UN environment programme CMS

MEMORANDUM OF UNDERSTANDING ON THE CONSERVATION OF MIGRATORY SHARKS

CMS/Sharks/MOS4/Doc.10.5
12 January 2023
Original: English

4th Meeting of the Signatories (Sharks MOS4)
Bonn, 28 February – 2 March 2023
Agenda Item 10

REGIONAL PRIORITIZATION OF SHARK AND RAY SPECIES LISTED IN SHARKS MOU ANNEX 1 AND CMS APPENDICES

(Prepared by the Advisory Committee and the Secretariat)

1. The 3rd Meeting of Signatories (MOS3) of the Sharks MOU tasked the Advisory Committee (AC) with developing a methodology to prioritize, on a regional basis, recommendations for conservation and management action, as outlined in the Sharks MOU Programme of Work and Sharks MOU fact sheets for individual species or species complexes.

2. As a first step to addressing this request, the AC has developed a preliminary methodology to prioritize CMS- and Sharks MOU-listed shark and ray species for which research and conservation efforts should be increased. The two main areas of focus are fisheries stock assessments and management, and habitat and spatial management.

3. This document provides information on the development of this methodology. The methodology is presented in Annex 1.

4. This document also provides examples of the use of the methodology, in two case studies for two different Food and Agriculture Organization of the United Nations (FAO) Fishing Areas, presented in Annex 2.

5. The Secretariat has proposed draft decisions of this meeting to support the continued work to refine the approach, included in Annex 3 for consideration at the meeting.

6. In Annex 4, the Secretariat has proposed a draft text of activities that Signatories may wish to include in their Programme of Work (2023-2025), also discussed under agenda item 12.

Background

7. Many species of sharks and rays are, to varying degrees, data limited. Generally, the main types of data and knowledge that are required to allow for more robust consideration of status, and to inform management options, include:

   — Stock structure (i.e., whether there is a single panmictic population, or whether there are discrete biological stock units that should be assessed separately);
   — Catch data, comprising landings data as well as estimates of total (and dead) discards;

- Indices relating to the size of the stock (which may be estimates of biomass for stocks that have been subject to commercial exploitation, or indices of abundance for rarer species);
- Life-history information, including reproductive parameters (e.g., periodicity of the reproductive cycle, age, and growth data);
- Spatial ecology, including movements, migration, and habitat use.

8. All shark and ray species listed in the Appendices of CMS and/or in Annex 1 of the Sharks MOU are assessed periodically by the International Union for Conservation of Nature (IUCN), as part of the IUCN Red List of Threatened Species™. These assessments provide important summary information and can also highlight species of concern. For some of the listed species, however, more thorough and data-driven, evidentiary stock assessments are undertaken by the relevant Regional Fisheries Management Organisations (RFMOs) and/or Regional Fisheries Bodies (RFBs). Such stock assessments, however, tend to focus on the main commercial species for which there are more data, whilst those species that are data-limited may not be subject to robust and/or regular stock assessments.

9. Progress has been made by various RFMOs and RFBs in conducting robust stock assessments for commercially important species that are also listed in Annex 1 of the Sharks MOU (e.g., Shortfin Mako Shark (*Isurus oxyrinchus*) in the North Atlantic and Porbeagle (*Lamna nasus*) in the North-east Atlantic). These stocks will generally be expected to be assessed over varying scales (usually on a biannual to quinquennial basis) by the relevant organizations. However, it is still unclear as to whether comparable efforts would be undertaken for the relevant stocks of other Sharks MOU and CMS-listed shark and ray species.

10. In future, national research efforts may often be focused on those shark and ray species that are of greater national interest. This may relate to species that are either relatively more common in national waters (and so may be studied with greater scientific rigour), that interact with national fishing fleets in national or international waters, that are of commercial interest (whether historically and/or currently), or due to other policy drivers (e.g., concerning biodiversity issues and national/international biodiversity commitments). Such national interests may also translate into greater interest from international meetings of relevant RFMOs and RFBs.

11. Given the above, it is important to identify those CMS- and Sharks MOU-listed shark and rays species which should be subject to more coordinated and collaborative regional research. In this document, the AC has focussed on developing a methodology for the prioritization of species for future research to support fisheries management and stock assessments, and habitat and spatial management. This initial focus should not lead to inhibiting existing work programmes and ongoing assessment, nor should advisory cycles for other stocks be reduced.

12. Notwithstanding the rationale for prioritizing species for more dedicated research, it is stressed that relevant studies to monitor population trends, improve biological understanding of the stocks and evaluate anthropogenic impacts, including fisheries interactions (e.g., catch (landings and discards), catch rates and discard survival) and habitat degradation are, in general, needed for many species, including listed species. Specific research requirements for individual species have been provided on the Sharks MOU fact sheets for individual species or species complexes.

13. Prioritizing species/stocks for further work may consider a range of factors, including:

- Conservation importance (determined by (1) listing status under relevant international conservation treaties and (2) status according to the IUCN Red List;
- Frequency and type of assessment in place;
- The current population trend;
- Management measures currently in place;
- The ecosystem and habitat that the species occupies;
- The degree of habitat protection in place;
- The interaction between species and fisheries;
- The importance of the region to species and its constituent stocks.

MOU Mandate

14. In accordance with activity 3 of the Programme of Work (2019-2021), the AC was tasked to “further develop and prioritize areas of action with options by taxa, region, and other relevant factors".

Methodology to prioritize species for conservation

15. The AC has developed a methodology, based on a scoring system, to prioritize shark and ray species for increased research and conservation efforts in fisheries management areas, as well as habitat and spatial management. A detailed description of the methodology, including the underlying criteria used, scoring levels, and formulas to calculate the relative priority of species is provided in Annex 1.

Regional prioritization assessment

16. FAO Fishing Areas were chosen as the most appropriate regional units for the assessment.

17. This methodology was then applied in two case studies of FAO Fishing Areas: 21 (Northwest Atlantic) and 27 (Northeast Atlantic). The results of these case studies are presented in Annex 2 of this document.

