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 2024

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 twenty-third meeting of the FAO Working Group on the Assessment of Small Pelagic Fish off Northwest Africa, from 25 June–2 July 2024 in Dakar, Senegal. Scientists from the Gambia, Mauritania, Morocco, Senegal, Spain, and the Netherlands attended the meeting, as well as representatives of the European Commission (DG MARE) and the Russian Federation. 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.

During the meeting, the Working Group members discussed the submitted data by species (chapter), performed the stock assessments (including exploratory approaches), and formulated the final management recommendations. The meeting was organized by the CECAF Secretariat, hosted by the Office of the Sub-Regional Fisheries Commission and supported by the EAF-Nansen Program.

The species assessed by the Group were: sardine (*Sardina pilchardus*), round and flat 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 are also considered by the group.

The Working Group was chaired by Mr Cheikh-Baye Braham (IMROP, Mauritania).

KEY FINDINGS AND RECENT DEVELOPMENTS IN THE FISHERIES

Four out of nine stocks were determined to be within biologically sustainable limits (status of fully exploited), while five stocks were considered overexploited. The assessments show that action is needed to rebuild stocks of sardine in zone C, round sardinella, flat sardinella, European horse mackerel, and bonga, which are all overexploited.

Table 1: Summary of assessment results

Species	Area	Not fully exploited	Fully exploited	Overexploited
Sardine *(Sardina pilchardus)*	Zone A+B		√	
	Zone C			√
Round sardinella *(Sardinella aurita)*	Whole subregion			√
Flat sardinella *(Sardinella maderensis)*	Whole subregion			√
European horse mackerel *(Trachurus trachurus)*	Whole subregion			√
Cunene horse mackerel *(Trachurus trecae)*	Whole subregion		√	
Chub mackerel *(Scomber colias)*	Whole subregion		√	
Anchovy *(Engraulis encrasicolus)*	Zone N & Zone A+B		√	
Bonga *(Ethmalosa fimbriata)*	Mauritania / Senegal / Gambia			√

No assessments for *Caranx rhonchus*. Assessments do not include data from the Canary Islands stocks.

OVERALL REGIONAL TRENDS

CATCH

The total catch of small pelagics has been fluctuating since the beginning of the time series in 1990 (Figure 1 and 2, Table 1). There was a moderately increasing trend from 2013 to 2019, followed by a decrease down to 2.0 million tons in 2023, which is similar to the total catch level in 2013. This is the same value as the average of the whole time series (1990–2023). The five-year average for the period 2019-2023 of 2.4 million tons is higher than the 2023 catch value.

