in northwest Africa (northern CECAF subregion) both as a target species by the specific fishery and as bycatch by the non-specific fishery. These fisheries are led by a heterogeneous fleet of vessels from small canoes to bottom trawlers using fishing gear such as pots, jiggers and bottom trawls. Depending on nationality and characteristics, the fishery is divided into three main components for statistical purposes: i) artisanal, ii) national industrial, iii) industrial from other countries operating under fishing agreements, the most important of which are those between the European Union and nearly all the northwest African coastal countries.

The main target species in the cephalopod fisheries are the octopus (*Octopus vulgaris*), the cuttlefish (*Sepia* spp., *Sepia hierredda* mainly and *Sepia officinalis* of which the proportion decreases towards the south) and the squid (*Loligo vulgaris*). *Sepia bertheloti* is another quite important cuttlefish species in the subregion which is sold under the name "bobtail squid". Generally octopus is the most abundant species and has the highest commercial value in the cephalopod fisheries, with 65 to 75 percent of total landings. Its importance decreases towards the south where it is replaced by growing proportions of *Sepia hierredda*. Squid virtually disappears in landings in the south of Senegal.

Three main bottoms are found along the northwest African coast, more or less coinciding with the distribution zones of the three octopus stocks of the subregion. From north to south these are: i) the zone between Cape Bojador (26 ºN) and Cape Blanc (21 ºN); ii) the zone between Cape Blanc (21 ºN) and the mouth of the Senegal river (16 ºN); and iii) the zone between the mouth of the Senegal river (16 ºN) and the border with Guinea-Bissau (12 ºN).

In Morocco, the cephalopod fishery is characterized by large fluctuations in catch and effort. It can be divided into several distinct periods depending on where in the region the fleet comes from and the management measures that are in place for this fleet:

Exploitation by foreign fleets: The cephalopod fishery started at the beginning of the 60s in the Atlantic zone south of Morocco between Cape Bojador and Lagouira. At this time, cephalopods (octopus, cuttlefish and squid) were only exploited by foreign fleets (Japanese, Spanish). At the beginning, this period saw the best catches per unit of effort reaching between two and three tonnes per day per vessel. The economic attraction for a fishery of this species provoked an intensification in their exploitation.

Exploitation by mixed companies: The cephalopod fishery saw an intermediate phase when the Spanish fleet was joined by a Moroccan fleet in establishment. There was then a period of combined exploitation beginning in the 1980s which continued until the departure of the EU fleet in 1999. The national cephalopod fishery only began to develop in 1973 with four freezer trawlers. Afterwards it saw considerable impetus and stabilized, after the freeze in investment since 1992, at around 290 active freezer trawlers. In reply to an increase in effort and to the realization of overexploitation, a system of biological rest periods was started in 1989. These last for the month of October and correspond to the main recruitment period. Due to their distance, until 1990 the cephalopod stocks were only accessible to the Moroccan and Spanish freezer trawlers operating under a series of Morocco–EU fishing agreements which ended in 1999. However, with the development of the infrastructure and the attraction of the value of the products landed since 1993, there has been a massive migration of canoes (artisanal boats) from the north towards southern zones to exploit octopus. Coastal trawlers have also joined this movement, attracted mainly by the consequences of the biological rest period.

Due to the overexploitation, the cephalopod fishery has undergone a series of management measures integrating the new fleets (artisanal and coastal), notably the regulation of trawl mesh size and the size of first catch, as well as the reduction in fishing activity in the coastal zone. Additionally, since 1993 the biological rest period has increased by one month to protect the reproduction period (one month in autumn and one in spring). Since 1997, this has grown from two to four months, two months in spring and two in autumn.

Exclusively Moroccan exploitation: Since 2000, the cephalopod fishery is only composed of a very heterogeneous Moroccan fleet, subdivided into three sections (ocean-going, coastal and artisanal). The artisanal section has become an important component of the fishery. In order to offset the effects of the increase in effort, the biological rest periods have gone from four to seven months. Following a large drop in production in 2001, a management plan for the octopus fishery based on an overall quota was created. 2004 is the year in which the longest biological rest period for octopus is seen, lasting eight months.

In 2004, the fall in production necessitated a revision of the management plan, which was based partly on the reduction of the overall quota adjusted seasonally and partly on the reduction in effort of the coastal and artisanal sectors following their uncontrolled development over the last decade. The artisanal sector saw the number of vessels reduced to 2 800. For the coastal fleet (190 trawlers), only 100 trawlers are authorized to fish in the zone to the south of Cape Bojador per trip. As for the ocean-going sector, a system of individual transferable quotas has been created. The revision of the cephalopod fishery management plan also covered zoning with a demarcation of fisheries sub-units and zones where trawling is forbidden. In November 2002, the zone between 24 °N and 25 °N which is normally the main nursery for the Dakhla stock, where the greatest concentrations of juveniles are usually found in autumn, was declared a protected zone and therefore fishing was forbidden. This remained in place until 2005. The revision of the management plan also covered other technical aspects, notably passing from a minimum size of T8 to T7 with a tolerance threshold of five to ten percent for T8 depending on the season and the increase in minimum mesh size to 70 mm instead of 60 mm.

Several fleets share the exploitation of cephalopod resource along the Moroccan continental shelf. They differ in their technical characteristics and above all in the level of investment and employment generated. Their strategies are tied to the dynamic of the resources and the markets.

Freezer trawler fleet: This is composed of 290 vessels which practise trawl fishing (Spanish and Korean types). They go to sea for an average of fifty days. With the setting up of the seasonal quota, the trips cover a period of between 100 and 120 days on average. The length of these vessels is between 30 and 40 metres. Their tonnage varies between 200 and 600 GRT with an engine power of 600 to 2 000 HP. During the last trips, the number of active vessels has been around 230.

EU fleet: This fleet operated under the Morocco–European Union fishing agreement from 1995 to 1999. It was mainly composed of around one hundred Spanish cephalopod trawlers. These vessels practised the Spanish technique of backwards or sideways trawl fishing using three types of conservation. The GRTs varied between 100 and 400 GRT, with an engine power of 600 to 1 000 HP. The European trawlers ceased operations on 30 November 1999.

Coastal fresh fish fleet: This fleet is made up of around 100 vessels. The average power and tonnage of this fleet are 400 HP and 60 GRT respectively. The type of trawl used is the atomic trawl (60 mm) and a trip lasts between six and ten days during which time the fish are preserved in boxes under ice. Since 2003, the presence of around one hundred longliners fishing squid and cuttlefish can also be seen, with 235 HP and an average estimated age of four years.

