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Report of the

**FAO WORKING GROUP ON THE ASSESSMENT OF SMALL PELAGIC
FISH OFF NORTHWEST AFRICA**

Banjul, the Gambia, 18-22 May 2010

Rapport du

**GROUPE DE TRAVAIL DE LA FAO SUR L'ÉVALUATION DES PETITS
PÉLAGIQUES AU LARGE DE L'AFRIQUE NORD-OCCIDENTALE**

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PREPARATION OF THIS DOCUMENT

A permanent FAO Working Group composed of scientists from the coastal States, and from countries or organizations that play an active role in northwest African pelagic fisheries, was established in March 2001.

The overall objective of the Working Group is to assess the state of the small pelagic resources in northwest Africa and make recommendations on fisheries management and exploitation options aimed at ensuring optimal and sustainable use of small pelagic fish resources for the benefit of coastal countries.

The tenth meeting of the FAO Working Group on the Assessment of Small Pelagic Fish off Northwest Africa was held in Banjul, the Gambia, from 18 to 22 May 2010.

A first editing of the report was made by the participants of the Working Group. Final technical editing was done by Ana Maria Caramelo and Merete Tandstad. We are grateful to Ad Corten, Marie-Thérèse Magnan and Sacha Lomnitz for their assistance in the final editing of this document.

PRÉPARATION DE CE DOCUMENT

Un Groupe de travail permanent de la FAO, composé de scientifiques des États côtiers et des pays ou organisations qui jouent un rôle actif dans les pêcheries pélagiques de l'Afrique nord-occidentale, a été créé en mars 2001.

L'objectif général du Groupe de travail est d'évaluer les ressources en petits pélagiques de l'Afrique nord-occidentale et de recommander des options de gestion et d'exploitation des pêches visant à assurer une utilisation optimale durable de ces ressources pour le bénéfice des pays côtiers.

La dixième réunion du Groupe de travail de la FAO sur l'évaluation des petits pélagiques au large de l'Afrique nord-occidentale s'est réunie à Banjul, Gambie, du 18 au 22 mai 2010.

Une première édition du rapport a été faite par les participants au Groupe de travail. L'édition technique finale a été faite par Ana Maria Caramelo et Merete Tandstad. Nous remercions Ad Corten, Marie-Thérèse Magnan et Sacha Lomnitz pour l'assistance apportée à l'édition finale de ce document.

FAO.

Report of the FAO Working Group on the Assessment of Small Pelagic Fish off Northwest Africa. Banjul, the Gambia, 18–22 May 2010.

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ABSTRACT

The tenth meeting of the FAO Working Group on the Assessment of Small Pelagic Fish off Northwest Africa was held in Banjul, the Gambia, from 18 to 22 May 2010. The Group assessed the status of the small pelagic resources in northwest Africa and made projections on the development of the status of the stocks and on future effort and catch levels. The advice for the stocks is given in relation to the agreed reference points $F_{0.1}$, F_{MSY} , $B_{0.1}$ and B_{MSY} and on the basis of the projections for the next five years.

The structure of the report is the same as that of the previous Working Group reports. A separate section is devoted to each of the main groups of species (sardine, sardinella, horse mackerel, chub mackerel, bonga and anchovy). For each of these, standardized information is given on stock identity, fisheries, abundance indices, sampling intensity, biological data, assessment, projections, management recommendations and future research.

In the absence of reliable age compositions, the Working Group used dynamic production models for all stocks. Most stocks in the area are influenced by abnormal hydrographical conditions in certain years. An index of environmental quality has, therefore, been introduced in the production models since 2005. It should be noted that, for most of the stocks, the time series from the acoustic surveys with the R/V DR. FRIDTJOF NANSEN and national research vessels are used as the index of abundance in the assessments and future assessments would, therefore, depend on the continuation of the time series by the local research vessels. The Norwegian research vessel, DR. FRIDTJOF NANSEN, surveyed the subregion from 1995 to 2006, carrying out acoustic surveys during the months October–December each year. From 2004 to 2006 intercalibrations and parallel surveys were carried out between R/V DR. FRIDTJOF NANSEN and the national research vessels AL AMIR, AL AWAM and ITAF DEME, and in 2007 and 2008 these national research vessels carried out a coordinated regional survey during the months of October–December. It should be noted that during the 2008 survey, the Gambia was not covered. The 2009 survey, hence, only provides a partial coverage of the region and estimates had to be made for Senegal and the Gambia. The Nansen series continues with a converted value from the national research vessels to the “Nansen Value”.