18. **Case study 1** (FAO area 21) highlighted that Giant Devil Ray (*Mobula mobular*) and Oceanic Whitetip Shark (*Carcharhinus longimanus*) are of particular importance and require a better understanding of their stock status. Furthermore, it was shown that Spiny Dogfish (*Squalus acanthias*) and Basking Shark (*Cetorhinus maximus*) should be prioritized for habitat-related research.

19. **Case study 2** (FAO area 27) highlighted that Angelshark (*Squatina squatina*) and Common Thresher Shark (*Alopias vulpinus)* are of particular importance and require a better understanding of their stock status. In addition, Angelshark (*Squatina squatina*) and Tope Shark (*Galeorhinus galeus*) should be prioritized for habitat-related research.

Conclusions and recommendations for future work

20. This work used an exploratory approach to identify which species and stocks of CMS-and Sharks MOU-listed sharks and rays should be subject to more detailed study and assessment. The approach aims to prioritize species for a more meaningful assessment using a structured, standardized, and impartial method.

21. Future work could include improving the basis for characterizing and defining the distribution and importance of these stocks, examining the variability in the approach by having multiple experts complete the scoring, applying the approach to additional fishing areas, and considering additional and alternative approaches to prioritizing species and stocks. For further information, please see Annex 2 of this document.

22. To better identify priority species for all regions, the AC recommends that regional prioritization assessments are undertaken for all remaining FAO areas (see Annexes 3 and 4).

Action requested:

23. The Meeting is requested to:

    a) Note the methodology presented in Annex 1;

    b) Note the results of the two case studies presented in Annex 2;

    c) Review and agree on a final version of Draft Decisions to the Meeting in Annex 3;

    d) Review and agree on activities as suggested in Annex 4 and consider including those in the Programme of Work (2023-2025).

ANNEX 1

REGIONAL PRIORITIZATION OF SHARK AND RAY SPECIES LISTED IN SHARKS MOU ANNEX 1 AND CMS APPENDICES

METHODOLOGY

Introduction

1. The Sharks MOU Advisory Committee (AC) has developed a methodology to prioritize CMS- and Sharks MOU-listed shark and ray species for which research and conservation efforts should be increased, in the two main areas of:

   a) Fisheries management and stock assessments; and

   b) Habitat and spatial management.

2. The methodology uses a scoring system for the following components to highlight priority species:

   - **Conservation importance - P_C**, determined by listing status under relevant international conservation treaties and status per the International Union for Conservation of Nature (IUCN) Red List of Threatened Species™ **(C_{1-5})**;

   - **Fisheries management importance – P_F**, determined by:

     - Frequency and type of assessment in place (A);
     - Current population trend (P);
     - Management applicable[1] (M);
     - Level of compliance with management measures (C), and
     - Discard survival (S).

   - **Habitat management importance – P_H**, determined by:

     - Ecosystem / habitat preference (E)
     - Degree of habitat protection (H);
     - The interaction between species and fisheries (O);

   - **Importance of the region to the species and its constituent stocks (R)**

Scores and Criteria

Conservation importance (PC)

3. The following criteria were considered appropriate for considering conservation importance: whether the species was listed on Appendix I or II of CMS, Annex 1 of the Sharks MOU, Appendix I or II of CITES, and IUCN Red List global status.

[1] Fisheries management measures that are in place and designed to have an impact on the fishing pressure on the stock in question (e.g., levels of fishing mortality or selectivity)

Conservation listings (C_{1-5})		Score
C_1	Sharks-MOU	Yes = 10 No = 1
C_2	CMS App I	Yes = 10 No = 1
C_3	CMS App II	Yes = 10 No = 1
C_4	CITES	Appendix I = 10 Appendix II = 5 No = 1
C_5	IUCN (Global)	CR = 10; EN = 8; VU = 6; NT = 5; LC = 2; DD = 5

4. A score for conservation importance (P_C) was then derived as:

$$P_C = (C_1 + C_2 + C_3 + C_4) \times C_5$$

5. The score for 'conservation importance' would range from 8 to 400. For example, if a species is not listed on the Sharks MOU, CMS, or CITES, and was assessed as Least Concern, it would be scored as:

$$P_C = (1 + 1 + 1 + 1) \times 2 = 8$$

6. Conversely, if a species were listed on both CMS Appendices, the Sharks-MOU and CITES Appendix I, and was assessed as Critically Endangered, it would be scored as:

$$P_C = (10 + 10 + 10 + 10) \times 10 = 400$$

Frequency and type of stock assessments (A)

7. The frequency and type of stock assessments, trends in population size, and the degree of applicable fisheries management measures were all scored to provide an indication of where more focused regional work could usefully be undertaken. The scoring system was based on more qualitative metrics, so as to allow all CMS- and Sharks MOU -listed species to be included.

8. The **frequency for which fish stocks are assessed** can vary, depending on the body coordinating the assessments, the advisory process, and the data available. For the purposes of the present study, 'frequent' stock assessments are considered to be those conducted on either an annual or biennial basis (as is the case for many data-rich teleost stocks), 'regular' stock assessments are considered to be undertaken on a triennial to quadrennial periodicity or cycle, or 'periodically' (>5 years between assessments).

9. Regular assessments are, in general, undertaken more for those stocks that are data-rich, subject to quota management (e.g., through a Total Allowable Catch (TAC)) or that may have variable and potentially high recruitment events. Whilst less frequent assessments may be undertaken for other stocks (e.g., that are less productive or not subject to TAC management), regular assessments for data-limited sharks and rays are required, if only to appraise new and available data and to better gauge stock status.