Small trade artisanal fishery fleet: This comprises wooden boats of less than 2 GRT and equipped with outboard motors of between 15 and 25 HP. This fishery uses passive gears: pot and jig.

The number of artisanal fishery vessels saw a notable increase between 1993 and 2002. After this time, the number of boats has not stopped decreasing following the censuses and the regulations which came into force covering this sector. Currently, there are 3 000 boats. The fishery is usually practised along the coast, but the range can go beyond 20 nautical miles.

Mauritania

Exploitation of cephalopods (particularly octopus) began in the 1960s. Several exploitation systems based on foreign fleets have followed each other in the country (Japanese, Korean, Chinese).

The establishment of a national cephalopod fleet was only possible in the 1980s. This comprised freezer and ice trawlers targeting octopus and exporting this to the Japanese market. The fleet is made up partly of old vessels whose activity has ceased and partly of chartered vessels. This is why their actual effort is very variable from one year to the next.

The fishing agreements between the European Union and Mauritania dating from 1996 have allowed European vessels to fish octopus in Mauritania. These vessels exerted a large effort and, under the last EU–Mauritania fishing agreement signed in 2006, the number of vessels authorized to fish cephalopods has passed from 55 to 43. The total number of cephalopod vessels (national and foreign) active in Mauritanian waters was 177 in 2006 and 146 in 2007 (until August 2007) (Table 5.5.3.a).

The ice and freezer cephalopod trawlers have very similar characteristics, except for their preservation methods. The foreign vessels, dominated by the Spanish cephalopod trawlers, measure on average 34 metres with a tonnage of 287 GRT and a power of 896 HP. The national vessels are slightly smaller with an average of 258 GRT in 2006.

The artisanal fishery is composed of small wooden, aluminium or plastic boats of a length of less than 16 metres generally and a power of less than 50 HP. These boats fish with very varied gears; handlines, longlines, squid nets, octopus pots, pots and gillnets (skate nets, croaker nets, shark nets, tollo nets, sole nets, shoulder nets, seabream nets, trammel nets). The most used gear to catch octopus is the octopus pot, which is very diffuse in the northern coastal zone. The jigger, which was much used in the south to fish octopus is no longer used. To catch cuttlefish, the Mauritanian artisanal fishery uses pots and trammel nets in the south.

Table 5.1: The cephalopod fleet in Mauritania (2000–2007)

Fleet/year	2000	2001	2002	2003	2004	2005	2006	2007
Foreign cephalopod trawlers	51	70	67	65	58	54	54	35
National cephalopod trawlers	110	132	126	130	139	139	123	111
Total	161	202	193	195	197	193	177	146

Current management measures in the Cape Blanc fishery are:

- A fishing closed season from 1 September to 30 October (in force since 1996).
- Since 2003, no new industrial fishery permit for octopus has been handed out. The vessels that have left the fleet have not been replaced. There are restrictions neither on the number of canoes fishing octopus nor on the number of pots used.
- A minimum mesh size of 70 mm for the industrial fishery.
- A minimum weight of 500 g (gutted) in landings.
- Trawling (mainly for the industrial fishery) forbidden in waters of a depth of less than 20 m.

Senegal and the Gambia

Cephalopod fishery in the region between the mouth of the Senegal river and the border with Guinea–Bissau is relatively new. It is mostly practised by Spanish ice trawlers working under the Senegal–EU fishing agreement. The number of vessels fluctuated greatly between 1991 and 2003 going from a minimum of one to a maximum of six. Their technical characteristics in 2003 were a length of 36 m, a tonnage of 244 GRT and a power of 771 HP. Trawlers from other countries under different types of permit also fish 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 fishery, part of which, more and more, seasonally targets cephalopods using jiggers and keepnets.

5.2 Sampling systems and intensity

5.2.1 Catch and effort

Statistics on landing and effort in the Moroccan fisheries are available by trip for the cephalopod freezer trawlers and by month and port for the coastal fishery at INRH in Morocco. The database contains raw data from all the fisheries. Statistics on cephalopod catch, particularly octopus, are available by month and by port for all sectors. Statistics on catch in the artisanal and coastal fisheries as well as the effort deployed by these two sectors are complemented by surveys of the fishing sites, the freezer factories and the fishing ports following a number of daily trips by vessel and the duration of the trips.

In Mauritania, the industrial fishery statistics come from catch and effort data declared by the vessel captains and extracted from the daily fishing logbooks. This covers all vessels active in the waters of the country. Landing data are currently being collected. Other data are also available from 1975 in the database of the Canary Island laboratory of the IEO on fishing activity of Spanish vessels in Mauritania and Senegal. It should be noted that the port of Las Palmas is where nearly all foreign vessels land their catch. Following a change in strategy of the European fleet in general, and in particular of the Spanish fleet, the IEO adapted its system of data collection. Currently, this system includes two main information sources:

1. A network of researchers based in the landing ports in Spain (Las Palmas de Gran Canaria in the Canary Islands and Vigo, Cangas and Marín in Galicia).

2. Copies of the fishing logbooks which are obligatory for all EU vessels above 80 GRT.

The researchers collate the detailed information by vessel and by trip, on fishing effort (fishing days and days at sea), the landings of the three target species (octopus, cuttlefish and squid) and bycatch. Copies of the logbooks are used, if necessary, to verify and complete the information. The combined analysis of the two sources provides the monthly landing and effort statistics which are kept in the IEO database.

For the Mauritanian artisanal fishery, the statistical system is based on surveys carried out along the coast by IMROP technicians who collect effort, catch and socio-economic data.

In Senegal, observers from the Office for Fisheries Protection and Surveillance collect data on board foreign fishing vessels. These data are transmitted to the Dakar Thiaroye Oceanographic Research Centre (CRODT) and to the Office of Maritime Fisheries (DPM) which ensures the centralisation of fishery statistics for different administrations. As for the national industrial fishery vessels, declarations of catch are made by the captains to the DPM. Effort is obtained by surveys carried out by CRODT researchers at landing.

The artisanal fishery is followed by a network of CRODT researchers installed in the different landing sites. They collect catch and effort data from the artisanal vessels.

5.2.2 Biological parameters

Biological sampling in the region is regularly carried out at the main landing ports in the region.

In Morocco, biological sampling is carried out at the main ports and landing sites as well as on board the R/V CHARIF AL IDRISSI.

Sampling is done for all cephalopods during the trawl surveys, whereas it only covers octopus in the ports and landing sites in the Laayoune–Dakhla region (Table 5.2.2a).