Although important changes were observed in the abundance and exploitation level for some of the stocks, the overall general situation with respect to the state of the different stocks was found to be similar to that of 2009, with the exception of the Atlantic horse mackerel (*Trachurus trachurus*), which this year was considered overexploited. The Cunene horse mackerel (*Trachurus trecae*) remains overexploited and the Small Pelagic Working Group recommends a decrease in catch and effort on the horse mackerels to ensure sustainable harvesting of this stock.

The catches of round sardinella (*Sardinella aurita*) are high for the last three years, probably associated with a very good recruitment of year class 2005. The estimated abundance index for 2009 was also high. However, given the uncertainties associated with last year's abundance indices, the lack of evidence of another good year class since 2005 and the high observed catches in recent years which exceed what the stock can sustain in the long run, the Working Group continues to be concerned about this stock and still considers it as overexploited. The Working Group reiterates its recommendation to reduce effort on this species and to respect the previously recommended catch levels.

The situation for the sardine stock in Zone A+B seems to have improved since 2006 and this stock is now considered fully exploited. However, as a precautionary measure, and taking into consideration the fluctuations observed in this stock, the Working Group maintains the 2008 and 2009 recommendations that catches should not exceed 400 000 tonnes.

Chub mackerel (*Scomber japonicus*), anchovy (*Engraulis encrasicolus*) and bonga (*Ethmalosa fimbriata*) were also found to be fully exploited. For the two latter species the Working Group noted that although the information available to the Group has improved, some deficiencies still remain.

As for the previous assessment, sardine (*Sardina pilchardus*) in Zone C was found not to be fully exploited. The estimated biomass index from the regional survey (Nansen index) decreased somewhat in 2009 as compared with 2008. Given the fluctuations observed in the abundance of this stock, care should be taken in its management. In 2007 and 2008, the national research vessels took over the responsibility of the November–December acoustic survey from the R/V DR. FRIDTJOF NANSEN. Many of the assessments made by the Working Group depend on this time series and hence the Working Group reiterates last year's recommendation that a thorough analysis of the properties and reliability of this data series should be carried out according to an agreed terms of reference. It also recommends continuing work on age reading of sardine and sardinella to improve the models of stock assessment.

RÉSUMÉ

La dixième réunion du Groupe de travail de la FAO sur l'évaluation des petits pélagiques au large de l'Afrique nord-occidentale s'est tenue à Banjul, la Gambie du 18 au 22 mai 2010. Le Groupe a examiné l'état actuel des ressources de petits pélagiques en Afrique nord-occidentale et fait des projections sur le développement ainsi que sur les niveaux futurs d'effort et de capture. Des conseils concernant l'état des stocks sont donnés par rapport aux points de référence convenus, $F_{0.1}$, F_{MSY} , $B_{0.1}$ et B_{MSY} et sur la base des projections pour les cinq prochaines années.

La structure du rapport est la même que celle des rapports précédents du Groupe de travail. Une section est consacrée à chacune des catégories principales d'espèces (sardine, sardinelles, chinchards, maquereau, ethmalose et anchois). Pour chacune d'elles, des informations standardisées sont données sur l'identité du stock, les pêcheries, les indices d'abondance, l'intensité de l'échantillonnage, les données biologiques, l'évaluation, les projections, les recommandations d'aménagement et la recherche future.

