Food and Agriculture Organization of the United Nations

FISHERY COMMITTEE FOR THE EASTERN CENTRAL ATLANTIC

SUMMARY REPORT

FAO WORKING GROUP ON THE ASSESSMENT OF SMALL PELAGIC FISH OFF NORTHWEST AFRICA 2019

INTRODUCTION

This summary provides the **preliminary results, not yet validated** by the Scientific Sub-Committee (SSC) of the Fishery Committee for the Eastern Central Atlantic (CECAF), of the nineteenth meeting of the FAO Working Group on the Assessment of Small Pelagic Fish off Northwest Africa held in Casablanca, Morocco, 8-13 July 2019. 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 first day was dedicated to planning the 2019 R/V *Dr Fridtjof Nansen* survey in the region and to review progress of research work under the EAF-Nansen Programme Science plan, that uses the data collected in these surveys to address research questions of importance to the Working Group.

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 colias*), bonga (*Ethmalosa fimbriata*) and anchovy (*Engraulis encrasicolus*) in the region between the southern border of Senegal and the northern Atlantic border of Morocco. The Canary Islands fisheries is also considered by the group.

Altogether 21 scientists from six countries, the European Union and the Food and Agriculture Organization of the United Nations (FAO) participated. The chairperson of the Group was Aziza Lakhnigue, *Institut national de recherche halieutique* (INRH), Morocco.

KEY FINDINGS AND RECENT DEVELOPMENTS IN THE FISHERIES

Six out of eight stocks were found to be within biologically sustainable limits, whereas two stocks were considered overexploited. While no formal assessment could be conducted for the two species of sardinella due to lack of data, other indicators point to overexploitation. Urgent action is needed to rebuild the stocks of round sardinella (*S. aurita*) and bonga (*E. fimbriata*).

Table 1: Summary of assessment results

Species	Area	Not fully exploited	Fully exploited	Overexploited
Sardine *(Sardina pilchardus)*	Zone A+B	V		
	Zone C	V		
Sardinella *(Sardinella aurita* et *S. maderensis)*	NWA			V
Cunene horse mackerel *(Trachurus trecae)*	NWA		V	
European horse mackerel *(Trachurus trachurus)*	NWA		V	
Chub mackerel *(Scomber colias)*	NWA		V	
Anchovy *(Engraulis encrasicolus)*	Zone N & Zone A+B		V	
Bonga *(Ethmalosa fimbriata)*	Maur./Sen./Gam.			V

No assessments for *Caranx rhonchus*.

Highlights of recent developments that impact the fisheries in the subregion:

- There has been an expansion of the fishmeal industry in some countries in the sub-region, with artisanal and costal fleets providing fish for fish meal factories. This has led to a strong increase in fishing effort and a depletion of the stocks of sardinella and bonga, and also other small pelagic species.
- The depletion of the stocks of coastal small pelagics pose a serious threat to food security in the subregion.
- Rapid changes in fleet composition have been observed, in particular in Mauritania, where a coastal fleet segment has developed in recent years. In the Gambia more people have engaged in the marine artisanal fisheries sector recently, moving from inland regions.
- A new fisheries agreement was concluded between Mauritania and Senegal in December 2019, allowing 400 Senegalese canoes to catch approximately 50 000 tonnes of sardinella in southern Mauritanian waters. The utilisation of this agreement, however, is hampered the obligation for Senegalese fishermen to land their catches in Mauritania.
- New management measures have been put in place in several of the countries in the region, which includes the setting of total allowable catches (TACs) and zoning measures.
- New management measures have been put in place in Mauritania, aimed at reducing the amount of round sardinella used for fishmeal. The application of this measure is still hampered by enforcement problems, due to the mixed nature of the catches.