Sampling of the coastal fishery vessels is carried out two or three times a week in the ports of Laayoune and Dakhla and once a month in the port of Tantan. Sampling in the artisanal fishery sites is done twice a week in Dakhla and twice a month for sites in the Laayoune region. Furthermore, information on the commercial length categories (T1–T9) from the cephalopod freezer trawlers is available from the Ministry.

In Mauritania, information on the commercial length categories is available from the Mauritanian Society for the Commercialisation of Fish (SMCP), a mainly state controlled society in which artisanal and industrial producer organisations are represented and which hold part of the capital. This society holds the monopoly on octopus commercialisation which is one of the pillars of the national economy. Sales are done following the commercial categories. The society has a large database on the structure of the commercial lengths and therefore catch by each fleet.

IMROP carries out scientific trawl surveys during different seasons on board the R/V AL AWAM. The biological closed season assessment surveys are also carried out before and after the closed period, that is at the end of August and October. During these surveys, data on the weight structure and octopus biology are collected.

A programme aiming at updating the biological parameters was begun in 2007 in collaboration with a private Spanish partner. Samples are collected from the artisanal fishery octopus landings. The results could be very useful for the artisanal fleet and the ice trawlers. No information is available for the Mauritanian ice trawlers.

Octopus, cuttlefish and squid sampling of the catches by the Spanish fleet operating in the subregion is carried out by the IEO as part of the "National programme of data collection for fisheries management" project under the common fisheries policy of the European Union. This programme provides data on biometric parameters, such as catch length frequency distributions and biology, the results of which are presented in different sections of this report.

Information on sampling intensity is available for the research vessels in Morocco and Mauritania (Table 5.2.2b).

5.3 Octopus (*Octopus vulgaris*)

5.3.1 Biological characteristics

The *Octopus vulgaris* biology has been the subject of several studies in the subregion. Recent breeding and tagging experiments in fish tanks have highlighted a very rapid growth and therefore a very short lifespan.

The biology of the main cephalopod species in the subregion has been studied intensively during the years. Much is known about numerous aspects of their life-cycle and the number of available biological parameters available in scientific literature is quite large. A summary of all this information was presented to the CECAF ad hoc Working Group on cephalopod resources in Santa Cruz, Tenerife in 1997 (Lamboeuf, 1997). Supplementary works have recently been published covering a series of biological aspects and questions about the fisheries, in particular about octopus. An updated reference list will be presented to the next Working Group.

5.3.2 Stock identity

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

Dakhla stock (26 °N–21 °N)
Cape Blanc stock (21 °N–16 °N)
Senegal–the Gambia stock (16 °N–12 °N)

This stock separation was based on data relative to the fisheries which has recently been confirmed by more accurate information thanks to the system of satellite control of vessels (VMS) and genetic analyses.

In Mauritania, studies on octopus distribution have shown a relatively clear spatial separation of the different cohorts exploited during the two distinct periods of the year. In practice, this means that if the catches made in this zone during the warm season are from the Cape Blanc stock, during the cold season (December–May), some of the catches in Mauritania will span both this stock and the Cape Blanc stock to the north.

5.3.3 Data trends

Catch

Dakhla stock (26 °N–21 °N)

Octopus catch trend is practically the same for all the different sectors of the fleet. Between 1991 and 1997, a general decrease in catch was seen. Total catch in 1997 was half of the 1991 level, that is 50 000 tonnes. Subsequently, the situation improved until 2000, the year in which a record 107 000 tonnes was caught of which 42 percent by the artisanal sector. Catches then decline continually between 2000 and 2004, the year in which they reach a minimum of 18 000 tonnes. Over the last two years (2005 and 2006), octopus catches in Moroccan waters have stabilized at around 34 000 tonnes (Table and Figure 5.3.3a).

Octopus catches by Moroccan freezer trawlers dominate this fishery and represent between 44 and 67 percent. The coastal trawlers which began working in 1994 have caught around ten percent of the quantities landed over the last few years. Catches by the Moroccan artisanal fishery represent a third of the catch in the country's waters.

Despite the introduction of new management measures in 2001 (TAC) and the extension of the close of the season, the trawler fleets have not been able to fill their quotas over the last two years.

Landings of the Spanish freezer trawlers show a constant decreasing trend from 1991 (40 600 tonnes) till the end of the EU–Morocco fishing agreements in 1999 (with a series minimum of 8 700 tonnes) (Figure 5.3.3a). This trend can be explained by the continual decrease in the number of vessels authorized to fish under the fishing agreements.

Cape Blanc stock (21 °N–16 °N)

Between 1990 and 2006 octopus landings have varied between a maximum of 44 600 tonnes in 1992 and a minimum of around 17 400 tonnes in 1998 (Table and Figure 5.3.3a). More recently, that is between 2000 and 2006, catches in Mauritania have remained between 20 000 and 30 000 tonnes (for all fleets). The Spanish cephalopod trawler catches were updated for the years 2000 and 2002 on those in the 2004 report (FAO, 2006). Since the start of the fishery in 1995, the Spanish cephalopod trawler production increased constantly until 2000 when it reached 12 265 tonnes. This maximum value was followed by an equally constant decrease until 2003 (6 402 tonnes) and a recovery in 2004 (7 321 tonnes) and 2005 (9 306 tonnes). The last available year in the series (2006) shows a new drop in catch to 6 482 tonnes (Table and Figure 5.3.3a).

Generally, the Mauritanian ice and freezer cephalopod trawler catches, which dominate the fishery, represent more than 40 percent of the total.

The Mauritanian cephalopod artisanal fishery, encouraged by different governmental policies, is becoming more and more important with around 20 percent of catches (22 percent in 2006). Catches by other European cephalopod trawlers should be added to the catches of the national fleets as should the bycatches of other fleets (shrimp, fish, hake).

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

A reconstructed data series of the Senegalese fisheries' catches was analysed during the Working Group. The differences between the data presented to the 2004 Working Group (FAO, 2006) were very small and did not change the general trend. Total landings of the Senegal–the Gambia stock during 1990–2006 varied between a minimum of 2 841 tonnes in 2001 and an unusual maximum of 44 304 tonnes in 1999. Other annual maxima were periodically observed in 1991, 1994 and 2002. Since this last year total production has undergone a progressive decline reaching 7 712 tonnes in 2005 and increasing in 2006 to 8 912 tonnes.