En l'absence de compositions par âge fiables, le Groupe de travail a utilisé des modèles de production dynamiques pour tous les stocks. La plupart des stocks dans la région sont influencés par les conditions hydrographiques anormales certaines années. Un indice de qualité de l'environnement a donc été introduit dans les modèles de production après 2005. Il faut cependant noter que les séries chronologiques des campagnes acoustiques avec le N/R DR. FRIDTJOF NANSEN et les navires de recherche nationaux sont utilisées comme indice d'abondance dans les évaluations pour la plupart des stocks. Les futures évaluations dépendent donc de la poursuite de la série chronologique par les bateaux de recherche locaux. Le navire de recherche norvégien, DR. FRIDTJOF NANSEN, a prospecté la sous-région de 1995 à 2006 en menant chaque année des campagnes acoustiques d'octobre à décembre. De 2004 à 2006, des intercalibrations et des campagnes parallèles ont été effectuées par le N/R DR. FRIDTJOF NANSEN et les N/R nationaux AL AMIR, AL AWAM et ITAF DEME et, en 2007 et en 2008, ces navires de recherche nationaux ont organisé une campagne régionale coordonnée d'octobre à décembre. Il faut souligner que la Gambie n'a pas été couverte pendant la campagne 2008. Celle de 2009 n'a fourni qu'une couverture partielle de la région et des estimations doivent être faites pour le Sénégal et la Gambie. Les séries Nansen continuent avec une valeur convertie des navires de recherche nationaux en «valeur Nansen».

Même si on a pu observer d'importants changements dans les niveaux d'abondance et d'exploitation de certains stocks, la situation générale a été jugée dans l'ensemble identique à celle de l'an passé, exception faite pour le stock du chinchard d'Europe (*Trachurus trachurus*) qui a été considéré surexploité cette année (2010). Le chinchard du Cunène (*Trachurus trecae*) demeure surexploité et le Groupe de travail sur les petits pélagiques recommande de réduire les captures et l'effort sur les chinchards de façon à garantir une pêche durable de ces stocks.

Les captures de sardinelle ronde (*Sardinella aurita*) sont élevées ces trois dernières années, probablement en raison d'un bon recrutement en 2005. L'indice d'abondance estimé en 2009 est également élevé. Cependant, en raison des incertitudes au sujet des indices d'abondance de la dernière année, de l'absence de preuves d'une autre bonne classe d'âge depuis 2005 et des captures élevées des dernières années qui dépassent ce que le stock peut soutenir sur le long terme, le Groupe de travail continue d'être préoccupé par ce stock dans la région et le considère toujours comme surexploité. Il réitère ses recommandations en matière de réduction de l'effort sur cette espèce et de respect des niveaux de capture recommandés.

Comme dans l'évaluation précédente, la sardine (*Sardina pilchardus*) est considérée comme n'étant pas pleinement exploitée dans la Zone C. L'indice de biomasse estimé pendant la campagne régionale (indice Nansen) a baissé en 2009 par rapport à 2008. En raison des fluctuations observées dans l'abondance de ce stock, son aménagement doit être géré avec soin. La situation du stock de sardine dans la zone A+B semble s'être améliorée depuis 2006 et ce stock est désormais considéré comme pleinement exploité. En guise de mesure de précaution et en prenant en compte les fluctuations observées dans ce stock, le Groupe de travail maintient cependant ses recommandations de 2008 et 2009 selon lesquelles les captures ne devraient pas dépasser 400 000 tonnes.

Le maquereau (*Scomber japonicus*), l'anchois (*Engraulis encrasicolus*) et l'ethmalose (*Ethmalosa fimbriata*) sont également considérés comme pleinement exploités et le Groupe de travail a remarqué que même si l'information disponible à leur sujet s'est améliorée, des manques perdurent.

En 2007 et 2008, les navires de recherche nationaux ont succédé au N/R DR. FRIDTJOF NANSEN pour la réalisation des prospections acoustiques en novembre-décembre. De nombreuses évaluations réalisées par le Groupe de travail dépendent de ces séries chronologiques et le Groupe de travail réitère la recommandation formulée l'an dernier, à savoir qu'une analyse minutieuse des propriétés et de la fiabilité de ces séries de données devrait être entreprise conformément aux termes de référence convenus. Il recommande aussi de poursuivre le travail de lecture d'âge de la sardine et de la sardinelle pour améliorer les modèles d'évaluation du stock.

