Sardina pilchardus

RA07_06_24

Risk Assessment for Sourcing Seafood (RASS) profile; sardines (*Sardina pilchardus)* off Northwest Africa captured in Moroccan fisheries.

Introduction

This document is a summary of information on the sardine[1] (*Sardina pilchardus*) fished using pelagic seines and trawls, off Northwest Africa in Moroccan waters derived from scientific assessments and risk assessed using Seafish's RASS scoring Guidance version 2.

RASS scoring guidance

RASS applies a framework which scores risk levels for stocks and fisheries on a five-point scale; from 1 very low risk to 5 very high risk, as indicated by the number of solid blue circles shown on the profiles below.

Four aspects are assessed for each fishery;

1. Stock status as advised by [2]CECAF fishery Committee for the Eastern Central Atlantic. This is scored separately for the two main biologically recognised stocks of sardines (see Stock Structure section) in Moroccan and adjacent waters.

2. Stock management, using information from CECAF and other sources. This is also scored at the stock level for the two main stocks of sardines.

3. Bycatch effects; that is effects on species which are caught with the main species. In this case although sardines are the main species caught by volume, the fishery has to be considered a mixed fishery with other pelagic species. It also covers bycatch of Endangered Threatened or Protected species. The catch compositions of the Moroccan fishery are distinctly different from those of fisheries further south so are scored separately.

4. Habitat effects; in this case the sardine is an important component of the pelagic ecosystem, so the potential effects of harvesting sardines are discussed

Scores should not be used in isolation to decide on a purchase of seafood from a stock. Profiles are designed to:

- enable the main features of a fishery to be examined within a structured format,

- inform buyers of questions they might ask about a fishery and where improvements could be made to improve sustainability.

Inevitably there are several technical terms used. Please see the Glossary at the end of the document, where there are also links to further reading.

Stock structure

Fish populations are divided into stocks. A fish stock is a sub population of a fish species which inhabits a defined area of sea. Fish stocks are the units used by scientists and governments to assess and manage fish populations.

For the purposes of assessment of sardines, the Northwest African coast is divided into zones – Mediterranean, North, Central (A and B) and south (C) (Figure 1). Differentiation between sardines in Central and Southern zones was found to have a biological basis by the characteristic parasite fauna of the sardines of the two areas, the main discontinuity occurring at Cap Bojador (Shukhgalter, 2013), the boundary between the Central and South zones. Also morphometric characteristics of the sardines (Mounir et al, 2022) and their otoliths (Mounir et al, 2023) are distinctly different in the Northern, Central and Southern zones. Hence there is a biological basis for differentiation of these populations.

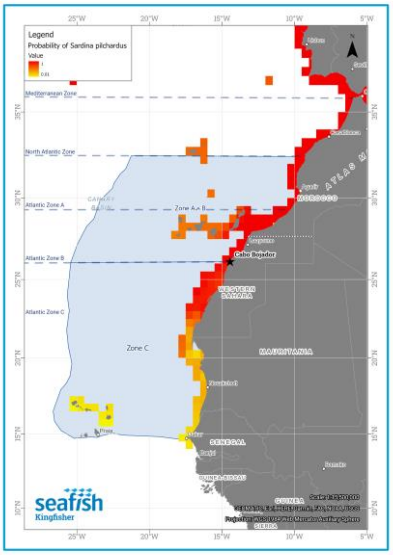

Figure 1 Zones for assessment and management of sardines (*Sardina pilchardus*) off Northwest Africa. Also shown is the relative probability of occurrence of sardines based on environmental data from fishbase

[1] *Sardina pilchardus* are also known as pilchards.
[2] CECAF = Fisheries committee for eastern central Atlantic – in French COPACE

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Stock Assessment

The main stocks and fisheries are in the Central (A and B) and South zones (C), catches in the North zone only amounting to 1.5% of the catch. The two stocks in the Central and Southern zones were assessed by the CECAF working group which met in 19th-21st July 2023, based on data collected in 2022. Currently the results are only published as preliminary results, not yet validated. Given that the previous assessment was in 2019 based on data collected in 2018 showed similar results it was decided to use the most up to date information for this assessment, albeit based on preliminary results.