The general trend in catch is followed by all the fleets of the fishery. The industrial Senegalese fleet is the main contributor with landings that regularly represent more than 50 percent of the total. This is followed, in terms of landings, by the artisanal Senegalese fleet and by the industrial Gambian fleet with

smaller catches. Annual production of the Spanish industrial fleet did not rise above five percent of total catch in the whole series. This fishery stopped in 2005 with the end of the fishing agreement between Senegal and the European Union (Table and Figure 5.3.3a).

Effort

Dakhla stock

Ocean-going trawler freezers effort which was between 60 000 and 70 000 fishing days before 2001 (the year in which the octopus fishery management plan was introduced), stabilized at 50 000 fishing days in 2001 and 2002. It subsequently decreased to around 40 000 fishing days. This fall in effort is due to rest periods in the fishery which have continually increased (Table and Figure 5.3.3b). The number of active vessels has dropped from 290 in 1992 to 264 in recent years.

The increasing trend in effort of the artisanal and coastal fisheries amply compensated for the decrease in the ocean-going fishery and the departure of the EU fleet. It later decreased markedly between 2003 and 2004 due to the application of a new strategy limiting the number of vessels in 2004. In 2005 and 2006, effort stabilized at around 151 000 fishing days.

The coastal trawler fleet maintained a more or less constant effort, except for 2001 and 2002 when it almost doubled with respect to previous years. It then fell in 2003 and began to increase from 2004 despite the limitation placed on the number of vessels in the zone to 150 and the number of pots of octopus landed by each vessel to 200. It reached 30 554 fishing days in 2005, then decreased slightly to 28 834 fishing days in 2006.

Cape Blanc stock

Fishing effort applied to octopus in Mauritania saw large variations between 1990 and 2006. The trends more or less follow those of the catches (with a time-lag of one or two years). It will be noted that these fluctuations affect above all the national freezer trawlers and the artisanal fishery vessels. Effort by the ice trawlers registered a sustained increase from 1990, stabilizing between 1996 and 2002, before declining in a sustained manner until 2006 (Table and Figure 5.3.3b).

The national freezer trawlers, after seeing a marked increase until 1996 with nearly 27 000 fishing days, suffered a notable decrease in effort, reaching their lowest level over the period in 1999 (with less than 12 000 fishing days). The overall trend in effort of these vessels increases until 2005.

The European freezer trawlers that began operating in Mauritanian waters at the end of 1995 saw their effort increase continually, slightly overtaking that of the national vessels between 1999 and 2001 and reaching a maximum of 12 589 fishing days in 2002. Afterwards, the European fleet effort saw a strong decline reaching 7 454 fishing days in 2006.

Artisanal effort increased markedly between 1990 and 1995, going from 58 000 trips to 234 000. It subsequently decreased until 1999 when it began to rise again reaching 156 000 trips in 2005.

Senegal–the Gambia stock

The largest effort directed at the Senegal–the Gambia stock is by the Senegalese industrial and artisanal fleets. These values were followed by strong declines in 2000 and 2001 for the artisanal fleet, followed by increases in the following years (Table and Figure 5.3.3b). The increasing trend is maintained until 2004 for the artisanal fleet when it reached its maximum of the series (627 000 exits, whereas the industrial fleet increased in 2001 to then decrease progressively in the following years. The minimum effort value of these fleets over the series is observed in 2005. Both increased slightly in 2006, to 32 000 days of fishing for the industrial fleet and 592 000 exits for the artisanal fleet.

Effort by the other fleets (Gambian industrial trawlers and Spanish trawlers) remained more or less stable over the whole series with small periodic fluctuations probably tied to the availability of octopus. Maximum effort by the Gambian trawlers was reached in 1991 with 9 620 fishing days whereas that of the Spanish was observed in 2003 (1 134 fishing days).

Abundance indices

CPUE

Dakhla stock

The annual average CPUE of the cephalopod freezer trawlers registered a continual decline. It went from 1 200 kg/fishing day in 1993 to 400 kg/fishing day in 1997. It then improved reaching 900 kg/fishing day in 2000. The average annual yield dropped in 2001, reaching its lowest level in 2003 where it is only 290 kg/fishing day. Since 2005, it has stabilized at around 470 kg/fishing day (Table and Figure 5.3.3c).

Prior to 2002, the average annual yield of the coastal octopus trawlers varied between 350 and 400 kg/fishing day, it then declined reaching 141 kg/fishing day in 2003 and 66 kg/fishing day in 2004. It subsequently climbed to 145 kg/fishing day in 2006.

The average annual octopus yield of the artisanal fishery vessels went from 15 kg/fishing day in 1994 to 57 kg/fishing day in 2000. In 2003 a large drop was registered at 14 kg/day. From 2004, it improved reaching 77 kg/fishing day in 2006.

In all cases, the abundance indices have seen large decreases over the last years of the series.

The CPUEs of the Spanish freezer trawlers strongly resemble those of the Moroccan freezer trawlers both in value levels and trends, this is true until the end of the fishery in 1999 (Table and Figure 5.3.3c).

Cape Blanc stock

The yields (or CPUE) of octopus in Mauritania were very variable during the period under consideration. This variability could be attributed to the overexploitation by the fishery for several years or to bio-ecological factors (recruitment, environment).

The pick of catch of octopus seen in Mauritania in 1992 has had repercussions on the octopus yields for all the fleets targeting this species. After this year, a heavy reduction for all fleets is recorded. This continued until 1997 before a slow improvement until 2000 (Table and Figure 5.3.3c). The CPUEs fluctuate greatly after 2000 and seem to remain at a very low level in comparison to the beginning of the period.

A strong consistency in CPUE trends of the different fleets fishing octopus in this zone should be noted.

The Spanish freezer trawlers joined the fishery at the end of 1995. The CPUEs quickly overtook those of the other fleets but followed the same annual trend. Only 2004 saw an increase which was not reflected in the series of Mauritanian freezer and other cephalopod trawlers.

Senegal–the Gambia stock

The abundance indices of the Senegal–the Gambia octopus stock follow the same pattern for all the fleets involved in the fishery, with maxima and minima in the same years. Differences can only be seen during the last period of the series (2000–2005) (Table and Figure 5.3.3c). The Spanish trawler CPUEs increased continually between 2000 and 2005 (the year in which the Senegal–EU fishing agreement ended) whereas those of the other fleets decreased before increasing again in 2006.

In general, the CPUEs are relatively stable, with a very high peak in 1999 for all fleets. The highest CPUEs were recorded by the Spanish freezer trawler fleet with values of between 70 and 2 300 kg/fishing day in all series analysed.