10. The **types of assessments** that may be undertaken for fish species range from fully quantitative stock assessments to data-limited approaches. The former provides reference points regarding the stock status and fishing pressure and may also provide projections and probabilities of stock recovery. The latter may rely on the different approaches being developed for data-limited stocks and may include indicators of stock size (e.g., trends in catch-per-unit effort (CPUE), which may be from scientific surveys or commercial data), and/or the use of length-based indicators.

11. The frequency and type of assessments[2] were scored (1-5) as follows:

Stock assessment (A)	Description of the frequency and type of assessment	Score
Frequent stock assessment	Frequent (every 1-5 years) quantitative stock assessment(s) of the stock(s)	1
Regular stock assessment	Regular (every 6-10 years) quantitative stock assessment(s) of the stock(s)	2
Periodic stock assessment	Periodic (once every 10 years or more) quantitative stock assessment(s) of the stock(s)	3
Frequent stock evaluation	Frequent (every 1-5 years) evaluation of the stock, including information on landings, stock trends, and reference points	4
Regular stock evaluation	Regular (every 6-10 years) evaluation of the stock, including information on landings, stock trends, and reference points	5
Periodic stock evaluation	Periodic (once every 10 years or more) evaluation of the stock, including information on landings, stock trends, and reference points	6
Frequent data appraisal	Frequent (every 1-5 years) appraisal of the stock, including available catch data, but no information on stock trends and reference points	7
Regular data appraisal	Regular (every 6-10 years) appraisal of the stock, including available catch data, but no information on stock trends and reference points	8
Periodic data appraisal	Periodic (once every 10 years or more) appraisal of the stock, including available catch data, but no information on stock trends and reference points	9
Not assessed	Insufficient data to conduct appropriate assessments, or no assessments undertaken	10

Population trend (P)

12. Where data on **population trends** are available, these can generally be classified as ‘increasing’, ‘stable’ or ‘decreasing’, though the perception of these may also be influenced by the temporal extent of relevant data. There can, however, also be species for which robust data to inform on population trends are unavailable. This lack of data can relate to a lack of appropriate monitoring, and/or a low likelihood of census due to a depleted status. For example, existing scientific survey data and/or commercial CPUE data from gears that are not appropriate for catching a particular species (i.e., catchability is low) cannot provide an appropriate abundance index. In contrast, if a species has a greatly reduced population size, then there would likely be a reduced encounter rate in surveys that would be expected to catch (or observe) the species effectively.

[2] Here, the term ‘assessment’ is used to refer to the range of assessments that may be undertaken by relevant RFMOs or RFBs (or national authorities if there is a discrete stock in national waters), and not IUCN assessments, which may have differences in underlying data and approaches.

13. Whilst detailed stock assessments, if undertaken, can be expected to provide the most robust data (e.g., using standardised abundance indices from fishery-independent and/or fishery-dependent data sources), other national studies (e.g. sightings schemes and other non-destructive surveys, citizen science projects, and collation of local ecological knowledge) may also provide useful indicators of stock size to inform on recent population trends, though these might only be semi-quantitative or qualitative in nature.

14. Information relating to stock trends should be based on the most robust and relevant information available. For the purposes of the present study, the status given in IUCN Red List assessments was not used. This was because IUCN Red List status was included in the scoring of 'conservation importance', the population trends reported in IUCN Red List assessments can be 'suspected', 'inferred', or 'observed' depending on the species, region, and data available, and the global scale of IUCN Red List assessments means that these publications may not always provide the fine scale population-level details required to analyse perceived stock units for the various species.

15. Population trends were scored (1-5) as follows:

Current population trend (P)	Description	Score
Increasing (high confidence)	Increasing population size (as indicated by a quantitative stock assessment) evident for a meaningful time-period[3]	1
Increasing	Consistent increase in a stock-size indicator evident for a meaningful time-period	2
Stable	Population size (or stock-size indicator) stable	3
Decreasing	Population size (or stock-size indicator) decreasing	4
Low population size	Population likely depleted, as indicators of population size are unquantified/uncertain, despite there being appropriate sampling programmes to survey the species[4]	5
Unknown	Population trends are unquantified/uncertain, as there are no appropriate input data for monitoring the stock size	4

Applicable Management (M)

16. The types of management measures that may be in place to limit/prohibit the retention of a species include measures such as quotas, trip limits, size restrictions, and prohibited listings. The effectiveness of the management of the various fisheries encountering sharks and rays can vary across the regions, depending on whether there are national or internationally-agreed measures in force across the main areas of the stock range where fisheries also occur, the level of compliance and enforcement, and the degree of discard survival.

[3] The extent of the time-period should relate to longer-term dynamics (e.g., generation length), and short-term increases, which may simply relate to inter-annual variation in estimated population size should not be used here.

[4] Appropriate sampling programmes would be those that use a gear (or technique) that would be suitable for catching (or observing) the species, have appropriate spatial and seasonal coverage, and a suitable number of sampling events.

17. The level of **management applicable to the stock** was scored (1-5) as follows:

Management applicable (M)	Description	Score
High	Prohibition or restrictive catch limits across most (>75%) of the stock range	1
Moderate	Prohibition or restrictive catch limits across much (>50%) of the stock range	2
Low	Prohibition or restrictive catch limits across some (>25%) of the stock range	3
Very low	Prohibition or restrictive catch limits across little (<25%) of the stock range	4
None	No protection/catch limits across the stock/species range	5

18. The effectiveness of management measures will also vary in relation to awareness programmes, fisher and fleet behaviour, **compliance,** and the degree and nature of any enforcement.