RASS Scoring

Sardines in central zones; A and B, 2022

●○○○○ **Very Low risk**

The stock was assessed using a production model[3] by the CECAF working group based on data up to and including 2022 as being above the management target for biomass and below the management target for fishing mortality. The management targets are more precautionary than maximum sustainable yield (MSY) targets, and the stock status is not fully exploited which corresponds to a very low risk under the RASS guidelines.

However, significant catches were recorded for this stock in 2022, with an increase in catch by 78% from 2021 to 611,000 tonnes in 2022. Whilst biomass levels remained stable in 2022, there is a downward trend in the average size of sardines caught in this area in recent years, which implies that vigilance should be exercised in the exploitation of this highly variable stock. Although projections indicate that the stock could sustain a slight increase in catches, the variability of the stock in relation to environmental conditions requires the adoption of a precautionary approach, and the Working Group advises that catches should not exceed 550,000 tonnes, which is less than the catch of 611,463 t in 2022.

[3] Schaefer dynamic production model; For a general description of how the production models work see Guide to Fishing at Maximum Sustainable Yield (MSY) — Seafish. For definitions and explanations of how the management targets are arrived at and how they relate to maximum sustainable yield (MSY) see section on Assessment models and reference points page 8

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Sardines in the southern zone C 2022

●○○○○ **Very Low risk**

The stock was assessed using a production model[3] by the CECAF working group in 2022 as being above the management target for biomass and below the management target for fishing mortality. The management targets are more precautionary than maximum sustainable yield MSY targets, and the stock status corresponds to a very low risk under the RASS guidelines.

Whilst the current status is assessed as under-exploited, there are trends which may be a cause for concern. The biomass, as estimated by acoustic survey, substantially decreased in Moroccan waters, which coincided with a decrease in catches, particularly for vessels fishing offshore. There is also a downward trend in the average size of the sardine caught in the fishery. In Mauritanian waters catches have substantially increased during the period 2015 until 2018 although now stabilised (see Management section), and this area is beyond the range of the routine acoustic survey used to assess biomass. These issues, and the variable nature of the stock in response to environmental conditions lead the Working Group to urge vigilance in the management of this stock.

This includes a advising that there should be total authorised catch (although they do not specify how much) set which is adaptive to variations in the stock. There is a need to monitor stock structure and abundance using fishery independent co-ordinated acoustic surveys throughout the species range, however the current surveys are centred on Moroccan waters.

Management in central zones A and B based on CECAF and Gascoigne 2019

●●●○○ **Moderate risk**

The management of sardine in Zones A and B has been scored a moderate risk.
Whilst the advice from the assessments does not currently translate transparently into management measures there are measures in place which are rational in relation to the life-history of the stocks and characteristics of the fisheries. These include licensing, which can be limited, if necessary, gear restrictions, spatial zoning, and seasonal closed areas. The surveillance and enforcement in this fishery are generally good.

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Advised and agreed catches

There is no Total Allowable Catch (TAC) specifically for this stock set, an average catch of 352,570 t per annum has been caught during the period 2015-2020. However, in 2021 catches were 344,261 t and increased to 611,463 t in 2022. This is compared with the advised catch of 550,000 t per annum for the period 2019-23 based on the 2019 and 2023 assessments. So the catches of sardines increased from 37% below to 11% above the advised TAC for this stock in the period 2021-22. Clearly there is a need for the Moroccan government to consider whether further measures are required within their management framework.

Stock harvesting strategy

Quote from Gascoigne 2019

"The decision-making process for fisheries management in Morocco has developed progressively, particularly since the implementation of the octopus fishery management plan in 2001. Overall, the structure for management decision-making has become a lot more robust but varies between fisheries depending on how much data and scientific analysis is available and the management objectives concerned. The central objective for all fisheries is, however, to find an appropriate balance between the sustainability of the resource and socio-economic needs of those depending on the fishery. This is particularly complex for the small pelagic fishery, because the size of stocks and their availability to the fishery is strongly dependent on environmental conditions (oceanography and weather)."