Sardines make up most of the total catch of small pelagics in the sub-region at 31 percent, followed by Chub mackerel at 14 percent and sardinellas (round and flat) at 12 percent of the total.
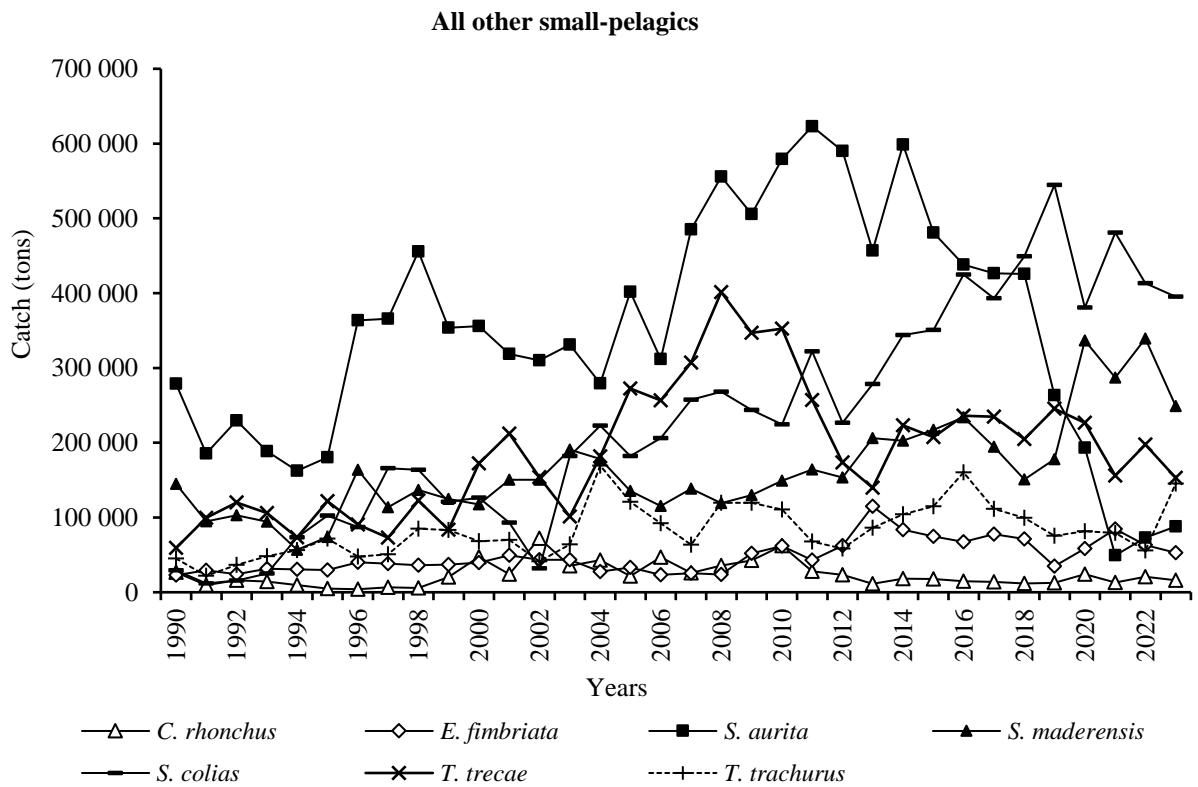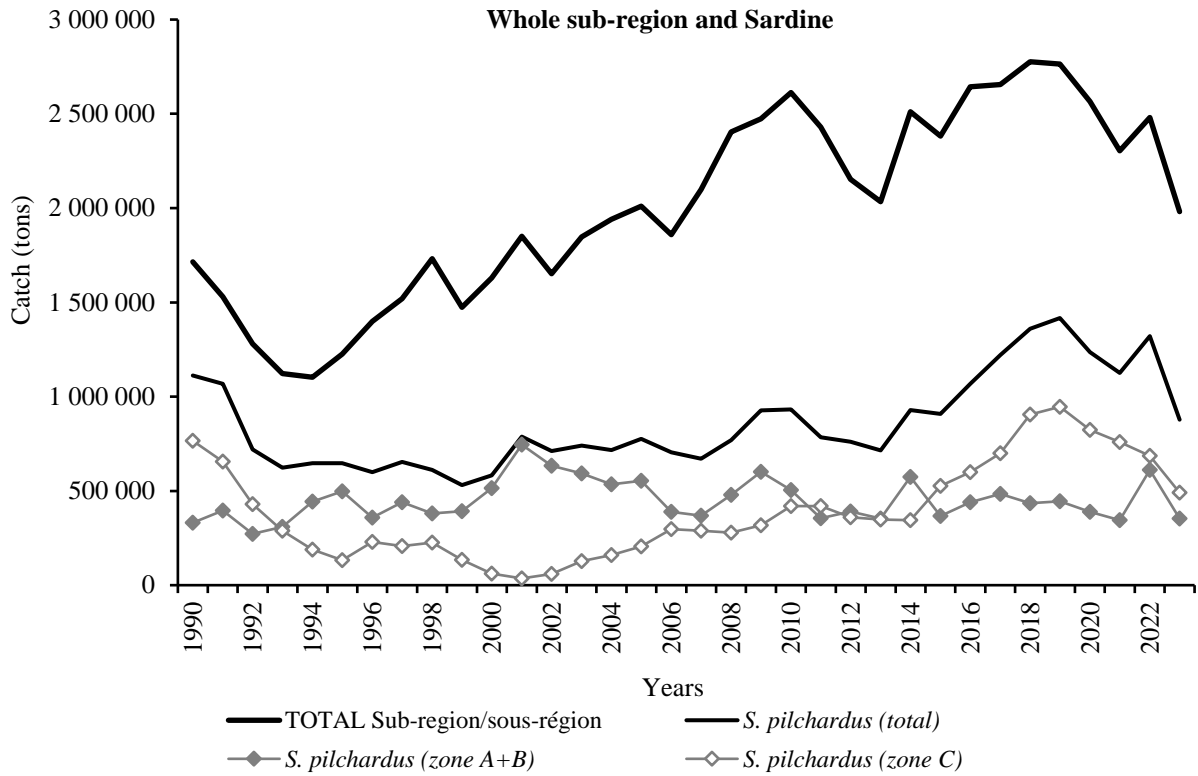