Level of Compliance (C)

19. The **level of compliance with management measures** was scored (1-5) as follows:

Compliance (C)	Description	Score
High	High levels of compliance/enforcement across the fisheries accounting for most of the exploitation of the stock	1
Moderate	Moderate levels of compliance/enforcement across the fisheries accounting for most of the exploitation of the stock	2
Unknown	Effectiveness of compliance/enforcement is unknown, but species of low economic value and so illegal fishing is unlikely	3
Low	Low levels of compliance/enforcement suspected across the fisheries accounting for most of the exploitation of the stock	4
Very low	Very low levels of compliance/enforcement and illegal fishing activity targeting the species is suspected to occur	5
Not applicable	No management measures to regulate fishing pressure on the stock, so 'compliance' is not applicable	3

20. **Discard survival**, which encompasses at-vessel mortality (AVM) and post-release mortality (PRM), is a key factor for considering both the efficacy of management measures and considering whether further management regulations may be required. Whilst there are numerous studies on AVM of, for example, the species taken in high seas longline fisheries, data are often more limited for other taxa and fisheries. Post-release mortality data are also often limited and given the low sample sizes in many such studies; the quantified values could be subject to change with improved sample sizes. Furthermore, both AVM and PRM will vary between fleets and gears, so available data may indicate a range of values. It is also noted that fisher behaviour can be a critical factor in influencing both AVM and PRM. Given the above, discard mortality may need to be scored here on a semi-quantitative scale, taking into consideration the available

data for the main fleets, or averaging values from available data. Depending on the area and the increasing amount of data becoming available, future iterations of this approach could potentially provide more specific approaches to scoring schemes.

Discard survival (s)

21. The discard survival was scored (1-5) as follows:

Discard survival (S)	Description	Score
Very high	At-vessel and post-release mortality indicates > 90% of captured individuals of the species (or closely related species) may survive capture in the main fisheries interacting with the species	1
High	At-vessel and post-release mortality indicates ca. 70-90% of captured individuals of the species (or closely related species) may survive in the main fisheries interacting with the species	2
Medium	At-vessel and post-release mortality indicates ca. 30-70% of captured individuals of the species (or closely related species) may survive in the main fisheries interacting with the species	3
Low	At-vessel and post-release mortality indicates ca. 10-30% of captured individuals of the species (or closely related species) may survive in the main fisheries interacting with the species	4
Very low	At-vessel and post-release mortality indicates <10% of captured individuals of the species (or closely related species) may survive in the main fisheries interacting with the species	5
Unknown	Data are unavailable and the potential magnitude of discard survival is unknown	4

Fisheries management importance (PF)

22. A relative score for **'fisheries management importance'** (P_F) was then derived as:

$$P_F = S \times (P + M + C + S)$$

23. The score would range from 4 to 200. For example, if a stock was subject to frequent quantitative assessments, was displaying an increasing population trend, fisheries exploitation was managed through regulations, compliance was high and discard survival was very high, then:

$$P_F = 1 \times (1 + 1 + 1 + 1) = 4$$

24. Conversely, if a stock was not assessed, if there were insufficient data to evaluate population trends (despite appropriate surveys being undertaken), if it was not subject to any fisheries management regulations to reduce fishing mortality, if there were low levels of compliance and enforcement and illegal target fisheries were known to occur, and if discard survival was very low, it would be scored as:

$$P_F = 10 \times (5 + 5 + 5 + 5) = 200$$

Habitat and spatial management

25. Spatial management is an important element for conserving biodiversity and managing human impacts for habitats and, potentially, species. The latter is of greater merit when the species has a restricted distribution/habitat and/or key stages of the life cycle utilises habitats that may be sensitive to anthropogenic disturbance or subject to high levels of anthropogenic activity.

26. In relation to species interacting with fisheries, however, there also needs to be due consideration of how spatial management may subsequently affect fisher behaviour and fisheries activity (e.g., vessel displacement, changing patterns of gear use), which can have knock-on effects on the species or other ecosystem features.

27. The merits of spatial management depend on the spatio-temporal distributions of the life-history stages of the species in question, their interactions with fisheries and other human activities (including the degree of mortality or population-level impacts), and habitat type (for species associated with coastal habitats or particular biological/geological seabed features).

28. Discard survival may also be an important factor when considering the utility of spatial management. For example, if a species interacts with one or more fishing gears but a high proportion of the individuals that are returned to the sea survive, then spatial management may not be required. Conversely, if managers wish to reduce fishing mortality on a stock, but discard mortality is high, then there may be merits in using spatial management to help reduce fishing mortality.

29. For the purposes of the present study, the prioritization of further work in relation to habitat-related management was related to the ecosystem/habitat occupied by the species, the degree of habitat protection in place, and the overlap with fisheries. The scoring system was based on more qualitative metrics, so as to allow all CMS-listed species to be included.

Ecosystem/ habitat preference (E)

30. The **ecosystem/habitat preference** of the species was scored as indicated below. Essentially, species with a more oceanic distribution and pelagic nature would receive a lower score than those species with more coastal distributions – given that their habitats would have a higher overlap with a range of anthropogenic activities.

Ecosystem and habitat (E)	Description	Score
Mesopelagic/ Oceanic	Pelagic species for which the species (and relevant life-history stages) are predominantly in oceanic waters (high seas), but spend most time in the mesopelagic zone (200-1000 m deep)	1
Pelagic/Oceanic	Pelagic species for which the species (and relevant life-history stages) are predominantly in oceanic waters (high seas), and spend most time in the epipelagic zone (0-200 m deep)	3
Pelagic/Oceanic and shelf seas	Pelagic species for which the species (and relevant life-history stages) are predominantly in both oceanic waters and shelf seas	4
Pelagic/Oceanic and important in shelf seas	Pelagic species for which the species are predominantly in both oceanic waters and shelf seas, but for which key life-history stages (e.g., feeding, mating, pupping, or nursery grounds) are concentrated in shelf seas (or around offshore islands and seamounts)	6

Shelf seas	Shelf species (pelagic or demersal) generally occur on the continental shelf (generally waters <200-400 m deep) with broad habitat use by all life-history stages	7
Shelf seas with key stages in defined areas	Shelf species (pelagic or demersal) generally occur on the continental shelf (generally waters <200-400 m deep) with key life-history stages occurring in more defined and restricted areas, or associated with specific habitats	8
Coastal species	Coastal species (generally waters <50 m deep) with key life-history stages in inshore and estuarine waters	10

Degree of habitat protection (H)

31. The **degree of habitat protection** was scored as below. It is noted that there are a wide range of Marine Protected Areas (MPAs), but many of these sites have not been designed specifically for sharks and rays (although in some cases, sharks and rays may be designated species of interest and known to occur in the MPA).