Surveillance and enforcement

An overarching framework for fisheries development and management in Morocco is provided by the strategy 'Halieutis' – for development and competitiveness of the Moroccan fisheries sector. The key elements for implementation of the management plan (i.e. research, control and enforcement system, traceability systems, review and evaluation) are all in place, according to the Halieutis strategy document. In relation to enforcement specifically, landings of the coastal and trawler fleets are carefully monitored and the vessels are equipped with VMS.

Management Zone C based on CECAF/FAO and Gascoigne 2019

●●●●○ **High risk**

There is evidence of collaboration between the parties exploiting this transboundary stock in research and assessment, within the framework of FAO/ CECAF. However, it is unclear whether this co-operation extends to joint management, for example regional agreements on catch or effort limits, hence management of this stock is perceived as at a higher risk level than the stock in Zones A and B.

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Advised and agreed catches.

The stock was considered not fully exploited in 2019, with the assessors commenting that the catches have risen in recent years, by 16% in the period 2016-2020. Advice indicates that status quo catches, which in 2018 totalled 904,442 t would be within sustainable limits in forward projections to 2023. Although catches have decreased in more recent years from 759,770 t in 2021 to 685,319 t in 2022, this coincided with a reduction in the estimated biomass from the acoustic survey. This implies that there is an imperative for more responsive management as advised by the CECAF/FAO working group.

There is a TAC set by Morocco for Zone C, which applies to species designated as small pelagics; sardines, sardinella, horse mackerel, mackerel, and anchovy. It is currently set at 1 million tonnes per annum, with a ceiling on catches by foreign-flagged freezer trawlers under fishing agreements (EU – 80,000 tonnes total, Russia – 100,000 tonnes total)

Stock harvesting strategy

There is an international dimension to the catches in the southern zone C making this a transboundary stock, the management of which requires collaboration with neighbouring countries most notably Mauritania. In particular the high rate of increases in purse seine catches reported by Mauritania, which has seen an increase in catch from 1678 t in 2015 to 294,953 t in 2018 may be a risk factor, although this increase has not continued, and catches are now more stable. A draft management plan was produced in Mauritania in 2022, which explicitly recognises that the stocks are shared and that consultation at the subregional level is required to ensure sustainability. More details are given in MRAG, (2021).

Ukrainian and Senegalese fleets have also reported catches from this stock although the Senegalese catch data were not available for the 2019 CECAF Working Group.

Surveillance and enforcement

In Moroccan waters the fishery is covered by the Halieutis strategy discussed above which includes monitoring, control and enforcement. In Mauritania the signing of a Sustainable Fisheries Partnership Agreement with the EU, should improve resources available for fisheries governance, which is not as well developed as in Morocco (MRAG, 2021)

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Bycatch in Moroccan waters of Zones A,B and C

●●○○○ **Low risk**

This fishery has been scored low risk Capture of resource species horse mackerel (*Trachurus trachurus* and *T. recae*) chub mackerel (*Scomber colias*) and anchovy *Engraulis encrasicolus* occurs and all these stocks are assessed as fully exploited, using the same precautionary reference points as the sardines. Results from observer surveys indicate a low level of interaction with Endangered Protected and Threatened (ETP) species.

Targeting

The predominant gears used in this mixed pelagic fishery are seine netters and pelagic trawlers. Whilst in general, pelagic fisheries can be more targeted than demersal fisheries, the management of these fisheries in Moroccan waters is under a combined management approach for several species. Besides sardines, the other named species are sardinella (round sardinella *Sardinella aurita*, and flat sardinella *S. maderensis*), horse mackerel (*Trachurus trachurus* and *T. recae*) chub mackerel (*Scomber colias)* and anchovy *Engraulis encrasicolus*. Although catches of round sardinella, which is assessed as overfished by CECAF, have occurred in Moroccan fisheries during the decade 2010-20, the catches have fallen substantially and amount to less than 2 percent of the catch of this stock in 2020. The catches of flat sardinella, which is also overfished, have not been very high in Moroccan fisheries in the decade 2010-20 and are reported as zero in 2020 (based on CECAF 2021).