CATCH

The decreasing trend in total catch observed from 2010 to 2013 was reversed in 2014 and since then a general increasing trend was observed until 2017, from around 2.5 million in 2014 to around 2.7 million tonnes in 2017. In 2018 the total catch of small pelagic fish could not be estimated with precision because the data from Senegal, due to a problem in the data base in 2018, was not available to the Working Group. The catch in 2018, without Senegal, was around 2.6 million tonnes. The total catch for the period 1990–2018 has been fluctuating with an average of around 1.9 million tonnes, while the average for the five last years was 2.6 million tonnes not including the 2018 Senegal catches (Figures 1 and 2).
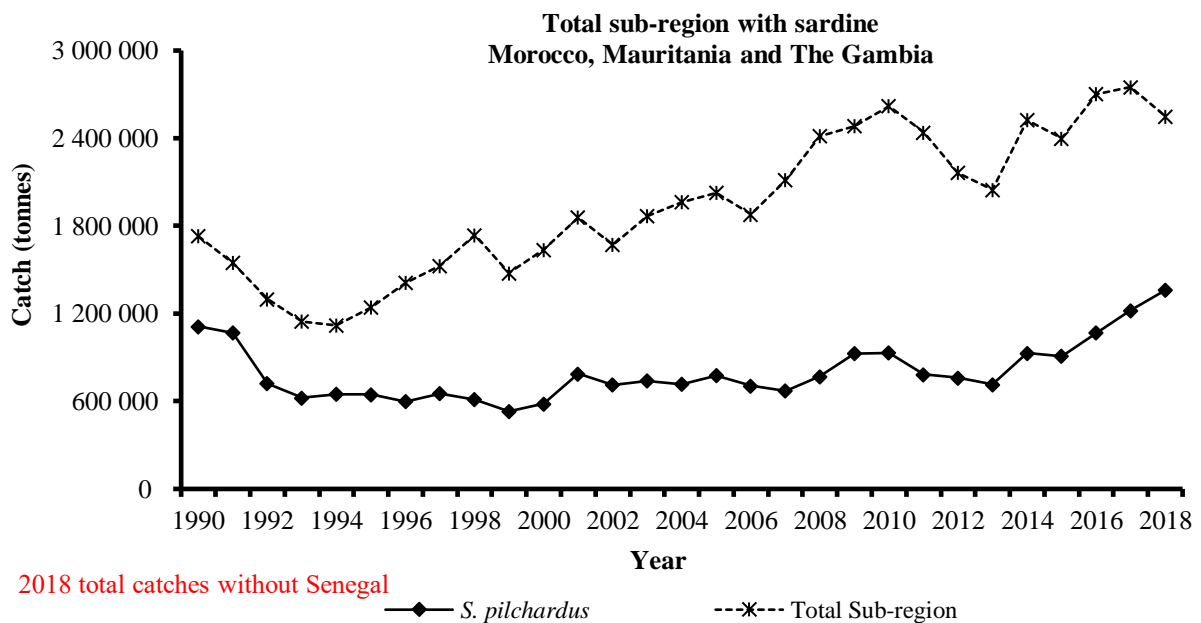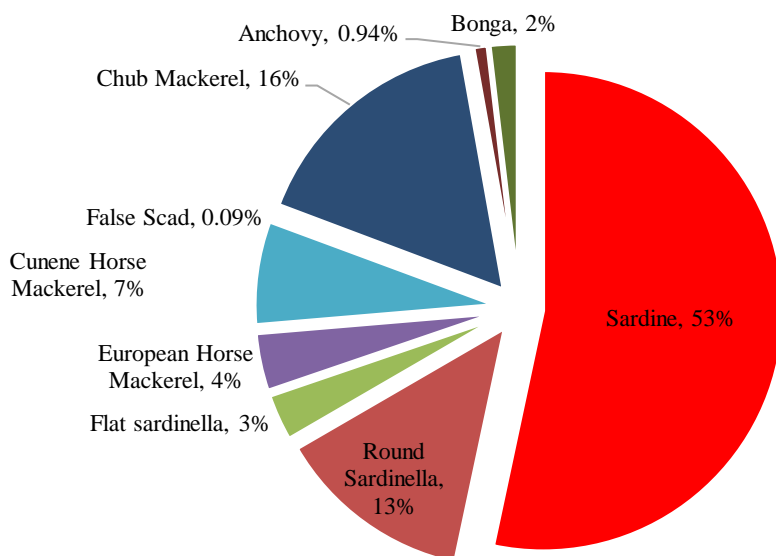
Figure 1: Total small pelagic species and sardine catches in the subregion by species and year without Senegal catches

Anchovy, 0.94% Bonga, 2%
Chub Mackerel, 16%
False Scad, 0.09%
Cunene Horse Mackerel, 7%
European Horse Mackerel, 4%
Flat sardinella, 3%
Round Sardinella, 13%
Sardine, 53%

2018 total catches without Senegal

Figure 2: Percentage of each species in catches in Northwest Africa region in 2018 (without Senegal catches)

Sardine *(Sardina pilchardus)* remains the dominant species, constituting about 53 percent of overall catch of the main small pelagic species in 2018. Catches of this species increased about 11 percent from 2017 to 2018, from around 1 220 500 tonnes in 2017 to around 1 360 000 tonnes in 2018. Sardine is followed by *Sardinella* spp. (16 percent, without Senegal), chub mackerel (16 percent), Cunene horse mackerel (7 percent), European horse mackerel (4 percent), Bonga (2 percent, without Senegal), Anchovy (1 percent) and false scad (0.1 percent).