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1. INTRODUCTION

The tenth meeting of the FAO Working Group on the Assessment of Small Pelagic Fish off Northwest Africa was held in Banjul, the Gambia, from 18 to 22 May 2010. The overall objective of the Working Group is to assess the state of the small pelagic resources in northwest Africa and make recommendations on fisheries management and exploitation options aimed at ensuring optimal and sustainable use of small pelagic fish resources for the benefit of coastal countries.

The species assessed by the Group were: sardine (*Sardina pilchardus*), sardinella (*Sardinella aurita* and *Sardinella maderensis*), horse mackerel (*Trachurus trecae*, *Trachurus trachurus* and *Caranx rhonchus*), chub mackerel (*Scomber japonicus*), bonga (*Ethmalosa fimbriata*) and anchovy (*Engraulis encrasicolus*), in the region between the southern border of Senegal and the northern Atlantic border of Morocco.

The meeting was funded by the countries of the region. It was organized by FAO and the Fisheries Department of the Gambia. Altogether, 14 scientists from seven countries and FAO participated. The chairman of the Group was Birane Samb from the Oceanographic Research Centre of Dakar-Thiaroye (CRODT).

1.1 Terms of reference

The terms of reference of the Working Group were:

Part 1: Weeks 3–16 May. Internet communication

Week 3–7 May

1. Updating of existing database – Updating the catch, fishing effort, sampling intensity and biological data by country databases as well as surveys.
2. Analyses of catch, fishing effort and biological data for the period 1990–2009 and, if possible, also for the period before 1990.

Week 10–16 May

3. Finalize section on fisheries and trends for the report (subsections 1 to 5 of species).
4. Discussions on constraints for the assessments.

Part 2: Week 18–22 May. Fisheries department, Banjul, the Gambia

5. Review of the research activities carried out during 2009/2010, as recommended by the Small Pelagics Working Group in 2009. Presentation of working papers.
6. Presentation of reports of the acoustic surveys carried out in October–December 2009 and from surveys carried out by the research vessels of other countries.
7. Presentation of the report of the Planning Group for the coordination of acoustic surveys.
8. Report on the progress made on age readings of sardine and sardinella in the region.
9. Review and discuss the analyses of catch, fishing effort and biological data updates and chapters finalized through communication. Discuss eventual issues.
10. Discussions on the methods for assessment, including eventual new methods and approaches.
11. Update stock assessments and projections for sardine, sardinella, horse mackerel, chub mackerel, bonga and anchovy.

1.2 Participants

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Pedro Pascual Alayon	IEO–Tenerife
Birane Samb (Chairperson)	FAO
Merete Tandstad	FAO
Nikolay Timoshenko	AtlantNIRO

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

1.3 Definition of working area

The working area for the Working Group is defined as the waters between the southern border of Senegal and the northern Atlantic border of Morocco.

1.4 Structure of the report

The structure of the report is the same as that of the previous Working Group report (FAO, 2009). A separate section is devoted to each of the main groups of species (sardine, sardinella, horse mackerel, chub mackerel, bonga and anchovy). For each of these, information is given on stock identity, the fisheries, abundance indices, sampling, biological data, assessment, projections, management recommendations and future research.

1.5 Follow-up on the 2009 Working Group recommendations on future research

For most recommendations, follow-up activities had been continued. More specifically, efforts were made to continue acoustic surveys and related activities such as coordination between countries and intercalibration. A coordinated regional survey using the local research vessels was carried out in October–December 2009, although this did not cover the Gambia and Senegal owing to the constraints with the research vessel of Senegal. A coordinated survey is also scheduled for October–December 2010 (see also Section 1.11). One acoustic and one recruitment survey for sardine, carangidae and mackerel were carried out by R/V ATLANTIDA in July–August 2009 and November 2009 to January 2010, respectively, covering the area from Safi in the north to Saint Louis in the south.

Given the need for continuation and the long-term commitments required for the achievement of the recommendations, the 2010 session of the Working Group recommended that the research areas that had been identified be pursued in 2010/2011.

