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Development of a Rapid Management-Risk Assessment Method for Fish Species through its Application to Sharks

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Framework and Results

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Caveat

The time available to the authors under this project dictated that a rapid risk assessment approach be adopted for the purposes of testing the management risk assessment method. Within those constraints, the authors have made a concerted effort to bring the most up to date and relevant information to the 46 species assessments conducted. However, it is acknowledged that the involvement of management and scientific experts, together with additional time to seek out and consider information on individual assessments, would undoubtedly result in more accurate assessments. The risk ratings attributed to shark stocks assessed in this report should be considered in this light.

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Front cover photo: Blacktip reef sharks *Carcharhinus melanopterus* swimming in shallow crystal clear water, Aldabra Atoll, Seychelles, Indian Ocean. © naturepl.com / Cheryl-Samantha Owen / WWF-Canon

Executive Summary

The development of an assessment framework for exposure and management risk (M-Risk) builds upon earlier work by Sant *et al*., 2012 and Oldfield *et al*., 2012. The work was funded by the Department for Environment, Food and Rural Affairs (Defra) with the aim of developing a transparent, repeatable risk assessment framework suitable for application to marine taxa, and demonstrating the feasibility of the framework by its application to species of shark with medium to high levels of intrinsic vulnerability. The resulting framework could be used to facilitate efforts to improve management which may include a listing on an Multilateral Environmental Agreement (MEA) or, in fact, preclude the need for such a listing.

The rapid M-Risk assessment framework presented in this report was developed iteratively through trial application, review by an Expert Workshop, input from the Project Steering Group and application to 46 shark species. The focus of the work is the development of a meaningful M-Risk assessment method rather than the risk outcomes for individual shark species. The risk ratings attributed by the species assessments conducted as part of this project should be regarded as preliminary pending further consideration by experts in the science and management of those species / stocks. Nevertheless, the authors are confident that the assessment results confirm that the risk assessment framework is sound.

Exposure risk, potentially assessed on the basis of scale and value, had been envisaged as an integral component of this project. After further consideration of what an assessment of 'exposure' should ideally capture, the information available to inform this and how these factors might be incorporated into the assessment in a meaningful and consistent way, it was concluded that this was beyond the scope of the project. Instead, the project focused on M-Risk. However, the assessment framework does include a weighting to reflect the higher risk of species in international trade and species of high value, as a proxy for some elements of exposure risk. Thus, while the assessment method developed is entitled M-Risk, it includes a component of exposure risk.

The M-Risk Assessment is based on three elements:

- stock status;
- adaptive, species-specific management; and
- generic management.

These elements are weighted by 2, 4 and 1 respectively. That is, adaptive, species-specific management is given the greatest emphasis in calculation of M-Risk.

The indicators used to assess each of these elements are:

- Stock Status
  a) What is the status of each stock OR the status of the species in each management unit if stocks are not well-defined?
- Adaptive Management System
  b) Is information collected to inform the status of the stock?

c) Have the available data been analysed to inform management decisions?

d) How does the management unit manage the stock?

e) Are the measures consistent with the species-specific advice for the stock?

f) How comprehensive is the compliance regime in place to support these species-specific measures?

g) What is the level of compliance with the reporting requirements for the stock?

h) Is illegal, unregulated and unreported fishing recognized as a problem for the stock (if it is a target) or for the fishery in which the stock is taken (if it is a bycatch)?

- Generic Fisheries Management

i) Are the generic fisheries management measures in place likely to reduce the impact on the species / stock being assessed?

j) How comprehensive is the compliance regime in place to support the generic management measures that are relevant to the species/stock being assessed?

Scores of 1-4 are attributed to each indicator, with the highest score reflecting better management and lowest risk. This approach was dictated by the need to weight the elements of M-Risk. The resultant scores are then further weighted to reflect the influence of trade and/or high value on risk.

The M-Risk assessment framework identifies the species / stocks of sharks of potential concern and the level of concern relative to other species. This allows for prioritization of those species / stocks for which closer scrutiny of management arrangements is warranted. M-Risk assessment also has the capacity to identify those stocks where improvements in specific aspects of management are required. This can facilitate efforts to improve management, such as through a listing in the appendices of a multilateral environmental agreement or, in fact, preclude the need for such a listing by prompting action by the relevant management body to address the identified problem.