Table 2: Comparative catches between 2014 and 2018 in thousand tonnes

Species	Catch 2014 (thous. tonnes)	Catch 2015 (thous. tonnes)	Catch 2016 (thous. tonnes)	Catch 2017 (thous. tonnes)	Catch 2018 (thous. tonnes)***	% 2018 related to total catch	Average (2014-2018)	Average (1990-2018)
S. pilchardus∗	930	908	1 068	1 220	1 360	53%	1 097	803
S. aurita	598	481	502	461	339	13%	476	388
S. maderensis	203	217	224	232	80	3%	191	143
T. trachurus	104	115	160	112	99	4%	118	82
T. trecae	223	207	236	235	178	7%	216	185
C. rhonchus	18	18	15	14	2	0%	13	24
S. colias∗	345	352	401	379	420	16%	379	192
E. encrasicolus	19	26	29	20	24	1%	24	81
E. fimbriata	84	75	68	78	48	2%	70	45
Sardinella spp.∗∗	0	0	0	0	0	0%	0	-
Trachurus spp.∗∗	0	1	1	1	0	0%	0	-
Total	**2 525**	**2 399**	**2 702**	**2 752**	**2 550**	**100%**	**2 585**	**1 943**

*with Canary Island catches; ** Canary Island catches; *** Without Senegal

REGIONAL SURVEYS

Between May and July 2017, a pelagic survey was conducted with the research vessel (R/V) *Dr Fridtjof Nansen,* operated through the EAF-Nansen Programme. No regional coverage of the small pelagic stocks was carried out in 2018. Both Morocco and Mauritania conducted acoustic surveys in 2018, but these were not coordinated in terms of regional coverage and timing.

The Moroccan R/V *Al-Amir Moulay Abdallah* conducted two acoustic surveys in the summer and autumn period of 2018 in each of the following areas: Cape Spartel-Cap Cantin; Cape Cantin-Cap Bojador; and Cape Bojador-Cap Blanc.

The Mauritanian R/V *Al-Awam* also conducted two acoustic surveys in 2018, one in the cold season (March) and the other one in the hot season (July), covering the area from Cape Blanc to the border with Senegal.

In 2018 a survey to study the recruitment of small pelagic species were carried out in winter covering predominantly the area between Cap Juby–Cap Blanc by the Russian research vessel R/V *Atlantida.*

MAIN ENVIRONMENTAL EVENTS

In 2018, the position of the southern boundary of the Senegalese-Mauritanian Thermal Front (SMTF) (24ºC) was mostly to the south or within its average long-term position for most months (Figure 3). Throughout the year, the region was located in the negative area of sea surface temperature (SST), considering the average long-term aspect, 2018 was the coldest since 1981 (Figure 4).
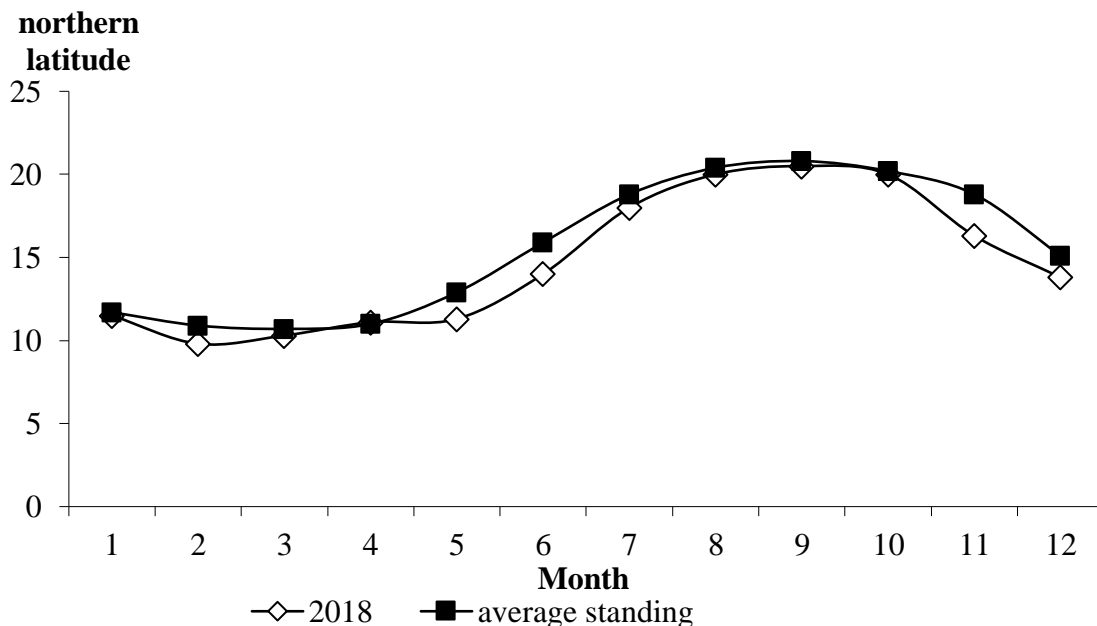