Scientific surveys

Dakhla stock

The abundance indices from the INRH scientific surveys show a decreasing trend. The half-hourly yields go from 35 kg/30 minutes in October 2000 to 2.8 and 3.6 kg/30 minutes in October and

December 2003. The abundance indices then improved without however exceeding 13 kg/30 minutes, except for November 2006 when they reached 16.28 kg/30 minutes (Figure 5.3.3d).

Cape Blanc stock
Catches per 30 minute trawl by the R/V AL AWAM fluctuate greatly, showing a continual decreasing trend. After reaching over 24 kg per trawl (cold season 1989), yields decrease greatly, not exceeding 5 kg/30 minutes from 2001 onwards (Figure 5.3.3d).

Senegal–the Gambia stock
No results from the octopus research surveys in Senegal and the Gambia were presented to the Working Group.

Biological data
Length distribution and other information
Information on average length, sex-ratio, length at first sexual maturity, the length-weight relationship and growth parameters of the Dakhla octopus stock as well as data on length at first sexual maturity, sex-ratio, and the length-weight relationship of the Cape Blanc stock were given to the Working Group by INRH (Morocco), IMROP (Mauritania) and IEO (Spain) (Table 5.3.3d).

In the Dakhla stock, the average length from the different surveys shows large fluctuations depending on whether the survey was carried out in autumn or spring. For Mauritania, however, average weight shows a decreasing trend (Figures 5.3.3e and f).

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 the fisheries of *Octopus vulgaris*. The model is described in Appendix 2.

Dakhla stock
Data
The data series in tonnes for the 26 °N to 20°50 'N zone of the three sectors of the national fleet and the Spanish industrial fleet was used in the model. As an abundance index, the Working Group used two different abundance indices series, the CPUEs from the ocean-going Moroccan cephalopod fishery and those of the trawl surveys between Cape Bojador and Lagouira.

As the data series did not provide a good fit to the model because of an irregularity in the series due to changes in the way the octopus stock is exploited, several attempts were made using annual and monthly catches. It was however decided to only consider the data series from 2001 onwards as this was estimated to be relatively homogeneous. It also coincided with the application of the management plan in this fishery. The trawl survey indices were kept as they cover the whole distribution zone.

Results
The model provides a satisfactory fit to the data (Figure 5.3.4a). Current biomass is half the target biomass $B_{0.1}$ (Table 5.3.4a) and effort in the last year is above that producing the $B_{0.1}$ biomass.

Discussion
The results show that the Dakhla octopus stock is overexploited. This situation is confirmed by the last survey results carried out by the research vessel in which the relative biomass fell due to the way the stock is exploited which does not allow it to build up again.

Cape Blanc stock
Data
The total catch data series from 1990 to 2006 is very heterogeneous from a catch and, above all, quality point of view. From 1990 to1995 catches were relatively high compared to 1996–2006. For the analysis, the series from 1996 to 2006 was used as the pattern of exploitation is relatively stable.

Overall catch includes data from the industrial and artisanal fisheries. The CPUEs for the model were those of the Mauritanian freezer trawlers (and those of the Spanish cephalopod trawlers).

Results
The model provides a very good fit (Figure 5.3.4b). Current biomass is half the target biomass $B_{0.1}$ and effort in the last year is above that which would produce the $B_{0.1}$ biomass (Table 5.3.4a).

Discussion
The Cape Blanc stock is overexploited. The results are analogous with those from previous assessments (CECAF 2004 and IMROP 2006 working groups). This situation is confirmed by the decrease in abundance indices and the average sizes of the octopus caught during the surveys.

Senegal–the Gambia stock
Data
Data on total annual landings by all fleets exploiting the stock between 1990 and 2006 were used for the analysis. Some changes were introduced compared to previous assessments by the Working Group. These apply mainly to landings by the Senegalese fleets which were revised in line with the new CRODT database. The changes are very slight and do not affect the trend in catch. The large catch and CPUE values observed in 1999 were considered in the analysis as external information suggests that these are a characteristic of the resource and not a mistake in the sampling. The CPUEs of the Senegalese industrial fleet targeting cephalopods were used as abundance indices to fit the model. This differs from the last assessment carried out in 2004 when the CPUEs of the Spanish freezer trawlers were considered to be the most representative of stock abundance. The Working Group took into consideration the disappearance of the Spanish fleet from the zone in 2005 due to the end of the Senegal–EU fishing agreement, and consequently, the lack of an abundance index for 2006. Given the necessity of having a continuous abundance indices series for future assessments, the Working Group adopted the CPUEs of the Senegalese industrial fleet as the most representative of stock abundance.

Results
The fit of the model was judged to be acceptable (Figure 5.3.4c). Current biomass is far lower than the target biomass $B_{0.1}$ and effort in the last year is above that with would produce the $B_{0.1}$ biomass (Table 5.3.4a).

Discussion
The assessment results are given in Table 5.3.4a. These diagnostics show that the stock is overexploited both in terms of biomass and fishing mortality. Nevertheless, fishing mortality in the last year is below that necessary to maintain the stock at its current level (F_{cur}/F_{SYcur} is below 100%). It should be pointed out that keeping effort at its 2006 level would not be sufficient to return the stock to the reference target biomass level $B_{0.1}$.

Table 5.3.4a: Indicators on the state of the stock and the fishery of *Octopus vulgaris*

Stock/abundance index	F_{cur}/F_{SYcur}	$B_{cur}/B_{0.1}$	$F_{cur}/F_{0.1}$	B_{cur}/B_{MSY}	F_{cur}/F_{MSY}
Dakhla Stock/surveys	90%	50%	147%	55%	132%
Cape Blanc Stock/CPUE Mauritanian cephalopod freezer trawlers	90%	51%	143%	56%	129%
Senegal–Gambia/Senegalese industrial fleet	75%	25%	144%	28%	130%

F_{cur}/F_{SYcur}: Ratio between the observed fishing mortality coefficient during the last year of the series and the coefficient that would give a sustainable yield at current biomass levels.
$B_{cur}/B_{0.1}$: Ratio between the estimated biomass for the last year and the biomass corresponding to $F_{0.1.}$
$F_{cur}/F_{0.1}$: Ratio between the observed fishing mortality coefficient during the last year of the series and $F_{0.1.}$
B_{cur}/B_{MSY}: Ratio between the estimated biomass for the last year and the biomass coefficient corresponding to F_{MSY}.
F_{cur}/F_{MSY}: Ratio between the observed fishing mortality coefficient during the last year of the series and the coefficient giving maximum long term sustainable yield.