Habitat protection (H)	Description	Score
Spatial management in place	Network of MPAs already designated to protect key habitats/critical areas for the species across important parts of the species/stock range	1
Partial spatial management	Partial network of MPAs designated to protect key habitats/critical areas for the species across some parts of the species/stock range, but some areas of the species/stock range not included	2
Moderate spatial management	Species-specific spatial management measures apply in important parts of the species/stock range.	3
Limited spatial management	Spatial management measures that afford a degree of protection apply in some parts of the species/stock range.	4
No spatial management	No relevant spatial management in place for the species/stock	5

Interaction and overlap between species and fisheries (O)

32. The **interaction and overlap between species and fisheries** was scored as below, noting that the values given below may need to be treated as indicative values and to some extent a degree of 'expert judgement' may be required. This is particularly the case as the horizontal and vertical habitat use is uncertain or unknown for many species and may also vary between different environments.

Overlap with fisheries (O)	Description	Score
Very low	Very low (<10%) overlap between the spatial and bathymetric distribution of the stock with fisheries that may have a high catchability for the species in question	1
Low	Low (10-30%) overlap between the spatial and bathymetric distribution of the stock with fisheries that may have a high catchability for the species in question	2
Moderate	Moderate (40-70%) overlap between the spatial and bathymetric distribution of the stock with fisheries that may have a high catchability for the species in question	3

High	High (70-90%) overlap between the spatial and bathymetric distribution of the stock with fisheries that may have a high catchability for the species in question	4
Very high	Very high (>90%) overlap between the spatial and bathymetric distribution of the stock with fisheries that may have a high catchability for the species in question	5
Unknown	The level of overlap between the spatial and bathymetric distribution of the species/stock with fisheries is not known	4

Habitat management importance (P_h)

33. A relative score for '**habitat management importance'** (P_H) was then derived as:

$$P_H = E \times (H + O + S + P)$$

34. The score would range from 4 to 200. For example, if a species occurred in coastal and estuarine waters, was not the focus of any spatial management, had a very high spatial overlap with fisheries, had a very low discard survival, and had an unknown population trend due to its scarcity in surveys, it would score the highest.

$$P_H = 10 \times (5 + 5 + S + P)$$

Importance of the region to the species and its constituent stocks (R)

35. In terms of regional priorities, there is a rationale that any endemic species may be of proportionally greater relevance, given that the region could include the entire global population of that species.

36. Given that accurate, quantitative data on the distribution and abundance of most fish species are lacking, a qualitative score was used to allow the other factors to be weighted according to the importance of the region.

Regional importance (R)	Description	Score
Absent	Species does not occur in the area (excluding cases of extirpation), or no reliable records of occurrence	0
Extralimital	Isolated extralimital records of the species from the area of interest	1
Vagrant	Occasional records from the area of interest, but the species is only reported occasionally	2
Minor part of stock	Defined stock with only a small part (<25%) of the stock range in the area, and the main parts (>75%) of the stock range in neighbouring region(s)	3
Moderate part of stock	Defined stock with a moderate part (25-75%) of the stock range in the area	4
Moderate part of stock with key stages	Defined stock with a moderate part (25-75%) of the stock range in the area, but key life-cycle components (e.g., mating, nursery area) occur in the area	5
Main part of stock	Defined stock with most (>75%) of the stock range in the area, with a lower proportion (<25%) of the stock range extending into neighbouring region(s)	7
Defined stock unit(s)	Distinct stock(s) have been defined in the region of interest, but there are populations of the species elsewhere	8

Endemic	The species is endemic to the area of interest, but widespread in the area	9
Endemic and restricted	The species is endemic to the area of interest, and has a restricted distribution in the area	10

Regional prioritization

37. Regional priorities in relation to fisheries management and stock assessments were then prioritized as:

$$\text{Prioritization score} = (P_F \times R) + P_C$$

38. Similarly, regional priorities in relation to habitat and spatial management were prioritized as:

$$\text{Prioritization score} = (P_H \times R) + P_C$$

Suggestions for additional criteria for prioritization

39. Further criteria may be considered to be included in future regional prioritizations, such as:

- **Economic importance** (e.g., the economic importance for commercial, subsistence, and recreational fishers, and ecotourism);
- **Social/Cultural importance**;
- **Ecological importance**;
- **Biological vulnerability**, which may be based on the rate of population growth (if available) or various life-history parameters (e.g., maximum size, reproductive strategy), as well as the degree of overlap with fishing activities;
- The **degree of habitat degradation and habitat** loss;
- **Other potential threats** (e.g., the potential impacts of climate change, pollution (contaminants), marine plastics, underwater power cables, aggregate extraction, and deep-sea mining).

List of acronyms used throughout this document and its Annexes

AVM	At-vessel mortality
CPUE	Catch Per Unit Effort
CITES	Convention on the International Trade in Endangered Species of Wild Fauna and Flora
CMS	Convention on the Conservation of Migratory Species of Wild Animals
FAO	Food and Agriculture Organization of the United Nations
IUCN	International Union for Conservation of Nature
MPA	Marine Protected Area
PRM	Post-release mortality
RFB	Regional Fisheries Body
RFMO	Regional Fisheries Management Organization
Sharks MOU	Memorandum of Understanding on the Conservation of Migratory Sharks
TAC	Total Allowable Catch

ANNEX 2

CASE STUDIES ILLUSTRATING THE METHODOLOGY DEVELOPED FOR THE REGIONAL PRIORITIZATION OF CMS- AND SHARKS MOU-LISTED SPECIES

To illustrate the utilization of this approach, the methodology outlined in Annex 1 to this document has been applied in two case studies, which are presented below.