The cause of this reduction in sardinella catches is likely to be linked to changes in the distribution of the species linked to hydrographic conditions. Sardinella species are associated with warmer sub-tropical waters and sardines associated with the colder south flowing Canary current. Catches of sardines in Mauritanian waters have been higher in recent years, hence indicating that the colder waters of the Canary current are flowing past the Moroccan-Mauritanian boarder, hence constraining the range of the sardinella species to the south of the boarder. This is a simple explanation of what is a complex system, which should be understood through several indicators (Gascoigne pers. com).

Endangered Threatened and Protected (ETP) species and discards

It is not completely clear what species are formally protected under Moroccan law, so here we follow others in assuming that groups such as marine mammals, turtles and seabirds have some protection either nationally or internationally (e.g. via CITES or other international agreements). Results from 2015-17 observer data from the

Refrigerated Sea Water (RSW) seiner, EU and Russian freezer trawler fleets, found very low rates of discarding and found low interactions with protected species. The conclusion of the analysis of observer data is that discard rates are minimal (<<5%) for both gear types and that interactions with ETP species are rarely observed.

Mitigation measures

For chub mackerel a reduction in catch of around from 413,875 t in 2022 to 340,000 t is advised for 2023, on precautionary grounds. These measures would require international management agreement. However, stock biomass has increased since the previous assessment in 2018 and catches have shown a downward trend since 2020. There is some evidence that purse seiners and pelagic trawlers are targeting chub mackerel as a substitute for sardines in locations where sardines are less available.

For horse mackerel catches there is scope for an increase level of catch up from 253,469 t (both species) in 2022 to 300,000 t in 2023.

Habitat risk

●○○○○ **Very Low risk**

The seabed effects of the fishery are scored a very low risk. The gear is pelagic so does not impinge on marine seabed habitats.

However, the fishery may have effects on the pelagic ecosystem. The marine ecosystem off the Atlantic coast of Morocco is largely driven by physical processes – notably upwelling of cool, nutrient-rich water, making it highly productive (hence the reason why this fishery exists). Sardines and other small pelagics are key species in the trophic web because they are the prey species for larger fish, birds, marine mammals and other species.

Because of this the FIP investigated whether these sardine stocks qualified as key low trophic level stocks (key LTL stocks) under the MSC certification process and hence would require more precautionary management. This has stimulated ecological modelling work and discussion to determine whether these sardine stocks should be regarded as key LTL stock and whether the management of the stocks can meet the more precautionary LTL criteria. The results indicate that this is possible, if managers adopt approach whereby a certain level of spawning stock biomass were left in the sea annually; the $B_{escapment}$ approach (Cook 2019). Preliminary analysis of the data up until 2019 indicates that this approach may be viable at least for the stock in the southern zone (see link to FIP).

Assessment models and reference points

The main assessment models used for these stocks are based on production models. The assumption behind production models is that if an unfished population is reduced by fishing there will be Figure 2 compensatory growth and/or reproduction. That is, the fish will grow and/or breed faster, creating 'surplus production'.

By modelling the surplus production response at different levels of biomass, the biomass B_{MSY} and fishing mortality F_{MSY} which produces maximum sustainable yield (MSY) are estimated. The concept is illustrated in, where high fishing mortalities result in a low biomass, unproductive stock and yields are maximised at F_{MAX} and B_{MAX} which is the point of maximum surplus production.