5.3.5 Management recommendations

The assessment indicates that the octopus stock in the subregion is overexploited. Consequently, the Working Group recommends that fishing effort be reduced in all fleets targeting the octopus stock in the region.

It is also recommended to reinforce the control of the management measures.

5.4 Cuttlefish (*Sepia* spp.)

5.4.1 Biological characteristics

New data on the biology of this species were presented to the Working Group. They covered *Sepia officinalis* length at first sexual maturity and growth parameters of the Dakhla and Cape Blanc stocks (Table 5.4.3d).

5.4.2 Stock identity

During the 2003 meeting, the Working Group adopted the three following administrative stocks:

Dakhla stock (26 °N–21 °N)
Cape Blanc stock (21 °N–16 °N)
Senegal–the Gambia stock (16 °N–12 °N)

As there was no new information on stock structure, the Working Group did not further discuss the definitions of these stocks and used them as they are.

5.4.3 Data trends

Catch

After a small drop at the beginning of the period, there appears to be an overall increasing trend in catch from 25 000 tonnes in 1993 to 40 000 tonnes in 2000. A decreasing trend follows until 2004 (15 800 tonnes) then a slight increase in 2005. The largest quantities landed are by the Moroccan fleets totalling between 35 and 78 percent of all recorded catch in the subregion. In this country, the Moroccan trawlers carry out almost all cuttlefish catch, between 11 000 and 15 000 tonnes (Table and Figure 5.4.3a).

In Mauritania, the Mauritanian freezer trawlers catch the largest quantities of this species group. In the Senegal–the Gambia zone, the Senegalese industrial fishery records the highest catches.

An overall decreasing trend should be noted from the beginning of the period in Mauritania and Senegal–the Gambia. This trend begins later in Morocco, after 2000.

Total cuttlefish catch of the Senegal–the Gambia stock has seen a decreasing trend since the maximum value of 13 744 tonnes in 1991. Other secondary maxima can be seen in the series in 1997 (7 438 tonnes) and in 2003 (5 776 tonnes). Catch over the last four years has been around 5 000 tonnes annually (Table 5.4.3a).

Most of the catch is carried out by the Senegalese industrial fleet, followed by the Gambian one then by the Senegalese artisanal fleet which overtook Gambian trawler production in 2002 (Table and Figure 5.4.3a). Landings by the Gambian artisanal vessels have gradually increased over the years and amounted to more than 25 percent of total catch in 2006. Catch of the Spanish trawlers isnegligible and never exceeds five percent of total catch. This fleet left the fishery in 2005 with the end of the fishing agreement between Senegal and the European Union.

Effort

Fishing effort on this species comes under the total effort aimed at cephalopods and is described under the effort aimed at octopus in the Table 5.3.3b. A particular and “temporary” effort towards cuttlefish

and squid was observed in Morocco. This is from artisanal boats and other coastal vessels (longliners and trawlers) (Table 5.4.3b).

Abundance indices

CPUE

In Morocco, cuttlefish are caught by coastal and ocean-going freezer trawlers as well as boats fishing octopus. They are also found in longliner catches and in catches in boats whose effort is aimed at demersal fish (Table 5.4.3c). The CPUEs of the freezer trawlers are relatively stable from 1990 to 1998 when they increase, reaching a maximum in 2000 and 2001. They then decrease till 2003 when they increase again over the next three years (Figure 5.4.3b).

In Mauritania, the CPUEs from the Spanish trawlers were high at the beginning of activity in 1996 with 1 200 kg/fishing day, they then decreased in 1997. Their CPUEs then follow the trend of the other fleets whilst still maintaining a higher level of fishery. This can be explained by a greater targeting. For the other fleets, the CPUEs fluctuate greatly and show a general decreasing trend from 1990 onwards (Table 5.4.3c and Figure 5.4.3b).

Cuttlefish CPUEs in the Senegal–the Gambia stock fluctuate greatly with an overall decreasing trend and low yield for all fleets in 1992 (Table 5.4.3c and Figure 5.4.3b). The highest values are those of the Spanish trawlers which show that this fleet targets cuttlefish rather than octopus. Yields have decreased from a maximum of 722 kg/fishing day in 1993 to a minimum of just 22 kg/fishing day in 2005 when the fleet left the fishery with the expiry of the fishing agreement. These yields are followed in decreasing order by the Gambian industrial vessels and the Senegalese artisanal fishery. The Senegalese industrial trawlers CPUEs are negligible over the whole period probably due to their specializing in octopus and demersal fishes.

Scientific surveys

The cuttlefish abundance indices for the Dakhla stock recorded during the INRH research surveys show a general decreasing trend from 2001 to 2006. The abundance indices vary between 2 kg/30 minutes and 1 kg/30 minutes between 2002 and 2005 (Figure 5.4.3c).

In Cape Blanc, cuttlefish stocks appear to be in a worse state. Following several fluctuations, the survey yields show a strong drop from 2003. In 2007, they were close to 0 kg/30 minutes (Figure 5.4.3c). The Figure 5.4.3d shows the average length of the Dakhla stock.

No new cuttlefish abundance index from the scientific surveys of the Senegal–the Gambia stock was presented to the Working Group.

Biological data

Length distribution and other information

New information on average length, length at first sexual maturity, growth parameters, sex-ratio and the length-weight relationship of cuttlefish stocks in the subregion are shown in Table 5.4.3d.

5.4.4 Assessment

Methods

The Schaefer dynamic production model implemented in an Excel spreadsheet was used to assess the state of the cuttlefish (*Sepia* spp.) stocks in the subregion. The model is described in Appendix 2.

Dakhla Stock

Data

As for octopus, and for the same reasons, the Working Group used the 2001–2006 data.

The data series of total cuttlefish catch in the zone between 20°50’ N and 26 °N was used in the model and two series were used as abundance indices, the CPUE series of the Moroccan freezer cephalopod trawlers and the trawl survey abundance indices.

Results
The model gives a satisfactory fit to series of trawl survey abundance indices (Figure 5.4.4a).

Current biomass is greatly below the target biomass $B_{0.1}$. Fishing effort in the last year is far greater than that which would produce the $B_{0.1}$ biomass (Table 5.4.4a).

Discussion
The Dakhla *Sepia* spp. stock is overexploited. The trawl survey abundance indices show a decreasing trend. It is therefore necessary to reduce fishing mortality on this species to allow a sustained natural production of the stock.