Case study 1 – Northwest Atlantic (FAO area 21)

1. There are approximately 19 species of CMS- and Sharks MOU-listed sharks and rays that occur in FAO Area 21. Some species that are in the more southern part of the area, such as Smalltooth Sawfish, are considered vagrants in the area.

Table 1: Species that may be of particular importance for research in FAO Area 21 in relation to fisheries exploitation and habitat use.

	Prioritization in relation to fisheries		Prioritization in relation to spatial management	
Rank	**Species**	**Score**	**Species**	**Score**
1	Giant Devil Ray *Mobula mobular*	760	Spiny Dogfish *Squalus acanthias*	902
2	Oceanic Whitetip Shark *Carcharhinus longimanus*	620	Basking Shark *Cetorhinus maximus*	784
3	Atlantic Devil Ray *Mobula hypostoma*	600	Great White Shark *Carcharodon carcharias*	749
4	Longfin Mako Shark *Isurus paucus*	592	Smalltooth Sawfish *Pristis pectinata*	680
5	Manta Ray *Mobula birostris*	550	Great Hammerhead *Sphyrna mokarran*	680
6	Bigeye Thresher *Alopias superciliosus*	516	Giant Devil Ray *Mobula mobular*	595
7	Smalltooth Sawfish *Pristis pectinata*	512	Manta Ray *Mobula birostris*	595
8	Common Thresher *Alopias vulpinus*	480	Porbeagle *Lamna nasus*	576
9	Basking Shark *Cetorhinus maximus*	448	Dusky Shark *Carcharhinus obscurus*	544
10	Great White Shark *Carcharodon carcharias*	420	Shortfin Mako Shark *Isurus oxyrinchus*	523
11	Silky Shark *Carcharhinus falciformis*	399	Oceanic Whitetip Shark *Carcharhinus longimanus*	485
12	Great Hammerhead *Sphyrna mokarran*	341	Scalloped Hammerhead *Sphyrna lewini*	428
13	Scalloped Hammerhead *Sphyrna lewini*	341	Atlantic Devil Ray *Mobula hypostoma*	408
14	Shortfin Mako Shark *Isurus oxyrinchus*	334	Smooth Hammerhead *Sphyrna zygaena*	396
15	Porbeagle *Lamna nasus*	282	Longfin Mako Shark *Isurus paucus*	352
16	Dusky Shark *Carcharhinus obscurus*	280	Bigeye Thresher Shark *Alopias superciliosus*	324
17	Smooth Hammerhead *Sphyrna zygaena*	276	Common Thresher *Alopias vulpinus*	324
18	Spiny Dogfish *Squalus acanthias*	202	Silky Shark *Carcharhinus falciformis*	324

	Prioritization in relation to fisheries		Prioritization in relation to spatial management	
Rank	**Species**	**Score**	**Species**	**Score**
19	Blue Shark *Prionace glauca*	158	Blue Shark *Prionace glauca*	305

2. Using the approach outlined above in Annex 1 of this document, the CMS- and Sharks MOU-listed species that were identified as being of particular importance for better understanding stock status (i.e., in relation to fisheries) in FAO Area 21 were Giant Devil Ray, Oceanic Whitetip Shark, Atlantic Devil Ray, and Longfin Mako Shark (Table 1).

3. Of these species, two are more associated with the continental shelf (*Mobula* spp.), and two are oceanic (Oceanic Whitetip and Longfin Mako) species.

4. The lowest ranking species were Blue Shark (assessed by ICCAT and with a broadly stable population) and Spiny Dogfish (currently assessed by the United States and Canada as showing signs of population stability or increase, following the introduction of management measures) (Table 1).

5. In terms of habitat-related research priorities, the highest-ranking species (Table 1) were Spiny Dogfish, Basking Shark, White Shark, and Smalltooth Sawfish. These species are all, wholly or partly, reliant on continental shelf seas and ranked highest primarily due to a combination of their IUCN Red List assessment and listing statuses on international agreements, as well as having no spatial or habitat management.

Case study 2 – Northeast Atlantic (FAO area 27)

6. At least 18 species of CMS- and Sharks MOU-listed sharks and rays occur in FAO Area 27. Whilst there are potentially some other species that might occur in the southernmost parts of the area (e.g., Great Hammerhead, Dusky Shark) these species would at most be vagrants to the area (Ebert & Dando, 1921).

Table 2: Species that may be of particular importance for research in FAO Area 27 in relation to fisheries exploitation and habitat use.

	Prioritization in relation to fisheries		Prioritization in relation to spatial management	
Rank	**Species**	**Score**	**Species**	**Score**
1	Angelshark *Squatina squatina*	870	Angelshark *Squatina squatina*	1670
2	Common Thresher Shark *Alopias vulpinus*	695	Tope Shark *Galeorhinus galeus*	970
3	Oceanic Whitetip Shark *Carcharhinus longimanus*	680	Common Thresher Shark *Alopias vulpinus*	828
4	Tope Shark *Galeorhinus galeus*	669	Porbeagle *Lamna nasus*	828
5	Longfin Mako Shark *Isurus paucus*	658	Spiny Dogfish *Squalus acanthias*	804
6	Basking Shark *Cetorhinus maximus*	560	Basking Shark *Cetorhinus maximus*	670
7	Common Guitarfish *Rhinobatos rhinobatos*	520	Common Guitarfish *Rhinobatos rhinobatos*	620
8	Manta Ray *Mobula birostris*	520	Oceanic Whitetip Shark *Carcharhinus longimanus*	494
9	Giant Devil Ray	520	Manta Ray	460