One-hundred and seventy three shark management units or shark stocks were assessed for the 46 shark species assessed. Of those, 150 (87%) were assessed as having high M-Risk and 23 as medium M-Risk. No shark management unit / stock was assessed to be at low M-Risk. The percentage of high M-Risk shark stocks is not surprising since the inadequacy of shark catch and bycatch data and the lack of management of shark stocks are well documented.

The results of the assessments are consistent with existing listings of shark species under the Convention on International Trade in Endangered Species of Wild Fauna and Flora and the Convention on the Conservation of Migratory Species. Of the 53 management units / stocks of listed shark species assessed here, 48 were assessed as high M-Risk. This supports the view of the Parties to these Conventions that additional management intervention is required for these species and provides some confidence that the assessment method is delivering meaningful outcomes.

The development of the M-Risk assessment method and its application to the shark taxa has significantly improved the assessment of the impact of management in mitigating the inherent risks faced by species subject to fishing mortality. The method developed is transparent and repeatable, providing the opportunity for the assessment framework to be used to monitor changes in management and M-Risk status over time. The authors see no reason why the method could not be applied equally successfully to any fished species, however further work is recommended to validate this.

There remain a number of important qualifications in relation to the application of the M-Risk assessment framework to the shark species assessed in this report. These include:

- it is essentially a rapid risk assessment method to guide more detailed investigation;
- identification of the main management units and stocks that are subject to fishing is based on the best available, but flawed, data on global catch and on major catching countries;
- the shark species risk assessments should not be considered definitive assessments of the risk for each species/stock, since
    - the assessments were deliberately time constrained (on average one day/species assessment) and the application of more time and effort will likely deliver different M-Risk assessment outcomes on a stock basis; and
    - the application of the framework by experts on specific stocks / management units is likely to result in refined and more confident M-Risk assessment outcomes. Definitive assessments would require the involvement of scientific and management experts with specific knowledge of the stocks and of the fisheries and management regimes that apply to them.

The authors believe that there is real value, in terms of the accuracy of M-risk assessment outcomes, in investing further time and effort providing technical input to the species / stock M-Risk assessments. However, users of the M-Risk framework should not lose sight of the fact that the framework was developed as a rapid M-Risk assessment method and it is not intended to be a substitute for a full risk assessment of a stock. A point of diminishing marginal returns to further investment in refining the M-Risk species assessments may be reached quite quickly and time and effort might then be more productively expended on addressing identified management issues.

The authors recommend that further work be conducted to refine and improve confidence in the M-Risk assessment framework and its outcomes through further work in the following areas:

1. validation of the method's applicability to all marine species through its application to a range of species representing different taxa and different biological and management profiles;
2. sensitivity testing of the scoring bands for high, medium and low risk and to the weights applied to the scoring;

3. alignment of the intrinsic vulnerability and M-Risk scoring systems and/or development of a mathematical approach to presenting a combined intrinsic and M-Risk rating, preferably in a graphical format;
4. closer interrogation of the species assessment to identify the nature of the uncertainties that are driving high risk ratings; and
5. investigation of the feasibility of including a more explicit assessment of exposure risk, based on fishing effort by gear type.

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1 Background

In 2010, the Joint Nature Conservation Committee (JNCC)[1] commissioned TRAFFIC to develop a risk assessment process to identify commercially exploited aquatic organisms in trade which were at highest risk of over-exploitation and to consider whether those species would benefit from measures under Multilateral Environmental Agreements (MEAs). The MEAs of primary interest were the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the Convention on the Conservation of Migratory Species of Wild Animals (CMS). The risk assessment process was intended to highlight species for which the application of CITES or CMS might make a tangible difference to conservation and sustainable use. It was not intended to provide a definitive statement on the need for the listing of such species.

The risk assessment process developed by TRAFFIC (Sant *et al*., 2012) assessed risk according to vulnerability, value and violability, based on previous work by the Food and Agriculture Organization (FAO) of the United Nations (FAO, 2000). The risk assessment process was subsequently peer reviewed at a workshop in 2011[2] which recommended that a two-step approach be adopted to further develop the process:

1. intrinsic vulnerability (based on biological and life-history characteristics) be reviewed for one taxonomic group; and
2. 'exposure' and management risk for that group be reviewed (Fleming *et al*., 2012).