Cape Blanc stock
Data
The total catch series estimated by the Working Group for the region between 21 ºN and 16 °N for 1990–2006 was used in the model as the total catch series of the Cape Blanc *Sepia* spp. stock. As an abundance index series the Working Group used the CPUE series of the Mauritanian cephalopod freezer trawlers.

Results
The model fits the data poorly and the results were judged to be unreliable.

Discussion
Given the CPUEs of the Mauritanian trawlers and the abundance indices from the scientific surveys which have collapsed, the Working Group estimates that the 2004 expert opinion indicating that the stock is overexploited is still valid.

Senegal–the Gambia stock
Data
Total annual landing data of all fleets exploiting the Senegal–the Gambia cuttlefish stock from 1993 to 2006 were used for the analysis. Some changes were introduced on previous assessments. These concerned mainly the landing data of the Senegalese fleet which were revised in the new CRODT database. Total catch for 2005 was removed from the analysis as the CPUE value was not considered credible. The CPUE series of the Spanish freezer trawlers was used as an abundance index to fit the model. The doubts expressed by the 2004 Working Group (FAO, 2006) on the reliability of this series were resolved after investigation into the targeting of cuttlefish by this fleet (see Section 5.4.3 of this report: Abundance indices and CPUE).

Results
The fit of the model was judged to be acceptable (Figure 5.4.4b). Current biomass is well below the target biomass $B_{0.1}$ and fishing effort in the last year is above that which would produce the $B_{0.1}$ biomass (Table 5.4.4a).

Discussion
The assessment results are relatively reliable. They clearly show that the stock is overexploited both in biomass and fishing mortality terms. This agrees with other indicators on the fishery which show that the stock is in bad condition and that it could degrade further if the current level of exploitation is maintained.

Table 5.4.4a: Indicators on the state of the stock and the fishery of *Sepia* spp.

Stock/abundance index	F_{cur}/F_{SYcur}	$B_{cur}/B_{0.1}$	$F_{cur}/F_{0.1}$	B_{cur}/B_{MSY}	F_{cur}/F_{MSY}
Sepia spp. (Dakhla stock)/ Moroccan surveys	273%	13%	563%	15%	507%
Sepia spp. Senegal–the Gambia/Spanish trawlers	157%	31%	289%	34%	260%

F_{cur}/F_{SYcur}: Ratio between the observed fishing mortality coefficient during the last year of the series and the coefficient that would give a sustainable yield at current biomass levels.
$B_{cur}/B_{0.1}$: Ratio between the estimated biomass for the last year and the biomass corresponding to $F_{0.1.}$
$F_{cur}/F_{0.1}$: Ratio between the observed fishing mortality coefficient during the last year of the series and $F_{0.1.}$
B_{cur}/B_{MSY}: Ratio between the estimated biomass for the last year and the biomass coefficient corresponding to F_{MSY}.
F_{cur}/F_{MSY}: Ratio between the observed fishing mortality coefficient during the last year of the series and the coefficient giving maximum long term sustainable yield.

5.4.5 Management recommendations

The cuttlefish stocks in the region (Cape Blanc, Dakhla, Senegal and the Gambia) show a greatly reduced biomass and a fishing pressure which is far greater than the production capacity of the stock. In most of the fisheries cuttlefish is both a target species and a bycatch of the octopus fishery. For this reason, any recommendation covering cuttlefish should also take into account eventual effects on the octopus stock. The Working Group therefore made the following recommendations:

- For the Dakhla, Cape Blanc and Senegal– the Gambia stocks, fishing effort should be reduced.
- Cuttlefish catches in the Dakhla stock by the cephalopod fishery should be followed to ensure that effort is not directed away from octopus towards cuttlefish.

5.5 Squid (*Loligo vulgaris*)

5.5.1 Biological characteristic

No new data on the biology of this species was presented to the Working Group.

5.5.2 Stock identity

No information is available on the identity of any squid stocks in the subregion. This species, which is distributed as far as Mauritania, is very rare in the catches of Senegal and the Gambia.

5.5.3 Data trends

Catch

In Morocco, squid catches landed by the ocean-going sector have seen large fluctuations from one year to the next. The maximum catch was recorded in 2000 with 13 730 tonnes. The lowest level was reached in 2004 with 122 tonnes. Catches by coastal vessels (trawlers and longliners) are also characterized by considerable variations from one year to the next. Of these vessels, it is the coastal trawlers that land large quantities of squid (Table and Figure 5.5.3a).

In Mauritania (Table and Figure 5.5.3a), total annual catch rose progressively from 1990 (1 100 tonnes) to 1999, the year in which it reached a maximum of 5 000 tonnes. The largest catches were at the beginning of the series by the Mauritanian cephalopod freezer trawlers. These were replaced by the Spanish cephalopod trawlers from 1999. The total catches after this year show a decreasing trend.

Catches for Senegal and the Gambia are given in Table and Figure 5.5.3a. Total catches of all the fleets combined remained stable, around 30 tonnes per year, until 1998. After this year they began to increase rapidly to reach a maximum value of 234 tonnes in 2002. They then fell in 2004 before increasing again in 2005 and falling in 2006 to a value of 133 tonnes. The artisanal fleets catch squid in this zone, particularly that of Senegal. Of the industrial vessels, only the Spanish trawlers reported catches in some years. These catches vary between one and five tonnes.

Effort
As with cuttlefish, no effort is aimed at squid so effort aimed at octopus or certain high value demersal fish has to be considered. Consequently, trends in effort are those already described for the octopus fishery (Table 5.4.3b).

Abundance indices
CPUE
Before 2001, average squid yields by the Moroccan freezer trawlers reached more than 100 kg/day. From 2002 they saw a heavy decline to around 40 kg/fishing day. The coastal and artisanal vessel yields are very low in comparison. Year 2005 is the year in which squid yields are marked by an improvement in all three sectors (Table 5.5.3b).

In the Mauritanian zone, average squid yields vary between 3 and 246 kg/fishing day for all the fleets (Table and Figure 5.5.3b). The particular trends of each are fairly fluctuating with a period of high CPUE for all fleets between 1997 and 2002 followed by a general decrease until the last year of the series. The highest performing fleet in terms of yield is the Mauritanian freezer trawler fleet which was replaced by the Spanish trawlers after their entry into the fishery in 1995.

As for Senegal and the Gambia (Table and Figure 5.5.3b), the CPUEs are much lower and more fluctuating than in the two previous zones. They indicate the growing shortage of the species towards more southerly latitudes. The highest CPUE can be seen in the Spanish trawler and Senegalese artisanal fleets with maximum values of 10 tonnes per fishing day in 1995 and 6 kg per trip in 2002 respectively.