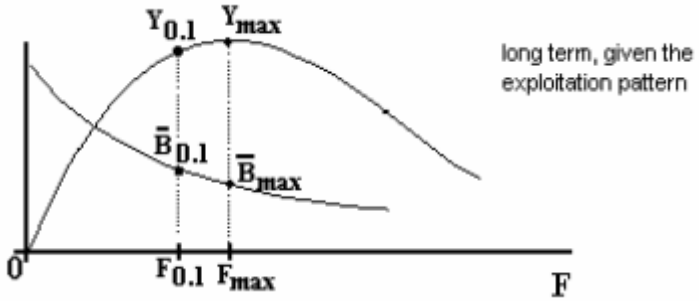

Figure 2 Illustrates a yield curve (fishing mortality vis long term equilibrium catch) with the reference points for fishing mortality (x-axis) yield (y-axis) and biomass (y-axis). Y_{max} and F_{max} corresponds to MSY, B_{max} to the biomass which produces MSY. $F_{0.1}$ is fishing mortality where the gradient of the Yield Curve is $1/10$ of the gradient at the origin, and $B_{0.1}$ corresponds to the equilibrium biomass when fishing mortality is at $F_{0.1}$

The equilibrium model produces the yield and biomass curves illustrated in Figure 2. $F_{0.1}$ is the fishing mortality where the gradient of the Yield Curve is $1/10$ of the gradient at the origin and $B_{0.1}$ corresponds to the equilibrium biomass when fishing mortality is at $F_{0.1}$. So therefore $F_{0.1}$ is smaller than F_{MAX} (or F_{MSY}) and $B_{0.1}$ is larger than B_{MAX} (or B_{MSY}). Note that the shape of these curve is diagrammatic, the shape of the curves would depend on the data and the model fitted.

The target reference points used in these assessments are fishing mortality (F) = $F_{0.1}$ and Biomass reference points $B_{0.1}$. Limit reference points are F = F_{MSY} and B = B_{MSY}. Therefore, if the reference points are used for management the result should be long term biomass above that associated with MSY and fishing mortality below that associated with F_{MSY}. Although long term yield will be slightly lower than MSY this approach is more precautionary and should result in a larger, more resilient biomass in the sea.

Certification and Fisheries Improvement Projects (FIPS)

There are no currently certified fisheries on these stocks. Although the FIP is currently classed as inactive substantial progress has been made with a summary given in Gascoigne 2019. The main issue is in relation to how scientific advice is translated

into management action in terms of a harvest control rule (see management scores above) and harvest control rules and tools.

Other relevant FIPs

Mauritanain small pelagic FishSource
Mauritania small pelagics - purse seine | Fishery Progress

Glossary

Term	Definition
Fishing Mortality: F	The rate of mortality due to fishing. In some texts it is referred to as "Fishing pressure". The scientists and managers seek to adjust fishing mortality through management measures such as catch limits (or TACs) on a stock to keep the stocks inside safe biological limits and optimise yields at MSY (see below)
CECAF	Is an inter-governmental organisation established in 1967 under the auspices of the United Nations Food and Agricultural Organisation (FAO). Its main functions are to promote the rational use of fisheries resources, to assist in establishing a basis for regulatory measures and to encourage training. Its area of competence is the eastern central Atlantic between Cape Spartel and the Congo River. Fishery Committee for the Eastern Central Atlantic (CECAF) - United Nations Economic and Social Commission for Western Asia (unescwa.org)
Harvest Control Rule (HCR)	A Harvest Control Rule is a set of well-defined management actions that are taken in response to changes in stock status.
Management plans	Management plans are agreed between the parties exploiting a stock, usually governments. They can take the form of a set of decision rules guiding the management of the stock with pre agreed reference points.
Maximum Sustainable Yield: MSY	Catching the maximum quantity that can safely be removed from the stock while maintaining its capacity to produce sustainable yields in the long term.
Spawning stock biomass ('SSB');	This is an estimation of the quantity of breeding adults and hence the reproductive capacity of the stock, measured in tonnes.
Total Allowable Catch: TAC	The Total Allowable Catch (TAC) is a catch limit (expressed in tonnes for a fishery generally for a year or a fishing season.