Step one was completed by reviewing intrinsic vulnerability in 61 species of sharks (Oldfield *et al*., 2012). That study assessed 46 of those species as at medium to high intrinsic risk. In 2013, TRAFFIC was engaged by the Department for Environment, Food and Rural Affairs (Defra) to undertake Step two, assessment of exposure and management risk, for the 46 medium to high intrinsic risk shark species. This report provides the outcomes of that assessment.

2 Objectives

The objectives of this study are to:

- develop a transparent, repeatable exposure and management risk (M-Risk) assessment framework suitable for application to marine taxa; and
- demonstrate the feasibility of the framework through its application to the 46 species of shark identified as medium and high risk by the intrinsic vulnerability assessment.

The risk assessment framework developed needs to be comprehensive and at the same time facilitate the rapid, cost-effective assessment of a broad range of species within a particular taxonomic group. The outputs of the assessment framework

[1] JNCC is the public body that advises the UK Government and devolved administrations on UK-wide and international nature conservation.

[2] The workshop was attended by representatives from the CMS, Marine Stewardship Council (MSC), the US National Oceanic and Atmospheric Administration (NOAA), the Centre for Environment, Fisheries and Aquaculture Science (CEFAS), the Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO), TRAFFIC and JNCC.

should identify the relative priority of species for the purposes of ensuring adequate management. It is not intended that the framework provide a definitive statement of the species at greatest risk.

3 Method

Risk assessment and adaptive management are increasingly recognised as effective means of managing natural resources. In recent years risk assessment has been used to assess, for example, impacts of climate change and the ecological risk posed by fishing. The broad nature of the approach taken is described in Figure 1:

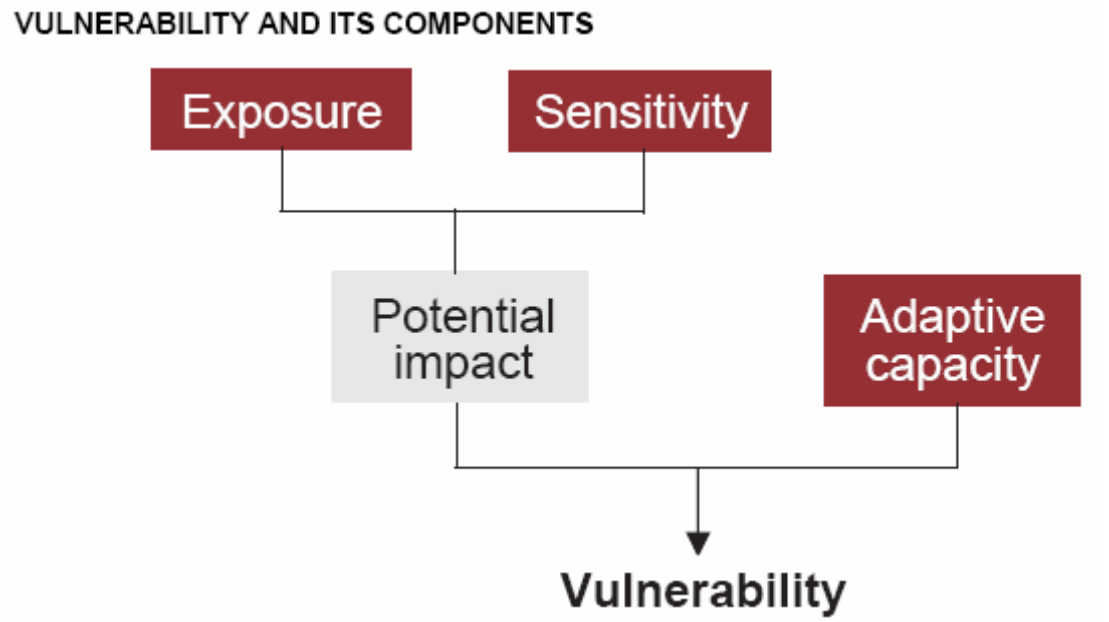

Figure 1: Vulnerability and its components (Source: Allen, 2005)

In the context of Figure 1, 'sensitivity' of shark species has been assessed by Oldfield *et al*.'s (2012) intrinsic vulnerability risk assessment. In this report an attempt is made to assess 'exposure' (fishing, trade and value) together with 'adaptive capacity' represented by adaptive fisheries management. The overall 'vulnerability', equivalent to M-Risk in this study, is essentially the residual risk that faces a species after the mitigating effects of management are taken into account.