Sampling intensity in the region remained at a similar level to 2009. The aim of covering all fleets' segments and quarters of the year has not yet been reached. The importance of preparing and sending the data to group focal points in advance of the session of the Working Group was stressed once more. In 2010, some improvements were noted and members from Mauritania, Morocco, the Russian Federation, Senegal and Spain had respected the recommendation made last year.

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

1.6 Overview of catches

Table 1.6.1 and Figure 1.6.1a show the catch of the main small pelagic species studied in this Working Group by country and total from 1990 to 2009.

There was an increase in the total catch of the main small pelagic fish in the subregion from around 2.3 million tonnes in 2008 to 2.4 million tonnes in 2009 (4 percent). The total catch of small pelagic fish for the period 1990 to 2008 fluctuated with an average of around 1.7 million tonnes. The overall trend in catch has been increasing since 1994 despite some fluctuations in 1999, 2002 and 2006 (Figure 1.6.1a).

Sardine (*Sardina pilchardus*) dominated the total catch of the main pelagic fish species in the subregion, constituting about 38 percent of the overall catch in 2009. An increase (20 percent) was observed from about 770 000 tonnes in 2008 to 920 000 tonnes in 2009 (Figure 1.6.1a).

Sardinella spp. constituted 26 percent of the total catch of small pelagic fish off northwest Africa in 2009, with 21 percent for round sardinella (*Sardinella aurita*) and 5 percent for flat sardinella (*Sardinella maderensis*). The round sardinella is the second most important in terms of catch. Over the last five years total catch of round sardinella (*Sardinella aurita*) has been fluctuating around an average level of about 475 000 tonnes (Figure 1.6.1a). The catch of flat sardinella (*Sardinella maderensis*) in 2009 was 113 000 tonnes. The average for the last five years for this species is 124 000 tonnes.

Cunene horse mackerel (*Trachurus trecae*) is the most important species of horse mackerel, constituting about 14 percent (approximately 347 000 tonnes) of the total catch of the main small pelagic fish in 2008. The average annual catch of the Cunene horse mackerel over the last five years was estimated at about 308 000 tonnes. The catch of this species fluctuates over the time series with an overall increasing trend in recent years. About 120 000 tonnes of Atlantic horse mackerel (*Trachurus trachurus*) were landed in 2009. This represents 5 percent of the main small pelagic fish in 2009. The average catch of Atlantic horse mackerel over the last five years was 107 000 tonnes. The third species in this group, the false scad (*Caranx rhonchus*), showed an increase in total catch from 2008 to 2009, with total catch of around 30 000 tonnes and 46 000 tonnes, respectively.

Catch of chub mackerel (*Scomber japonicus*) over the last five years has shown a general increasing trend, from around 180 000 tonnes in 2003 to an estimated 245 000 tonnes in 2009, the highest catch of the time series. The average catch for this period was estimated at around 231 000 tonnes.

The total catch of anchovy (*Engraulis encrasicolus*) in 2009 was around 122 000 tonnes, decreasing by about 5 percent compared with 2008 (Figure 1.6.1a). An average of around 116 000 tonnes of anchovy was recorded for the last five years.

Catch of bonga (*Ethmalosa fimbriata*) in 2009 constitutes around 1 percent of total catch of main small pelagic fish in the subregion. Total catch of bonga was 21 000 tonnes in 2009, being stable since 2008. An average of 24 000 tonnes of bonga was recorded over the last five years and the overall trend for this period is decreasing.

Morocco

Sardine (*S. pilchardus*) is the dominant small pelagic species constituting about 67 percent of the total catch of small pelagic fish catch in 2009. From 2001 to 2004 a gradual decline in catches of sardine from around 770 000 tonnes to about 640 000 tonnes can be observed, followed by an increase to 700 000 tonnes in 2005 then a decrease in 2006 (620 000 tonnes) and 2007 (570 000 tonnes) followed by an increase of about 19 percent in 2009 (Figure 1.6.1b). The average catches of sardine over the last five years (2005–2009) were about 678 000 tonnes.