Figure 1: Total catch of small pelagic species and sardine catch in the whole subregion (top) and catch of other small-pelagic species in the subregion.
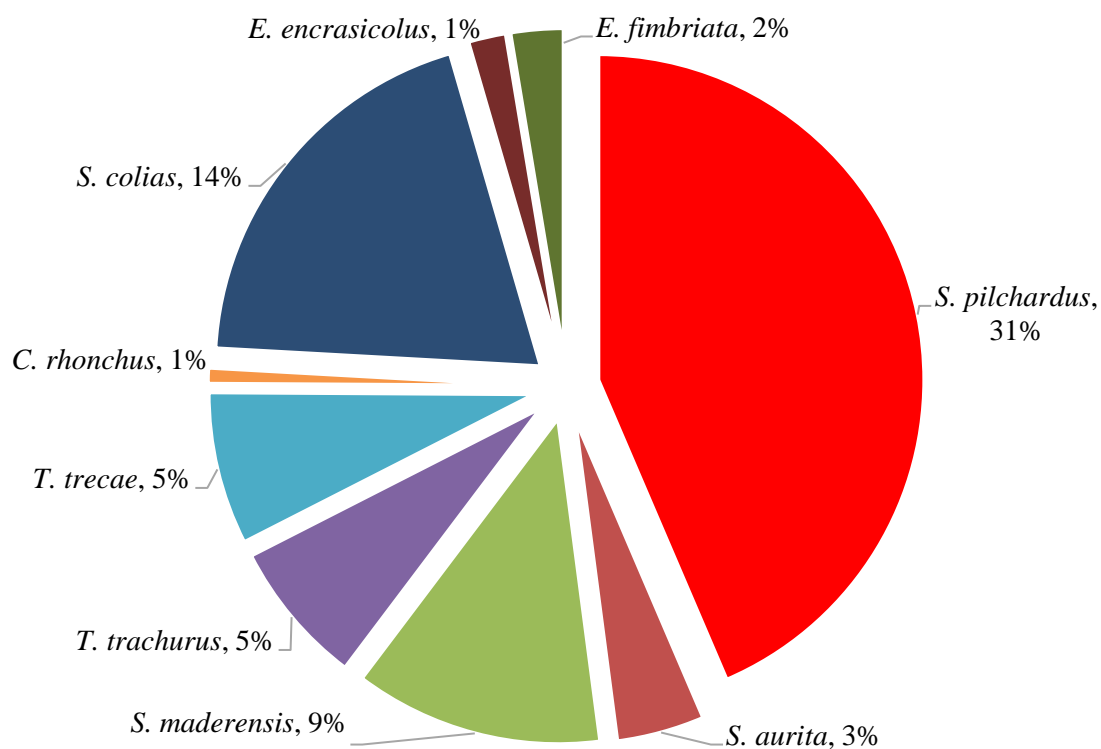
Figure 2: Percentage of each species in catches in Northwest Africa region in 2023.