	Prioritization in relation to fisheries		Prioritization in relation to spatial management	
Rank	Species	Score	Species	Score
	Mobula mobular		*Mobula birostris*	
10	Smooth Hammerhead *Sphyrna zygaena*	486	Giant Devil Ray *Mobula mobular*	460
11	Bigeye Thresher Shark *Alopias superciliosus*	486	Smooth Hammerhead *Sphyrna zygaena*	444
12	Silky Shark *Carcharhinus falciformis*	456	Whale Shark *Rhincodon typus*	364
13	Porbeagle *Lamna nasus*	396	Bigeye Thresher Shark *Alopias superciliosus*	348
14	Whale Shark *Rhincodon typus*	370	Shortfin Mako Shark *Isurus oxyrinchus*	343
15	Great White Shark *Carcharodon carcharias*	300	Longfin Mako Shark *Isurus paucus*	343
16	Shortfin Mako Shark *Isurus oxyrinchus*	268	Great White Shark *Carcharodon carcharias*	294
17	Spiny Dogfish *Squalus acanthias*	180	Silky Shark *Carcharhinus falciformis*	291
18	Blue Shark *Prionace glauca*	140	Blue Shark *Prionace glauca*	185

7. Using the approach outlined above in Annex 1 to this document, the CMS- and Sharks MOU-listed species that were identified as being of particular importance for better understanding stock status (i.e., in relation to fisheries) in FAO Area 27 were Angelshark, Common Thresher Shark, Oceanic Whitetip Shark, Tope Shark and Longfin Mako Shark (Table 2).

8. Of these species, two are more associated with the continental shelf (Angelshark and Tope Shark), two are oceanic (Oceanic Whitetip and Longfin Mako Shark), whilst Common Thresher Shark inhabits both shelf seas and extends into oceanic waters.

9. The lowest ranking species were Blue Shark (assessed by ICCAT and with a broadly stable population) and Spiny Dogfish (currently assessed by ICES and showing signs of population increase following the introduction of management measures) (Table 2).

10. In terms of habitat-related research priorities, the highest-ranking species (Table 2) were Angelshark and Tope, followed by Common Thresher Shark, Porbeagle, and Spiny Dogfish. These species are all, wholly or partly, reliant on continental shelf seas, and there are either discrete stocks within FAO Area 27, or that area is the main part of the perceived stock unit.

Conclusions and recommendations for future work

11. As highlighted earlier, the exploratory approach outlined here was designed to identify which species and stocks should be subject to improved study. Hence, those species subject to assessment and meaningful management would score less. Whilst current assessment and management for these stocks should be continued, the current approach aims to help prioritize which additional species should be subject to more meaningful assessment.

12. Future work could:

- Provide a more robust basis for characterising and defining the distribution and regional importance of stock units of CMS- and Sharks MOU-listed sharks and rays by FAO Fishing Area;
- Explore further factors that could be incorporated into the scoring approach (e.g. if there are national conservation regulations that could be considered);
- Explore the variability in the approach (e.g., by having multiple experts complete the scoring and then examine the variability in the outcomes);
- Undertake the current approach for additional FAO Fishing Areas (see Table 3);
- Consider additional and alternative approaches to prioritizing species and stocks.

13. There was also some consideration of incorporating 'biological vulnerability' in the approach. Several biological traits may result in a species being particularly susceptible to over-exploitation and/or to the impacts of other anthropogenic pressures. These traits include those relating to population productivity, life-history strategy (e.g., reproductive mode), and habitat requirements (e.g., critical habitats), whilst an aggregating nature can also make species more vulnerable to targeted exploitation.

14. Estimates of population productivity, such as the maximum intrinsic rate of population increase, require knowledge of age, growth rates, and reproductive potential, although the required age data are often limited, unreliable, or lacking for data-limited sharks and rays. In the absence of quantified data on population productivity, traits such as maximum size, fecundity, and duration of the reproductive cycle are potential surrogates.

15. In terms of habitat, fish species that utilise highly specific habitats and/or geographical locations for all or part of the life cycle (especially if these are subject to anthropogenic pressures) may also be impacted by habitat loss or habitat degradation.

16. Species that are aggregating may also be more susceptible to fishing pressure (e.g., through target fisheries), though scoring the aggregating nature of species may be variable and influenced by a range of factors (e.g., life-history stage, seasonal events in the life cycle or ecosystem, population size, environmental conditions, prey abundance etc).

17. Whilst biological attributes could be considered in future approaches to prioritize, they were not included in the current approach, as the CMS-listed species have typically been shown to have declined and already demonstrated a high susceptibility to fishing pressure. If prioritization exercises were to include a wider variety of species, and where there would be a greater range and more contrast in biological attributes, then the inclusion of biological vulnerability would be of greater importance.

Table 3: Occurrence of CMS- and the Sharks-MOU-listed shark and ray species by FAO Major Fishing Area.

(● = present; ◉ = edge of distribution/extralimital records; ○ = absent, ? = uncertain; NA = Not applicable) for FAO Fishing Areas 21 (NW Atlantic), 27 (NE Atlantic), 31 (Western Central Atlantic), 34 (Eastern Central Atlantic), 37 (Mediterranean Sea and Black Sea), 41 (SW Atlantic), 47 (SE Atlantic), 51 (Western Indian Ocean), 57 (Eastern Indian Ocean), 61 (NW Pacific), 67 (NE Pacific), 71 (Western Central Pacific), 77 (Eastern Central Pacific), 81 (SW Pacific), 87 (SE Pacific). Data combined for the Southern Ocean (SO; Areas 48, 58 and 88). Arctic Sea (FAO Area 18) not included. Adapted from Last *et al.* (2016) and Ebert *et al.* (2021).