The second most important species landed in Morocco in 2009 was the chub mackerel (*S. japonicus*) with total catches of about 194 000 tonnes constituting about 16 percent of small pelagic fish catch. The Atlantic horse mackerel (*T. trachurus*) and the Cunene horse mackerel (*T. trecae*) were the third most important species in 2009 constituting about 6 percent each of the main small pelagic fish caught, followed by the round sardinella (*S. aurita*) with about 4 percent. Catches of the round sardinella

(*S. aurita*) since the late 1990s have been fluctuating, with an increase in total catches of this species from 1 400 tonnes in 2004 to 43 000 tonnes in 2009.

The catch of anchovy (*E. encrasicolus*) increased from around 10 000 tonnes in 2006 to around 17 000 tonnes in 2009, constituting around 2 percent of total catches of main small pelagic fish caught.

Mauritania

Catches of all the main small pelagic fish in Mauritania have shown interannual fluctuations over the period from 1990 to 2009 with an overall increasing trend from 1994 until 2003, followed by a decrease until 2005 before increasing again until 2007, when the total catches of the main small pelagic fish were the highest of the time series (895 000 tonnes), decreasing about 2 percent in 2009 (Figure 1.6.1c).

Cunene horse mackerel (*T. trecae*) and round sardinella (*S. aurita*) dominated catches of the main small pelagic fish in Mauritania in 2009. The total catch of *S. aurita* in 2009 was around 151 000 tonnes (about 29 percent of total main small pelagic fish species in Mauritania), and the *T. trecae* catch was 293 000 tonnes (about 33 percent). For the round sardinella, it should be noted that the 2009 catch represents a 15 percent decrease of the 2008 catch.

Anchovy (*E. encrasicolus*), with about 95 000 tonnes in 2009, represents around 12 percent of the total main pelagic fish species in Mauritania with a decrease of 4 percent relative to 2008, followed by chub mackerel (*S. japonicus*) with about 46 000 tonnes (5 percent) (Figure 1.6.1c).

Senegal

Overall catches of the main small pelagic fish in Senegal show fluctuations from 1990 to 2009. The total catches of the main small pelagic fish in Senegal are dominated by the two sardinella species constituting, on average, about 93 percent of the total main small pelagics caught in Senegal in 2009. Catches of these species decreased from about 316 000 tonnes in 2005 to around 242 000 tonnes in 2006. The estimated total catch for 2009 was 345 000 tonnes and the average catch of *Sardinella* spp. for the last five years (2005–2009) was about 310 000 tonnes (Figure 1.6.1d). The high catch value for 2009 is influenced by the increase in catch by Senegalese fishermen in Mauritania, landing in Saint Louis.

Compared with the earlier years of the series, the catch of sardine (*S. pilchardus*) has become important since 2005 and represented 4 percent of the catch in 2007 (12 000 tonnes), but in 2009, however, the catch of sardine decreased 68 percent.

Catches of bonga (*E. fimbriata*) show a decreasing trend in recent years from 13 000 tonnes in 2003 to below 6 000 tonnes in 2006. In 2009, bonga contributed about 2 percent of total catches of small pelagic fish in Senegal with an estimated total catch of around 6 000 tonnes.

Horse mackerel and chub mackerel are taken as bycatch species in the Senegalese fisheries and hence low catches are recorded.

The Gambia

Bonga (*E. fimbriata*) is the main target species and dominates the catches of the main small pelagic fish in the Gambia. Bonga catch constituted around 58 percent of total catch of all the main small pelagic fish in the Gambia in 2009 (21 000 tonnes), decreasing about 1 percent in relation to 2008. Despite fluctuations in the catches of bonga, the trend shows a gradual increase over the period 1990 to 2003, with a peak in 1996 to 1998 and 2003. In 2004, catches decreased to around 16 000 tonnes, followed by an increase to 20 000 tonnes in 2005, before decreasing to around 13 000 tonnes in 2006 (Figure 1.6.1e). The average catch of bonga was around 24 000 tonnes over the last five years.