Table 2: Comparative catches between 2019 and 2023 in tons, for the whole region without the Canary Islands.

Species	Catch 2019	Catch 2020	Catch 2021	Catch 2022	Catch 2023	% of total catch in 2023	Average (2019-2023)	Average (1990-2023)
S. pilchardus	1 416 855	1 235 530	1 125 055	1 320 085	877 323	44%	1 194 970	860 299
S. aurita	263 205	193 408	49 344	72 845	87 990	4%	133 358	350 149
S. maderensis	177 962	336 480	286 826	339 223	248 934	12%	277 885	164 480
T. trachurus	75 509	81 709	79 558	55 800	145 179	7%	87 551	83 118
T. trecae	245 224	226 459	155 861	197 669	152 979	8%	195 638	187 103
C. rhonchus	12 526	24 273	12 824	20 638	15 898	1%	17 232	23 492
S. colias	544 597	380 505	480 815	413 181	395 177	20%	442 855	230 528
E. encrasicolus	19 797	50 629	49 410	20 746	37 774	2%	35 671	73 987
E. fimbriata	34 889	58 454	84 601	63 013	52 809	3%	58 753	47 952
Total	**2 790 563**	**2 587 447**	**2 324 294**	**2 503 200**	**2 014 063**	**100%**	**2 443 913**	**2 021 108**

Table 2 (continued): Comparative catches between 2019 and 2023 for the Canary Islands (in tons).

Species	Catch 2019	Catch 2020	Catch 2021	Catch 2022	Catch 2023	% of total catch in 2023	Average (2019-2023)	Average (1990-2023)
S pilchardus	89	46	44	34	9	3%	44	223
S aurita	85	48	179	206	362	17%	176	260
S maderensis	30	14	41	59	110	5%	51	94
Trachurus spp	492	636	280	239	120	20%	353	399
Scomber colias	1 101	723	705	654	710	55%	779	794
Total	**1 797**	**1 467**	**1 248**	**1 192**	**1 311**	**100%**	**1 403**	**1 771**

REGIONAL SURVEYS

The latest acoustic survey in the region with the R/V *Dr Fridtjof Nansen* was carried out in 2023, as part of a synoptic coverage of the pelagic resources and ecosystems off West Africa. The survey was conducted in the second half of the year, continuing the historical series used in the assessments. This survey included leg 5.1, which encompassed Senegal and the Gambia; leg 5.2 which covered the area between St. Louis and Cape Blanc; and leg 5.3 conducted the survey from Cape Blanc northward to Cape Spartel.

The Russian R/V *Atlantida* conducted recruitment surveys from October-November 2023 for sardine and mackerels, between Cap Cantin and Cap Blanc.

Morocco also conducted several acoustic surveys in Moroccan waters for small pelagic species in 2023 with the two research vessels *Al Amir Moulay Abdellah* and *Al Hassan Al Marakshi*. Six surveys with these vessels covered spring, summer, and autumn across the three Moroccan regions: North, Central, and South.

ASSESSMENT RESULTS AND MANAGEMENT ADVICE

The assessment results and management advice by stock as adopted by the Working Group are summarized in Table 3. They are applicable to the whole subregion excluding the Canary Islands, unless stated otherwise in the first column.

The results and management advice in Table 3 are not applicable to the Canary Islands. Although the sampling coverage for small pelagic species in the archipelago is greater than that observed in several other areas monitored by the Working Group and significant efforts have been undertaken to improve the assessments of the stocks, the current data series and available models are still considered insufficient to assess the state of the stocks in this area.

Table 3: Summary of the assessments and management recommendations by the 2024 Working Group.