Figure 3: The position of the southern boundary of the SMTF (24ºC) in 2018 and its average long-term position
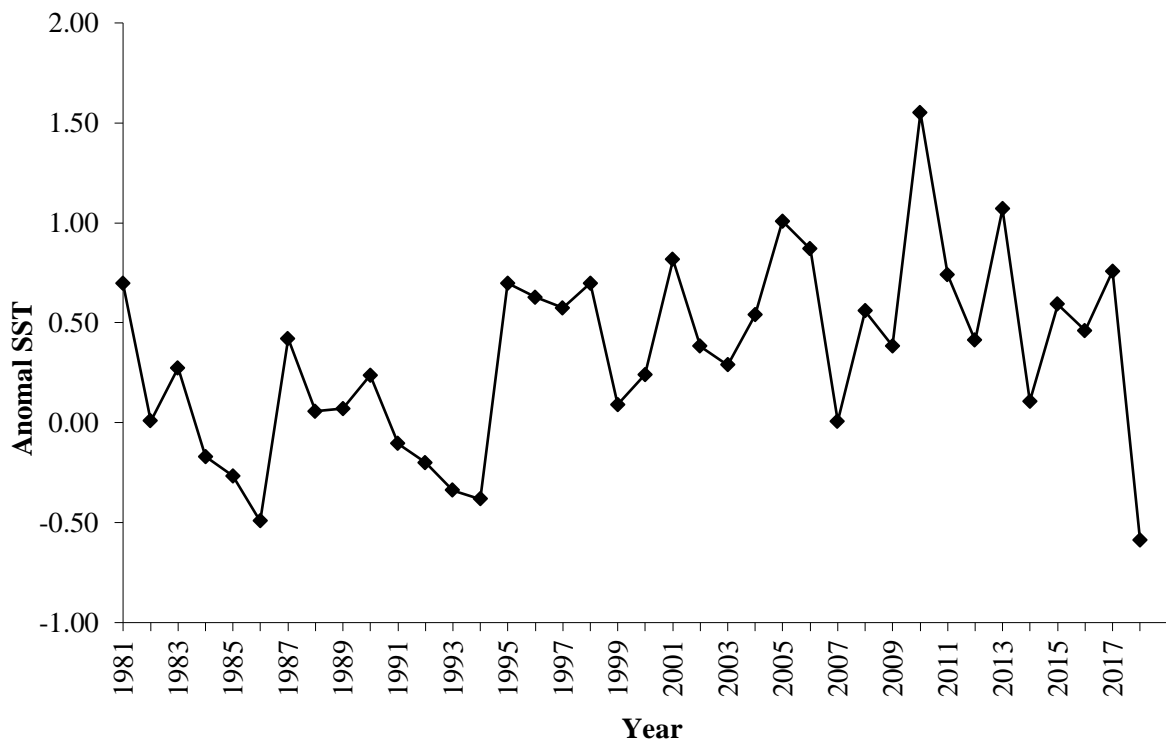
Figure 4: SST deviation from the norm averaged for the region of 15.5-21.5 N, -20.5-16.5 W. for 1981-2018

ASSESSMENT RESULTS AND MANAGEMENT ADVICE

Sardine (*Sardina pilchardus*)

The results of the assessment show that the stock is considered not fully exploited. The results of the projections show that the stock could support an increase in catch. Nevertheless, the variability of this resource due to the influence of hydro-climatic changes demand the adoption of a precautionary approach. The Working Group retains its recommendation from 2018 to take precautionary measures to ensure that the total catches in Zone A+B do not exceed 550 000 tonnes, the recommended catch in the period 2016-2018.