The key recommendations made for the assessment of exposure and M-Risk by Fleming *et al*. (2012) were that:

- a revised approach to the 'management risk' component of the risk assessment process be adopted by scoring 'exposure' by looking at the scale of the fishery as well as at the value (and other related factors) and combine that score in a meaningful (weighted) way with a score for the M-Risk (management and compliance risk);
- the following six factors were suitable for the assessment of M-Risk:
  - Is there a stock assessment?
  - Are there appropriate management controls to constrain catch levels?
  - Are scientific recommendations on catches adopted and implemented?

    - Are there compliance measures to address illegal, unreported and unregulated (IUU) fishing?
    - Are harvest rates reduced appropriately at low stock sizes?
    - Are landings monitored?
- it is necessary to look at the appropriateness of any management and not just equate high levels of regulation with good management; and
- the approach should identify the problems with existing management and compliance arrangements and logically draw attention to what management and compliance solutions may be used to reduce risk for a species through risk management.

The risk assessment framework developed by Sant *et al.* (2012) was revised, taking into account the above recommendations. The revised assessment method was then trialled by developing draft risk assessments for the following five shark species:

1. Porbeagle *Lamna nasus*
2. Scalloped Hammerhead Shark *Sphyrna lewini*
3. Oceanic Whitetip *S*hark *Carcharhinus longimanus*
4. Spiny Dogfish *Squalus acanthias*
5. Kitefin Shark *Dalatias licha*

Progress reports were made to the Project Steering Group (PSG), comprising representatives from Defra and JNCC, in June and July 2013. In response to the July 2013 progress report, the PSG provided comments and also sought an independent review of the draft framework and its application.

An Expert Workshop[3] was held in Wollongong, Australia in August 2013. The Workshop considered:

- a discussion paper outlining progress to date and highlighting issues requiring consideration by experts;
- the draft exposure risk framework;
- the five draft risk assessments; and
- the comments provided by the PSG and the independent reviewer.

The report of the workshop was provided to the PSG along with a separate response to the comments of the PSG and the independent reviewer. The draft risk assessment framework was then revised to reflect the outcomes of the workshop and the five draft risk assessments were revised accordingly. The revised framework was then applied to the remaining 41 shark species. The framework continued to evolve throughout the assessment process and as refinements to the framework were made, completed assessments were amended accordingly.

[3] The Workshop was attended by Dr Vin Fleming (JNCC), Dr Tony Smith (CSIRO), Glenn Sant and Markus Burgener (TRAFFIC), Karen Winfield (Australian Department of the Environment) and Mary Lack (Shellack Pty Ltd).

An examination of key elements of the method is provided in Section 5 and a detailed description of the M-Risk assessment method is provided in Annexes 1 and 2.

4 Structure of the Report

This report comprises four main sections:

1. discussion of the elements considered in exposure risk and M-Risk and in the Risk Assessment Framework (Section 5);
2. presentation and analysis of the results of the M-Risk assessment for sharks (Section 6);
3. results of the combination of intrinsic vulnerability and M-Risk for sharks (Section 7); and
4. conclusions and recommendations (Section 8).

Details of the M-Risk assessment framework, guidance on its application and a summary of the assessment results for 46 shark species are provided in Annex 1, 2 and 3 respectively. Individual species assessments (Annex 4) are contained in a separate Excel file.

5 Exposure and management risk

5.1 Exposure risk

The 2013 Expert Workshop considered a number of elements related to the exposure risk framework. In particular, the Workshop discussed the distinction between ‘exposure’ and M-Risk, the difficulties involved in assessing exposure and how it might best be assessed.

It was noted that exposure risk is largely about susceptibility of the species to various types of fishing gear, the proportion of the distribution of the species that is fished by those gears and the level of effort by that gear. However, detailed information on the nature of gears used to catch individual species or stocks, the relative susceptibility of the species to those gears and the relative effort by each of those gear types is not commonly available.