Stock	2023 catch in thousand tons (2019–2023) avg)	$B_{cur}/B_{0\,1}$	$F_{cur}/F_{0\,1}$	Assessment	Management recommendations
Sardine *S. pilchardus* Zone A+B	354 (429)	86%	57%	Fully exploited	The stock is considered to be **fully exploited.** After the peak in catches in 2022 (+78 per cent compared with 2021), sardine availability has become very limited in 2023. Furthermore, a general downward trend in the average size of sardines caught in the central zone has been recorded in recent years, prompting vigilance over the exploitation of this stock, whose biomass and recruitment levels fluctuate. Consequently, it is recommended that fishing mortality be reduced and that production methods and systems be better adapted, while preserving sensitive habitats (nursery and spawning areas, rocky zones, etc). In this context, biological rest, zoning, minimum sizes and capacity management are potential measures for improving the resilience of stocks to fishing in a context of climate change. Bearing in mind that this stock has moved from a situation of not fully exploited, which has been maintained for several years, to one of fully exploited in 2023, and as a precautionary approach, the working group recommends not exceeding the current level of catches (354,000 tons).
Sardine *S. pilchardus* Zone C	491 (741)	71%	98%	Overexploited	According to the model usually used (Biodyn), the stock is **overexploited**, after several years of not being fully exploited. This sudden change in status is likely due to a combination of high fishing effort in recent years and unfavorable hydro-climatic conditions (significant warming). The Working Group has always pointed out that this stock is strongly influenced by environmental factors and shows fluctuations in biomass that are independent of fishing. For this reason, the total allowable catch must be adapted to variations in the stock. The structure and abundance of the stock must also be closely monitored using fisheries-independent methods, such as coordinated acoustic assessment surveys throughout the species' geographical distribution range. The biomass has shown a sustained downward trend since 2021, which became more pronounced in 2023 (-66% obtained by the R.V. *Fridtjof Nansen* index and -41% by the R.V. *Al Hassan Al Marakshi* index), coinciding with a fall in catches throughout the region. Moreover, catches have continued to fall since 2019, a period that coincided with the introduction of several management measures at regional level (zoning, etc.). In recent years, the emergence of inshore fleets in Mauritania has contributed to large catches of sardines south of Cap Blanc. Abundance indices in this area are not regularly assessed. The average size of sardines caught has shown an overall downward trend, making it necessary to be vigilant in exploiting this stock. As with the Zone A+B stock, it is recommended that fishing mortality on the sardine stock in Zone C be reduced and that production methods and systems be better adapted, while better preserving sensitive habitats (nursery and spawning areas, rocky areas, etc.). In this context, biological rest,

Stock	2023 catch in thousand tons (2019–2023) avg)	$B_{cur}/B_{0\,1}$	$F_{cur}/F_{0\,1}$	Assessment	Management recommendations
					zoning, minimum sizes and capacity management are potential measures for improving the resilience of stocks to fishing in a changing climate.
Sardinella[1]		B_{cur}/B_{MSY}:			The various models show alarming situations for both round and flat sardinella stocks. Both stocks are in a critical situation, heavily **overexploited** and with very low biomass levels.
S. aurita	88 (133)	21% (JABBA) 14% (SPiCT)	200% (LCA) F_{cur}/F_{MSY}: 103% (JABBA) 157% (SPiCT)	Overexploited (*S. aurita*)	The round sardinella stock is still in a very critical situation, which has been maintained since 2016. The biomass in 2023 is the lowest in the entire historical series. The Working Group notes a slight increase in catches of round sardinella in 2023, but in terms of the stock, this increase is insignificant. The Working Group reiterates the recommendations of previous years for the management of the round sardinella stock and recommends a substantial and immediate reduction in fishing effort and mortality (60 percent of the current mortality on this stock), combined with other measures to improve the biological productivity of the stock, in particular protection of the recruitment and spawning phases.