Sardine (*Sardina pilchardus*) in Zone C is also considered not fully exploited. However, significant catches have been recorded over the last three years (29 percent increase between 2017 and 2018), while biomass has been stable. This stock is strongly influenced by environmental factors. For this reason, and given the observed fluctuations in biomass in previous years it is recommended that all catches be adjusted according to natural changes in the stock. The stock structure and abundance should be closely monitored by fishery-independent methods such as acoustic surveys throughout the distribution range of the species.

Sardinella (*Sardinella. aurita*, *S. maderensis* and *Sardinella* spp.)

The assessment of sardinella (*S. aurita*, *S. maderensis* and *Sardinella* spp.) continued a challenge to the Working Group. No stock assessment could be conducted for the two sardinella species due to lack of data. No new data was provided from Senegal, one of the main fishing countries for sardinella, and insufficient data was provided by the other major sardinella-fishing countries to apply any of the adopted assessment methods. An analysis of the available survey indices (biomass of acoustic surveys) and other selected indicators (total catch, the catch per unit of effort (CPUE) of artisanal fishery in Mauritania, the mean length in catch in Mauritania, etc.), indicate that the sardinella stocks, particularly *S. aurita*, are overexploited. The lack of comprehensive information on this stock, coupled with the expanding catches and low biomass, highlights the urgent need for countries to take action. The working group recommends an immediate and substantial reduction in fishing effort and catch in all countries of the subregion. The working group cannot quantify exactly how much fishing effort is needed, but it estimates that a 50 percent reduction is required. The Working groups stresses the urgency of taking strong action in the current situation. The lack of comprehensive information, quantitative assessments and scientific advice on this stock, coupled with the expanding catches and low biomass, highlights the urgent need for countries to take action to avoid that the resource and fishery is undermined.

Horse mackerel (*T. trecae* and *T. trachurus*)

The status of the two stocks of horse mackerel (*T. trecae* and *T. trachurus)* has improved, and these stocks are now considered fully exploited. This improvement is likely due to a decrease in fishing mortality in 2016 and 2017 as well as an observed improvement in the recruitment index for the Atlantic horse mackerel (*T. trachurus*). There is no information of improved recruitment for the Cunene horse mackerel. Given the multi-specific nature of these fisheries and the results of the projections, the Working Group recommends not to exceed the 2018 catch level for the two species (around 300 000 tonnes).

Chub mackerel (*Scomber colias*)

For mackerel (*Scomber colias*), the Working Group concluded, based on the results of both of the models applied, that the chub-mackerel stock is fully exploited. This is the same conclusions as for the 2018 assessment. The production model indicates that the current level of catch is not sustainable whereas the analytical model indicates an optimum level of spawning stock biomass at the current level of catch. To this end, the Group recommends a precautionary approach and renews the recommendation formulated last year with a maximum catch of 340 000 tonnes for the subregion.

Anchovy (*Engraulis encrasicolus*)

The assessment of anchovy was based on information from Zone North and Zone A+B area. The results of the model show that the stock of anchovy is fully exploited. The fact that the acoustic biomass (R/V *Al-Amir Moulay Abdellah*) in 2018 increased, in contrast to the decreasing trend that was observed for the four last years (2014-2017) combined with an increase in catch in 2018 compared to 2017, did not change the final diagnostic for this stock. Given that the availability of anchovy is highly dependent on environmental factors, it is opportunistically fished, and catches vary widely from year to year, the Working Group recommends that the effort be adjusted to the natural fluctuations of this stock.

Bonga (*Ethmalosa fimbriata*)

The assessment of bonga was also impacted by the non-availability of updated data from Senegal, Nevertheless, an update of the 2018 assessments was made, due to a revision of the 2017 Mauritania catch data. The results of the stock assessment of bonga show that the stock is overexploited. Catches and fishing effort of this species increased in 2017 compared with 2016, despite the 2017 recommendation that the effort be reduced compared to current levels. The Working Group reiterated the 2018 recommendation, and recommended that effort and catch be reduced to below the 2017 levels to allow a level of biomass that can ensure sustainability.