Scientific name	21	27	31	34	37	41	47	51	57	71	81	61	67	77	87	SO
S. acanthias (N)	●	●	◉	◉	●	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
S. squatina	○	●	○	●	●	○	○	○	○	○	○	○	○	○	○	○
A. pelagicus	○	○	○	○	○	○	○	●	●	●	◉	◉	○	●	●	○
A. superciliosus	○	●	○	○	○	○	○	●	●	●	●	●	○	●	◉	○
A. vulpinus	●	●	●	●	●	●	●	●	●	●	●	◉	◉	●	●	○
C. maximus	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	○
C. carcharias	●	◉	●	●	●	●	●	●	●	●	●	●	●	●	●	○
I. oxyrinchus	●	●	●	●	●	●	●	●	●	●	●	●	◉	●	●	○
I. paucus	●	●	●	●	◉	●	●	●	●	●	◉	●	?	●	●	○
L. nasus	●	●	◉	◉	●	●	●	◉	●	?	●	○	○	○	●	●
R. typus	○	◉	●	●	○	●	●	●	●	●	◉	◉	○	●	●	○
G. galeus	○	●	○	●	●	●	●	○	●	○	●	○	◉	●	●	○
C. falciformis	◉	◉	●	●	◉	●	●	●	●	●	○	◉	○	●	●	○
C. longimanus	◉	◉	●	●	?	●	●	●	●	●	◉	◉	○	●	●	○
C. obscurus	●	?	●	●	◉	●	●	●	●	●	◉	◉	○	●	?	○
P. glauca	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	○
S. lewini	◉	?	●	●	◉	●	●	●	●	●	◉	◉	○	●	●	○
S. mokarran	●	?	●	●	◉	●	●	●	●	●	◉	◉	○	●	●	○
S. zygaena	●	●	●	●	●	●	●	●	●	◉	●	●	○	●	●	○
R. rhinobatos	○	◉	○	●	●	○	●	○	○	○	○	○	○	○	○	○
R. australiae	○	○	○	○	○	○	○	●	●	●	?	◉	○	○	○	○
R. djiddensis	○	○	○	○	○	○	○	●	○	○	○	○	○	○	○	○
R. laevis	○	○	○	○	○	○	○	●	●	?	○	●	○	○	○	○
A. cuspidata	○	○	○	○	○	○	○	●	●	●	○	?	○	○	○	○
P. clavata	○	○	○	○	○	○	○	?	●	●	○	○	○	○	○	○
P. pectinata	◉	○	●	●	?	?	?	○	○	○	○	○	○	○	○	○
P. pristis	○	○	●	●	?	●	?	●	●	●	○	○	○	●	●	○

Scientific name	21	27	31	34	37	41	47	51	57	71	81	61	67	77	87	SO
P. zijsron	○	○	○	○	○	○	○	●	●	●	○	◉	○	○	○	○
M. alfredi	○	○	○	○	○	○	○	●	●	●	◉	◉	○	●	○	○
M. birostris	●	●	●	●	○	●	●	●	●	●	●	●	○	●	●	○
M. eregoodoo	○	○	○	○	○	○	○	●	●	●	◉	◉	○	○	○	○
{ *M. hypostoma*	◉	○	●	○	○	●	?	○	○	○	○	○	○	○	○	○
{ *M. rochebrunei*	○	○	○	●	○	○	●	○	○	○	○	○	○	○	○	○
M. kuhlii	○	○	○	○	○	○	○	●	●	●	?	?	○	○	○	○
{ *M. japanica* / *M. mobular*	◉	◉	●	●	●	●	●	●	●	●	●	●	◉	●	●	○
M. munkiana	○	○	○	○	○	○	○	○	○	○	○	○	○	●	●	○
M. tarapacana	?	?	●	●	○	?	●	●	●	●	?	●	○	●	●	○
M. thurstoni	○	?	?	●	○	●	?	●	●	●	?	●	○	●	●	○
Total no. of CMS-listed species	19	18	22	26	17	21	21	29	30	27	20	24	7	23	22	1
*Northern hemisphere populations only																

References

Ebert, D.A. and Dando, M. (2021) *Sharks, rays and Chimaeras of Europe and the Mediterranean.* Wild Nature Press, 383 pp.

Ebert, D.A., Fowler, S. and Dando, M. (2021) *Sharks of the World: A Complete Guide*. Wild Nature Press, 624 pp.

Last, P., Naylor, G., Séret, B., White, W., de Carvalho, M. and Stehmann, M. (Eds.) (2016) *Rays of the World*. CSIRO publishing.

ANNEX 3

DRAFT DECISIONS OF THE MEETING

Signatories

1. Requests the Advisory Committee to continue developing the methodology presented in CMS/Sharks/MOS4/Doc.10.5/Annex 1, and use the results of this, and other approaches that may be developed, to better identify CMS- and Sharks MOU-listed species and conservation measures of highest priority at regional scales (per FAO Major Fishing Area).

ANNEX 4

DRAFT ACTIVITIES FOR INCLUSION IN THE PROGRAMME OF WORK 2023 – 2025

No.	Activities	Mandate[5]	Priority ranking[6]	Time frame[7]	Responsible entity[8]	Funding needs for implementation	Secretariat staff required for implementation (working days)
Species Conservation/Habitat Conservation							
X. Regional prioritization of shark and ray species listed in Sharks MOU Annex 1 and CMS Appendices							
x.1	AC to continue to identify species of regional priority using the methodology presented and still under development.	MOS4 decisions	tbd	tbd	AC	**€25,000** (consultancy to support the AC)	
x.2	Provide financial support for the regional prioritization of additional FAO areas.	MOS4 decisions	tbd	tbd	SIG, SEC (as funds would be provided to the Secretariat)	See above	**P staff: 5** **G staff: 0.5** (recruiting and guiding consultant)

5 Conservation Plan (CP), Terms of Reference of the Advisory Committee (AC TOR), Terms of Reference of the Secretariat (SEC TOR)
6 Core Secretariat activities and suggested priorities (High, Medium)
7 Year(s) during which activity should be implemented
8 Signatories (SIG), Advisory Committee (AC), Secretariat (SEC), Conservation Working Group (CWS), Consultants, Cooperating Partners (CooP)