As for flat sardinella, the level of fishing mortality has been very high over the last four years. Fishing effort on both species is currently focused on flat sardinella. As a result, the working group is also recommending a reduction in the fishing effort directed at flat sardinellas. |
| *S. maderensis* | 249 (278) | 32% (JABBA) 41% (SPiCT) | 294% (LCA) F_{cur}/F_{MSY}: 373% (JABBA) 226% (SPiCT) | Overexploited (*S. maderensis*) | Furthermore, in order to improve the state of sardinella stocks, it is recommended that the ban on their use in the manufacture of fishmeal in Mauritania be maintained and extended to the entire sub-region. The working group recommends that concerted management measures be put in place between the various countries as a matter of urgency and encourages the dynamic implementation of national management plans. The working group also reiterates the need to strengthen the collection of data on these species throughout their distribution and encourages initiatives to harmonize management measures underway in the region. |
| Whole subregion | | | | | It should be noted that these two species are exploited in a mixed context. In fact, the two species mix in certain areas. The Working Group is aware of the difficulty of adapting measures for individual species and recommends measures for sardinella as a whole. |

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[1]Not including the Canary Islands

Stock	2023 catch in thousand tons (2019–2023) avg)	$B_{cur}/B_{0.1}$	$F_{cur}/F_{0.1}$	Assessment	Management recommendations
Horse mackerel[2] *T. trachurus* *T. trecae* Whole subregion	 145 (156) 153 (196)	 147% 117%	 97% 46%	 Overexploited (*T. trachurus*) Fully exploited (*T. trecae*)	Based on the results of the production model, the working group concluded that the Atlantic horse mackerel (*Trachurus trachurus*) stock is **overexploited**. The WG recommends a reduction in overall catches of this species. The stock of Cunene horse mackerel (*Trachurus trecae*) is **fully exploited**. This situation is confirmed by the improvement in biomass and abundance index with good recruitment observed since 2022. Improvements are observed for *T. trecae*, but the state of the *T. trachurus* stock has deteriorated. Consequently, as a precautionary approach, the Working Group recommends that the combined catch of the two species of horse mackerel should not exceed 300,000 tons for the sub-region as a whole. In addition, particular attention should be paid to the protection of juveniles and the reinforcement of sampling and breakdown of the different species of horse mackerel. Given that little progress has been made on implementing concerted management measures to protect juveniles, the Working Group recommends holding a specific scientific meeting as a matter of urgency, dedicated to harmonizing potential management measures at regional level, under the auspices of the FAO.
Chub mackerel[2] *S. colias* Whole subregion	 395 (443)	 105% (Biodyn) 109% (XSA)	 93% (Biodyn) 89% (XSA) 103% (LCA/YPR)	 Fully exploited	Based on the results of the production model and other analytical models, the working group concluded that the stock is **fully exploited**. The stock biomass has improved, and catches have shown a downward trend since 2020. Despite these positive indicators for the stock, which point to a stable state of exploitation, the projections show different response trajectories for the stock depending on the models used. As a result, the Working Group was unable to adopt projections for the evolution of this stock, which is complicated by inter-annual fluctuations in recruitment. The Working Group recommends maintaining the level of catches at the 2023 level, i.e. 395,000 tons, for the entire sub-region, which corresponds to the sustainable catch. Furthermore, the Working Group has noted for several years that there has been significant fishing of juveniles, which have not yet reached first maturity, and reiterates its recommendation that measures be implemented urgently throughout the region (e.g. time-area measures, revision of minimum catch sizes and landing tolerance thresholds, gear regulations, etc.), based on science, to reduce fishing mortality on this vulnerable fraction of the stock in order to improve its biological productivity. Given that little progress has been made on implementing concerted management measures to protect

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[2] Not including the Canary Islands