Canary Island stocks

For the Canary Islands, although the sampling coverage in the archipelago is greater than that observed in other areas for small pelagic species monitored by the Working Group, the current data series are not considered sufficient to assess the state of these stocks. The time series of catches are only available from 2013, when a monitoring program for the artisanal purse seine fishery entered into force as part of the European Union Data Collection Framework project. However, these data still have limitations, including the misidentification of species at the time of landings. For these reasons, catches of *Trachurus* spp. and *Sardinella* spp. are grouped at the genus level for scientific purposes. This issue should be addressed by the Canary Islands Regional Managers as soon as possible to facilitate the assessments of these species.

Table 2: Summary of the assessments and management recommendations by the 2019 Working Group. All advice is based on the results of the production model, unless otherwise indicated.

Stock	2018 catch in 1 000 tonnes (2014–2018) avg.)*	$*B_{cur}/B_{0.1}$	$*F_{cur}/F_{0.1}$	Assessment	Management recommendations
Sardine *S.pilchardus* **ZoneA+B**	435 (460)	145%	50%	Not fully exploited	The stock is considered not fully exploited. Projections show that the stock could support an increase in catch. However, the variability of the resource vis-à-vis hydro-climatic changes requires the adoption of a precautionary approach. The Working Group retains the recommendation to limit the sardine catch in this zone to a level that must not exceed the 550 000 tonnes (the recommended catch limit in 2016, 2017 and 2018).
Sardine *S.pilchardus* **Zone C**	904 (615)	137%	64%	Not fully exploited	The stock is considered not fully exploited. However, significant increases in catches have been recorded over the last three years (29% between 2017 and 2018), while biomass has been stable. This stock is highly influenced by environmental factors and shows biomass fluctuations independent of the fishery. For this reason, the total catch to be taken must be adjusted to the natural changes in the stock. Also, the stock structure and abundance should be closely monitored by fishery-independent methods such as acoustic surveys throughout the range of the species.

Stock	2018 catch in 1 000 tonnes (2014–2018) avg.)*	*$B_{cur}/B_{0.1}$	*$F_{cur}/F_{0.1}$	Assessment	Management recommendations
Sardinella1** *S. aurita* *S. maderensis* *Sardinella* spp **Whole subregion**	 3 392 (474) 80 (190) 419 (665)	 - - -	 - - -	Overexploited	The working group recommends an immediate and substantial reduction in fishing effort and catch in all countries of the subregion. The working group cannot quantify exactly how much reduction in fishing effort is needed, but it estimates that a 50% reduction is required. The Working groups stresses the urgency of taking strong action in the current situation. The lack of comprehensive information, quantitative assessments and scientific advice on this stock, coupled with the expanding catches and low biomass, highlights the urgent need for countries to take action to avoid that the resource and fishery is undermined.
Horse mackerel **** ***T.trachurus* ***T. trecae* **Whole subregion	 99 (118) 2 003 (220)	 83% 94%	 119% 80%	Fully exploited	The results of the assessments of the *T. trecae* and *T. trachurus* stocks indicate an improvement in the state of the stocks of the two horse mackerel species. The two stocks are now considered by the working groups as fully exploited, and not overexploited as in the 2018 Working Group assessment. This improvement is likely due to a decrease in fishing mortality in 2016 and 2017 as well as an improvement in the recruitment index for the Atlantic horse mackerel. There is no information of improved recruitment for the Cunene horse mackerel. Given the multi-specific nature of these fisheries and the results of the projections, the Working Group recommends not to exceed the estimated 2018 catch level for the two species (around 300 000 tonnes).
Chub mackerel ***Scomber colias **Whole subregion	419 (379)	107% (Global) 123% (XSA)*	126% (Global) 84% (XSA)*	Fully exploited	The Working Group concluded, based on the results of the production model and analytical models, that the stock is fully exploited. The projection results of the global and analytical models indicate different trends. The global model indicates that the current level of catch is not sustainable whereas the analytical model indicates an optimum level of spawning stock biomass (SSB) at the current level of catch. To this end, the working group considers it important to limit the increasing catch trend, and recommends a precautionary approach, and renews the recommendation formulated in the last years of a maximum catch of 340 000 tonnes (which corresponds to a reduction of 19% compared to the catches registered in the sub region in 2018).

[1] Catches without Senegal in 2018

[3] Includes an estimate for Senegal in 2018 for assessment purposes.