Scientific surveys
The largest abundance indices from the trawl surveys carried out in Dakhla were registered in February 2000 and March 2001 with 11 kg/30 minutes and 10 kg/30 minutes respectively. From September 2001, the yields have decreased varying between 1 kg/30 minutes and 3 kg/30 minutes, except for November 2005 when they reached 6 kg/30 minutes (Figure 5.5.3c).

No information on squid abundance indices estimated during the scientific surveys of Mauritania, Senegal and the Gambia was presented to the Working Group.

Biological data
Length distribution and other information
Information on average length, length at first sexual maturity and squid growth parameters for the Dakhla stock are shown in Figure 5.5.3d and Table 5.5.3c.

5.5.4 Assessment
Methods
The Schaefer dynamic production model implemented in an Excel spreadsheet was used to assess the state of the squid (*Loligo vulgaris*) stocks in the subregion. The model is described in Appendix 2.

Dakhla stock
Data
The series of total catch of squid in the zone between 20°50’ N and 26 °N was used in the model. Two abundance indices series were used, the CPUE series of the Moroccan cephalopod freezer trawlers and the abundance indices from the trawl surveys.

Results
The Schaefer model fits the data poorly and the results were judged to be unreliable.
Discussion
Based on the CPUEs of the freezer trawlers and the abundance indices from the surveys which are decreasing, the Working Group estimates that the stock is overexploited.

Cape Blanc and Senegal–the Gambia stocks
During the Working Group, no assessment could be carried out on these squid stocks.

5.5.5 Management recommendations
Squid stocks in the region show a decline in the CPUEs of the freezer trawlers and the abundance indices due to the heavy pressure exerted on the stock. At the same time, squid is basically, for most of the fisheries, a bycatch of the fleets targeting octopus. For this reason, any recommendation for squid has to take into account the eventual effect on the octopus stock. The Working Group therefore recommends a reduction in effort in the subregion.

5.6 Future research

The Working group recommends the following research criteria:

- Prepare seasonal or preferably monthly data on catch, effort and abundance indices for the next Working Group meeting.
- Continue studies into the octopus stock units and extend this study to other cephalopod species (cuttlefish and squid).
- Continue the biological studies of cuttlefish and squid.
- Analyse the environmental data to better work out the fluctuations in stock abundance.
- Try more suitable models for these short-lived species.

6. CONCLUSIONS

A summary sheet with assessment results and recommendations is presented in Table 6.1. The results of the assessments confirm the conclusion reached at the last meeting in 2004 that most of the stocks assessed are overexploited.

The white grouper (*Epinephelus aeneus*) stock in the Gambia, Mauritania and Senegal, is in danger of extinction. The severe situation for the white grouper was also observed in 2004 and the recommendation made by the Working Group to close the fishery to the fleets targeting this species was not taken into consideration.

Thirteen stocks were found to be overexploited, the octopus (*Octopus vulgaris*), the cuttlefish (*Sepia* spp.) in Senegal–the Gambia and Dakhla, the Moroccan deep-water shrimps (*Parapenaeus longirostris*), Senegal–the Gambia shallow water shrimps (*Penaeus notialis*), the white hake (*Merluccius merluccius*), the black hake (*M. polli* and *M. senegalensis*), *Pagellus bellotti* in Mauritania, Senegal–the Gambia, *Pagellus acarne* in Morocco and *Pagrus caeruleostictus* in Mauritania and Senegal. All these species were assessed in the 2004 Working Group and at that time some of them were considered fully exploited or even moderately exploited (i.e. black hake in Senegal–the Gambia). The Working Group reiterates the recommendation of reducing effort in order to reverse this serious situation.

Three stocks were found to be fully exploited, *Parapenaeus longirostris* (Mauritania), *Penaeus notialis* (Mauritania) and *Pseudotolithus* spp. (Senegal–the Gambia).

For seven of the species/species groups assessed no conclusive results were obtained from the models with the data available. This included six fish groups, *Pagellus* sp. (Morocco), *Dentex macrophtalmus* (Morocco, Mauritania, Senegal), *Sparus* sp. (Morocco), *Arius* sp. (Senegal and the Gambia) and the Senegal–the Gambia stock of deep-water shrimp (*Parapeneus longirostris*). Although the model did not provide reliable results for these species/species groups, other information from the fishery and scientific surveys indicate that most of them are overexploited.

All of the stocks analysed are either overexploited or at risk of being overexploited. It is therefore necessary to ensure that current restrictions imposed on these fisheries are adhered to, and measures should be taken to avoid further depletion.

For the next meeting, the Working Group should discuss how to formulate advice for fish stock management in terms of catch levels as well as effort. It may be difficult to manage catch levels if a system of fleet or vessel quotas is not in place. However, in such a case, catch levels can also be managed by adjusting effort accordingly. The members of the Group should discuss with managers of their countries their expectations in relation to management advice from scientists, and working papers should be presented at the next meeting.

As in the previous meeting the Working Group has restricted its assessments to production models, except for the white hake and some fish species for which length based models were also applied. Production models do not take into account variations in exploitation pattern. In this year's meeting simple medium-term projections of future yields and stock level development were made according to predefined scenarios using the Schaefer model fitted to the historical data, but time constraints did not allow a deep discussion of the results, and hence the results are not presented in this report. The Working Group should discuss the use of these projections in the assessment and advice process.

Although the amount of catch, effort and biological data available to the Working Group has increased in recent years, some deficiencies persist. The main deficiency remains reliable catch data for most of the demersal finfish stocks. Catch and effort data, and also biological sampling data, were sometimes incomplete for the last year (2006). This should be improved in future Working Groups.

7. RECOMMENDATIONS

Specific recommendations for each species group are given in their respective chapters.

1. Prepare all the databases necessary for the assessment so that they can be sent to all participants at least one month before the start of the Working Groups.

2. Devote one more day in future Working Groups to the presentation of new assessment models specific to demersals and to management recommendations.

3. Make managers aware of the worrying state of demersal stocks in their countries so that they apply the CECAF/COPACE Working Groups recommendations.

4. Improve the system of data collection so the species and catch origin can be identified better.

5. Study the effects of environmental factors on demersal species' abundance.

6. Carry out regular national and regional scientific surveys to obtain more reliable abundance indices for each stock.

7. Organize urgent regional seminars covering different subjects between the members of the Working Group (shared stocks, environmental effects, etc.).