Until recently, catches of sardinella and other species of small pelagic fish in the Gambia were considered bycatch because there was no fishery targeting them. Artisanal purse seiners targeting

sardinellas are beginning to fish in Gambian waters and this has led to increased catches of the two sardinella species (*S. maderensis* and *S. aurita*), which together constituted about 38 percent of total catches of the main small pelagic fish in 2009 in the Gambia. The average catch of *Sardinella* spp. over the last five years was around 13 000 tonnes; *S. maderensis* was the most important constituting about 25 percent of total catch of the Gambia in 2009.

1.7 Overview of regional surveys

1.7.1 Acoustic surveys

The Norwegian research vessel DR. FRIDTJOF NANSEN surveyed the subregion from 1995 to 2006, carrying out acoustic surveys during the months of October–December each year. In addition, between 2001 and 2003, the vessel carried out acoustic surveys covering the same area in May–July. Occasional surveys were carried out before 1995. From 2004 to 2006, intercalibrations and parallel surveys were carried out between R/V DR. FRIDTJOF NANSEN and the national research vessels AL AMIR, AL AWAM and ITAF DEME, and in 2007 and 2008 these national research vessels carried out coordinated regional surveys during the months of October–December, noting that the 2008 survey did not cover the Gambia. In 2009, the coordinated regional survey was conducted without the participation of the Senegalese R/V ITAF DEME. The 2009 survey, hence, only provides a partial coverage of the region and estimates had to be made for Senegal and the Gambia. These estimates are further explained below.

The surveys aimed at mapping the distribution and estimating the abundance of the main small pelagic fish species: sardine (*Sardina pilchardus*), sardinella (*Sardinella aurita* and *Sardinella maderensis*), horse mackerel (*Trachurus trachurus* and *Trachurus trecae*), chub mackerel (*Scomber japonicus*) and anchovy (*Engraulis encrasicolus*). The distribution of other pelagic resources (other carangids) was also mapped and their abundance was estimated. The abundance estimates from the surveys are presented as numbers and biomass per length-group.

The 2007, 2008 and 2009 biomass estimates from the national vessels were converted into Nansen equivalents using the conversion factors in Table 1.7.1. The Working Group decided to use the conversion factors obtained from the last intercalibration exercise (2005 in the case of ITAF DEME and AL AWAM and 2006 in the case of AL AMIR) as these were considered the more reliable values. In the case of ITAF DEME, given that this vessel used a different method for the allocation of *Sardinella* spp. to species level during the parallel surveys, it was decided at the 2009 meeting of the Working Group to convert the sardinella biomass estimates using the conversion factor for *Sardinella* spp. The estimates for 2007 and 2008 for the two sardinella species were thus recalculated. In addition, an extrapolation had to be made to account for the Gambia in 2008. This factor was based on the average proportion of *Sardinella* spp. in the Gambia in the 2005 and 2007 surveys covering Senegambia (global factor).

For 2009, the biomass estimate of *Sardinella* spp. and *Trachurus trecae* in the Gambia and Senegal was estimated using a statistical analysis taking into account three variables:

- the estimated time series of biomass in the area to the north of Senegal (Saint Louis–Cape Cantin) between 1995 and 2009;
- time series of annual catch in Senegal and the Gambia; and
- an environmental factor in Senegal–the Gambia calculated annually for the same period; the environmental parameter used was an upwelling index prepared by the National Institute of Fisheries Research (INRH) scientists using satellite maps of sea surface temperature (SST).

A multiparameter linear model was then applied to different variables covering the period 1995–2008 to estimate the biomass in Senegal–the Gambia in 2009. The calculations are shown in Appendix III.

Figure 1.7.1a shows the estimated abundance for all the target species during the surveys in October–December, while Figure 1.7.1b shows the estimated abundance for the target species excluding sardine.

For *S. pilchardus*, an increase in the estimated biomass was observed over the years 1997–2005, from a level of around 1 million tonnes to a record high biomass of around 8 million tonnes in 2005. In 2006, the estimated biomass dropped to 3.6 million tonnes. Lesions were observed on the fish during the surveys in 2005 and 2006, particularly on the larger individuals. The 2007 estimate indicates an increase of biomass to 5.9 million tonnes followed by a decrease to 4.4 million tonnes in 2008; the 2009 biomass increased to 5 million tonnes.