Stock	2018 catch in 1 000 tonnes (2014–2018) avg.)*	*$B_{cur}/B_{0.1}$	*$F_{cur}/F_{0.1}$	Assessment	Management recommendations
Anchovy *Engraulis encrasicolus* **Zone North, A and B**	24 (24)*	N/A	69% (LCA-Y/R)**	Fully exploited	The assessment of anchovy was based on information from the Zone North and Zone A+B. The results of the model show that the stock of anchovy is fully exploited. The fact that the acoustic biomass in 2018 increased as compared to the decreasing trend for the four last years (2014-2017), combined with an increase in catch in 2018 compared to 2017, did not change the final diagnostic for this stock. Given that the availability of anchovy is highly dependent on environmental factors, itis opportunistically fished, and catches vary widely from year to year, the Working Group recommends that the effort be adjusted to the natural fluctuations of this stock.
Bonga 4 *Ethmalosa fimbriata* **Whole subregion**	48 (70) 5	N/A	156% (LCA-Y/R)**	Overexploited	The Working Group considers that bonga in the subregion remains overexploited. The Working Group recommended that effort and catch be reduced to below 2017 levels to allow a level of biomass that can ensure sustainability.

* XSA = extended survivor analysis
** LCA-Y/R = length cohort analysis – yield per recruit

OVERALL OBSERVATIONS AND RECOMMENDATIONS FOR DATA AND RESREACH

- The main deficiency of biological data is reliable length and age data for most of the stocks. The study of age and growth, therefore, is a priority for the Working Group. Despite efforts to improve data, there are still data deficiencies concerning length composition of the landings and discards of the industrial fleets in Mauritania, length distribution of catches in the Gambia and Senegal and age distribution of catches per species in all countries of the region.
- There are also still uncertainties with regards to fishery statistics in the Northwest Africa region. The current models applied for the assessments depend strongly on the estimated levels of past and present catch. Unreliable catch data will impact directly on the quality and reliability of the assessment and recommendations made by the Group. Therefore, these issues should be addressed with urgency and insistence.
- Fisheries independent surveys have been the backbone of many of the assessments since the start of the FAO Working Group, however, since 2010 the regional acoustic surveys series covering the whole sub-region have been interrupted for several reasons. The Working Group stresses the importance of restarting the regular regional acoustic surveys of the pelagic stocks by the regional research vessels covering the complete distribution area of all the stocks. Only the northern part of the distribution of stocks in the CECAF North region is regularly covered by the Moroccan R/V *Al Amir Moulay Abdellah*. It is recommended that the regional planning group for the coordination of acoustic surveys should reconvene.

4 Not including 2018 catch for Senegal.
5This relates to 2017 catches given that Mauritania corrected their data.

- The recruitment surveys are also very important for management of small pelagic fisheries. The Working Group recommends the continuation of the recruitment surveys in the period November-January by the Russian research vessel and or national or other regional vessels.
- Given the marked variability of environmental conditions in this region, the Working Group again stressed the need to continue studies for the effect of hydrographical and/or ecological variability in the region and its effects on stock dynamics and to explore possibilities to further development of the production model used to better account for these factors.

METHODS AND APPROACH

METHODS

Consistent with previous years, the main model used by the Working Group was the dynamic version of the Schaefer (1954) model. This model was applied to sardine, horse mackerel and chub mackerel. Simple medium-term projections of future yields and stock development were made using this model fitted to the historical data with a projected time horizon of three/five years. All projections took as their departure point the estimated stock status in 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. An Excel spreadsheet implementation of the dynamic version of these models, with an observation error estimator, was used. The model was fitted to the data using the non-linear optimizer built into Excel, Solver.

For bonga and anchovy, a length cohort analysis (LCA) was applied to estimate the current F-level and the relative exploitation pattern on the fishery over the last few years. A length-based Yield per Recruit Analysis was then run on these estimates, to estimate the status of the stock in relation to the biological reference points F_{MAX} and $F_{0.1}$. Both the LCA and the yield-per-recruit analysis (YR)were implemented as Excel spreadsheets with instructions, developed specially for this Working Group.

For the mackerel stock, catch-at-age data from the Russian fleet, that covered most of the reported catches, were available. The results of the analysis of correlation within cohorts was considered acceptable and the Working Group decided to proceed with applying the age-based methods, extended survivor analysis (XSA) and integrated catch analysis (ICA) as well as the dynamic production model.

Based on the recommendations from the technical review carried out in 2015, possible new assessment methods that could broaden the tools available to the Working Group have been tested since 2016.

As a result, several methods have been tested on different stocks. The models/approaches that have been tested include the Monte Carlo-Catch Maximum Sustainable Yield (CMSY), catch curve analysis and length-based mortality estimates and SPICT a state space model fitting a surplus production model in a statistical framework based on estimation by maximum likelihood.