Stock	2023 catch in thousand tons (2019–2023) avg)	$B_{cur}/B_{0 1}$	$F_{cur}/F_{0 1}$	Assessment	Management recommendations
					juveniles, the Working Group recommends that a specific scientific meeting be held as a matter of urgency, dedicated to harmonizing potential management measures to reduce catches of juveniles in the region, under the auspices of the FAO.
Anchovy *E. encrasicolus* Zone North, A and B	36 (35)	-	88% (LCA-Y/R)	Fully exploited	The anchovy assessment was based on information from the North+A+B zone. The results show that anchovy is considered to be **fully exploited**. Given that the availability of anchovy is highly dependent on environmental factors, that it is exploited opportunistically and that catches vary considerably from one year to the next, the working group recommends adjusting fishing effort to the natural fluctuations in this stock. In order to carry out a large-scale assessment of the distribution of this stock, it is necessary to strengthen data collection in Zone C and to initiate stock identity studies at the regional level.
Bonga *E. fimbriata* Whole region (Mauritania+ Senegal+ Gambia)	53 (59)	B_{cur}/B_{MSY}: 37% (JABBA) 7% (LBB)	370% (LCA-Y/R) (Senegal + Gambia) F_{cur}/F_{MSY} 255% (JABBA) F/M : 8 7 (LBB)	Overexploited	The results of the size-based models (LCA, JABBA and LBB), show that the bonga stock is **overexploited**. Catches at the regional level have decreased in the last three years. The Working Group recommends reducing fishing effort and catches below 2023 levels. In addition, it is necessary to strengthen the collection of data (e.g., statistical and biological) to allow for a good assessment of this stock at the scale of its distribution. Given the absence of an abundance index for the stock, the standardization of CPUE of artisanal fisheries is recommended.

OVERALL RECOMMENDATIONS FOR DATA AND RESEARCH

- Organize a scientific meeting dedicated to the harmonization of potential management measures targeting the reduction of juvenile catches of mackerel and horse mackerel at regional level.
- Organize a workshop to discuss and harmonize sampling methods across sub-regional countries for the various species.
- Carry out further biological studies of the impact of environmental factors on small pelagics and specifically on the connectivity of sardine stock C and stock A+ B.
- Intensify biological sampling in the sub-region, focusing on size frequencies of sardinellas, anchovies (southern zone), and bonga.
- Conduct exploratory studies to provide standardized effort data for sardinella and bonga, and explore additional abundance indices for stocks like mackerel.
- Review historical data for horse mackerel stocks to apply analytical models.
- Ensure the 2026 N/R *Dr Fridtjof Nansen* survey includes an acoustic study addressing relevant scientific questions and previous workshop issues.
- Extend recruitment surveys to the entire sub-region.
- Use data from N/R *Dr Fridtjof Nansen* campaigns for time series analysis and spatio-temporal modeling, with capacity-building activities for scientists from partner countries.
- Conduct acoustic surveys around the Canary Islands to obtain abundance indices for small pelagic species.

METHODS AND APPROACH

METHODS

Consistent with previous years, one of the main models 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 ("Biodyn"), with an observation error estimator, was used. The model was fitted to the data using the non-linear optimizer built into Excel, Solver.

For round sardinella, chub mackerel, 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.

For sardinella, the Stochastic Surplus Production Model in Continuous Time (SPiCT) was applied. It is a state-space stochastic model that incorporates a surplus production model within a statistical framework based on maximum likelihood estimation. SPiCT can be seen as a model with two statistical parts. First, the process part which describes the dynamics of the stock and of the fishing mortality; second the observation model, which links the observations (catch and abundance indices) to the model.

For sardinella and bonga, *Just Another Bayesian Biomass Assessment* (JABBA) was also applied. Like SPiCT and Biodyn, this model uses catch and abundance indices.

Finally, for bonga, the length-based Bayesian biomass estimation method (LBB) was applied. This method uses a Bayesian model to estimate the biomass of a fish stock from the length distributions of catches.

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 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 $1/10^{th}$ 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.