For *S. aurita*, an overall general decreasing trend in the acoustic estimates from 2.1 million tonnes in 1999 to around 1 million tonnes in 2007 can be observed. However, in 2008, the estimated biomass increased to around 2 million tonnes and then again to 2.86 million tonnes in 2009, the highest values of the time series. For *S. maderensis*, the estimated biomass fluctuated with an average of 1.2 million tonnes for the period 1995 to 2002. Since then, an increase was observed until 2004, when a biomass of 2.5 million tonnes was recorded. The latter estimate is the highest on record. For 2005, the estimated biomass of *S. maderensis* decreased to 1.3 million tonnes followed by an increase in 2006 to 2.0 million tonnes. In 2007, the estimated biomass remained at the 2006 level, followed by a decrease to only 550 000 tonnes in 2008, the lowest value of the time series. It should be noted that in 2008 an inversion of the biomass level of the two sardinella species is observed. In 2009, the estimated biomass of *S. maderensis* increased to 1.67 million tonnes.

The abundances of the main horse mackerel species (*Trachurus trecae* and *T. trachurus*) have fluctuated over the time series. The Cunene horse mackerel (*T. trecae*) has been the dominating species in the acoustic estimates, and from 1996 to 1999 its abundance was estimated at between 600 000 to 800 000 tonnes. A peak was observed in 2000 with a value of 1.8 million tonnes. This peak was followed by a period of low biomass estimates for the period 2001 to 2003, with biomass as estimated by the acoustic survey in the range of 350 000 tonnes to 600 000 tonnes. Since then, the estimated biomass has been fluctuating with peaks of 1.2 million tonnes in 2005 and 990 000 tonnes in 2007. In 2008, the biomass of *T. trecae* decreased to around 700 000 tonnes, constituting a decrease of around 29 percent compared with 2007. In 2009, the biomass estimate for *T. trecae* increased to 867 000 tonnes. The estimated biomass of the other main horse mackerel species, *T. trachurus*, showed an increasing trend from 2001 to 2003, when it was estimated at 320 000 tonnes. Since then, the biomass of *T. trachurus* decreased to 40 000 tonnes in 2006, the lowest biomass estimate since the start of the data series. In 2007 the estimated biomass of this species increased to 450 000 tonnes, followed by a decrease to 330 000 tonnes in 2008 and a further decrease to 130 000 tonnes in 2009.

The estimated biomass of chub mackerel (*Scomber japonicus*) has also shown fluctuations over the time series. From 2000 to 2003 an increasing trend was observed, from the rather low level of 100 000 tonnes in 2000 to 550 000 tonnes in 2003. In 2004, it was estimated at 505 000 tonnes, while in 2005, the estimated biomass decreased to 239 000 tonnes. However, it should be noted that in 2005 the survey did not cover the entire region. From 2005 to 2008 an increasing trend is observed; the biomass estimates for the last three years are the highest of the time series (610 000, 613 000 and 760 000 tonnes in 2007, 2008 and 2009, respectively).

The estimated biomass of anchovy (*Engraulis encrasicolus*) shows fluctuations over the time series. After the drop observed from 2000 to 2001 from 240 000 tonnes to 20 000 tonnes, a general increasing trend was observed from 2001 to 2007. In 2007, the estimated biomass was 186 000 tonnes. In 2008, the biomass of anchovy decreased to 126 000 tonnes, followed by a further decrease to only 50 000 tonnes in 2009. Detailed estimates for the different species are given in the respective sections.

Several other surveys have been carried out in different parts of the subregion since the last meeting of the Working Group, including acoustic and recruitment surveys carried out by the Russian research vessels ATLANTIDA and ATLANTNIRO in July–August 2009 and November 2009–January 2010, respectively, and national acoustic surveys carried out by the national research vessels (R/Vs). The results of these surveys are described in the various species chapters.