References

Cook, R (2019) A Review of the assessment of the southern stock of Sardine*, Sardina pilchardus*, in Moroccan waters; University of Strathclyde https://fisheryprogress.org/system/files/action_proof_files/maroc-report_robin_1oct2019.docx#overlay-context=node/4196/improvement

FAO/CECAF (2019) Report of the WORKING GROUP ON THE ASSESSMENT OF SMALL PELAGIC FISH OFF NORTHWEST AFRICA Casablanca, Morocco, 8–13 July 2019 https://openknowledge.fao.org/server/api/core/bitstreams/85fbae8a-5137-4f11-a94f-59e3d52f86ea/content

FAO/CECAF (2021) Report of the Working Group on the Assessment of Small Pelagic Fish of Northwest Africa, Virtual Meeting, 21–25 June 2021/Rapport de groupe de travail sur l'évaluation des petits pêlagiques au large de l'Afrique nord-occidentale, Réunion virtuelle, 21-25 juin 2021 https://openknowledge.fao.org/items/66bcbfa4-94fb-487d-99ac-4f60a69ec082

FAO/CECAF (2023) FAO WORKING GROUP ON THE ASSESSMENT OF SMALL PELAGIC FISH OFF NORTHWEST AFRICA 2023 Summary Report; preliminary results https://openknowledge.fao.org/server/api/core/bitstreams/402e8343-87d0-471a-b288-4397f5e7af32/content

Gascoigne, J., (2019) Moroccan sardine fishery : assessment in relation to the MSC standard
FINAL – 29 October 2014 REVISED 17 January 2019 – revisions in red https://fisheryprogress.org/system/files/documents_assessment/sustainability%20evaluation%2029oct2014%20revised%2017jan2019.docx

Kingdom of Morocco; Halieutis strategy https://www.maroc.ma/en/content/halieutis

Mounir, A., Hichami, N., Chouikh N., Mounir M., Znari, El qendouci, M, Alahyane, H., (2022)
Discrimination of the sardine stocks by using a morphometric and meristic analysis along the Moroccan Atlantic coast Egyptian Journal of Aquatic Biology & Fisheries Vol. 26(4): 795 – 805 https://ejabf.journals.ekb.eg/article_254432_d1f2081eb1c1781826aeb1e0544f8915.pdf

Mounir, A., Hichami, N., Chouikh N., Ouknin,M., Alahyane, A., Alahyane, H., (2023) Evaluation of Otolith Shape as an Approach for Stock Discrimination of Sardina pilchardus off the Moroccan Atlantic Coast Egyptian Journal of Aquatic Biology &

Fisheries Vol. 27(3): 211 – 222.https://ejabf.journals.ekb.eg/article_300856_550c1dd7890a3c8561bb6fc06e281c7d.pdf

MRAG (2021) Mauritania small pelagics fishery by the coastal fleet Summary Report GB2786 https://fisheryprogress.org/system/files/documents_assessment/Summary_small%20pelagics_Mauritania_Final.pdf

REPUBLIQUE ISLAMIQUE DE MAURITANIE MINISTERE DES PECHES ET DE L'ECONOMIE MARITIME (2022) PLAN D'AMENAGEMENT DES PETITS PELAGIQUES DANS LA ZEE MAURITANIENNE https://www.marin-trust.com/sites/marintrust/files/2023-12/PAP-PP_VF%2008112022%20-%20compressed_compressed.pdf

Shukhgalter, O. A (2013) Parasite fauna of the European Pilchard (Sardina pilchardus Walbaum, 1792) from the Atlantic coastal water of North Africa: application of latitudinal patterns analysis for the host intraspecific structure Parazitologiia 47(4):273-87 https://pubmed.ncbi.nlm.nih.gov/25434194/

Further reading

Seafish has produced a series of further information including detailed guides to fisheries management and assessment. These can be accessed from here

Relevant fishsource profiles
FishSource - European pilchard - NW Africa southern
FishSource - European pilchard - NW Africa central

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