ASSESSMENT CLASSIFICATION

The Working Group adopted three assessment categories:

- **Not-fully exploited:** The stock is in good condition and fishing pressure can be increased without affecting the sustainability. All increases must be seen in the context of the general environmental situation.
- **Fully Exploited:** The Fishery operates within the limits of sustainability. Current fishing pressure seems sustainable and can be maintained.
- **Overexploited:** The Fishery is in an undesired state in terms of biomass or/and fishing mortality. Fishing pressure should be reduced to allow the stock to grow.

BIOLOGICAL REFERENCE POINTS

The Working group, consistent with CECAF, has adopted the following Biological Reference Points (BRPs):

Target Reference Points: $B_{cur}/B_{0.1}$ and $F_{cur}/F_{0.1}$

Limit Reference points: B_{cur}/B_{MSY} and F_{cur}/F_{MSY}

Where:

$F_{0.1}$ - The fishing mortality rate at which the slope of the yield – per - recruit curve is only one - tenth the slope of the curve at its origin or 90 percent of F_{MSY}

F_{MSY}-Value of F (and of other characteristics of the stock) where the long-term total yield is maximum

F_{Max} - Consider the long−term yield per recruit, Y/R, as a function of F, for a certain exploitation pattern. F_{Max} is the point of the curve, Y/R against F, where Y/R is maximum.
$B_{0.1}$ – is the value of Biomass corresponding to $F_{0.1}$

B_{MSY} – is the value of Biomass corresponding to F_{MSY}

The target reference points indicate what the current situation is like in terms of biomass and fishing mortality related to the ideal situation for the stocks whereas the limit indicate that the current situation related to what we want to avoid. The more conservative $F_{0.1}$ and $B_{0.1}$ have been selected as target reference points rather than the more traditional F_{MSY} and B_{MSY}, due to the inconsistencies of some data sets, and in line with the precautionary approach.

The Working Group estimates the status of the stocks and fisheries in relation to these agreed reference points adopted by CECAF. Whenever possible, the Group made projections of future yields and stock status under different scenarios for future management measures.

The management advice for the stocks is given in relation to the agreed reference points and on the basis of the projections. The advice is intended to provide guidance to management on how to make the different stocks can be maintained or develop in a direction where exploitation can be sustained at a level more conservative due to the inconsistencies of some data. As far as possible, advice for each stock is given both in terms of effort and/or catch levels. Since most of the stocks are shared by two or more

countries in the region, the Working Group strongly recommends the reinforcement of regional cooperation in research and management.

DEFINITIONS

- **Effort-** The fishing activity can be measured in a given unit of time e.g. number of boats, number of days fishing, number of trips, number of hours trawled per day, number of hooks set per day, number of hauls per day, etc.

- **CPUE-** Catch per unit of effort is the catch of fish in numbers or weight taken by a defined period of effort.

- **Exploitation rate (E) –** Ratio between the number of individuals caught and the total number of individuals dead, over a certain period of time, that is, **E = C/D** or can be E=F/(F+M) and is 0<E<1.

- **Exploitation pattern -** Fraction of the individuals of a given size, available to the gear, which is caught. Also designated by Selectivity or partial recruitment.

- **Fishing mortality (F) (fishing mortality coefficient)** – Relative instantaneous rate of the mortality of the number of individuals that die due to fishing.

- **Recruitment to the exploitable phase (R)** – Number of individuals of a stock that enter the fishery area for the first time each year.
- **Biomass –** Total weight of the stock in the ecosystem

- **Structural models** – Models that consider the structure of the stock by ages or sizes. These models allow one to analyze the effects on catches and biomasses, due to changes in the fishing level and exploitation pattern.

- **Global Models** - These models consider the stock globally, in particular the total abundance (in weight or in number) and study its evolution, the relation with the fishing effort, etc. They do not consider the structure of the stock by age or by size.

REFERENCE

FAO. 2020. *Report of the FAO Working Group on the Assessment of Small Pelagic Fish off Northwest Africa. Casablanca, Morocco, 8–13 July 2019. Rapport du Groupe de travail de la FAO sur l'évaluation des petits pélagiques au large de l'Afrique nord-occidentale. Casablanca, Maroc, 8-13 juillet 2019.* FAO Fisheries and Aquaculture Report/FAO Rapport sur les pêches et l'aquaculture. Rome.