The workshop concluded that fishing effort data by gear type were considered preferable to catch data as an indicator of the level of ‘exposure’ of a species to fishing impacts. Following the workshop, the availability of such data at the global level was investigated. Two recent attempts to collate and analyse global fishing effort data were identified. Anticamara *et al.* (2011) concluded that data deficiencies ‘currently hamper analysis of global fishing effort’ and ‘current estimates of global fishing effort …. are, however, underestimates given the data gaps that we have identified’. They found that for many countries ‘fishing effort data are patchy, non-existent, or inaccessible’. While Anticamara *et al*. present time series of estimates of total fishing effort by countries and by continent and by broad gear types, these data are not readily applied to the assessment of particular stocks of species. Watson *et al*. (2012) analysed spatial and temporal patterns of global fishing effort by bringing together data from the FAO, the European Union, the tuna regional fisheries management organizations (RFMOs) and the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) and standardized these based on

engine power and fishing days. Again, the level of the analysis is unsuitable for the assessment of the exposure of specific fish stocks to various gear types. While it may be feasible to interrogate the available data in a meaningful way for an individual species or stock, it was not feasible to attempt such an analysis in this project given the number of shark species being assessed and the resources available to the project.

Fleming *et al*. (2012) identified scale of the fishery, value of the species and 'other related factors' as the elements that should be considered in determining exposure risk. These are discussed below.

5.1.1 Scale

'Scale' can be assessed by reference to either the scale of the catch of a species or to the scale of fishing operations (i.e. subsistence, artisanal, small-scale commercial or industrial) or both.

The quantity of a species taken may not in itself be a good indicator of exposure risk. The impact of catch level on a species will vary according to the intrinsic vulnerability of the species. For example, a catch of 500 t per year from a relatively productive species or stock may pose little threat to the stock. However, for a less productive species, or an overfished stock, the removal of the same quantity may be unsustainable. Further, the actual level of removals of fish species is not well documented. There is, generally, a lack of reliable, species-based data on fish catch. The FAO Capture Production database (FAO Fisheries Department, 2013a) is the most comprehensive source of fish catch data. However, in total and, more importantly, on a species basis, the FAO database is known to underestimate total fishing mortality significantly due to under-reporting, inclusion of specific species catch in general fish catch categories, exclusion of discards in the data and, inevitably, exclusion of IUU catch. For example, Lack and Sant (2009) discussed the deficiencies in data on the global catch of sharks in detail. More recently, it has been reported that less than 30% of shark catch reported to the FAO is reported on a species basis (Fischer *et al*., 2012). In very few instances are observer-based programmes in place to provide reliable assessments of the species composition of shark catch. As a result our understanding of total shark catch and catch by species is limited, and meaningful monitoring of global trends in shark catch by species is impossible.

For the above reasons, scale, reflected by quantity of catch, has not been used in this study as an indicator of exposure risk. However, the available FAO catch data for each species are provided in the risk assessment framework as contextual information. These catch data are also used to identify the major catching countries of each species / stock for the purposes of M-Risk assessment. This has highlighted the lack of species-specific catch reporting in the FAO data with many of the top 20 shark catching countries not appearing as major catching countries for the shark species assessed, suggesting that their shark catch is generally recorded in only generic shark categories.

The merits of including the scale of the fishing operation on a species or stock, as an indicator of exposure, were also considered. As discussed in Sant *et al*. (2012), there is no international consensus on how categories of fishing operations should be defined and the categories are often blurred and many species will be subject to more than one of these operations. From a risk assessment perspective, the relative

risk posed to a species by each of these scales of fishing operations will vary, not intrinsically, but because of the impact each has on mortality of the species (with catch used as a proxy for total mortality) and because the nature and enforcement of management measures used may vary, particularly between artisanal/subsistence fisheries and the other groups. It was considered that these influences would be best assessed through the M-Risk assessment of the appropriateness of management and compliance with those measures. As a result, the nature of the fishing operations for a species has not been included explicitly as a factor in the risk assessment.

Recreational fishing can also be significant sources of mortality for some species. It is important that all sources of mortality are taken into account in the management of commercially fished species. The current assessment recognises this and utilises information on recreational fisheries where it is readily available. However, identifying information on the extent and management of recreational fisheries has been largely beyond the scope of the current project.

5.1.2 Value

In the initial exposure risk assessment, value of fish products was one of three core components of risk. As a result, despite noting that the value of fish products was positively correlated with non-compliance, and hence relevant to the violability assessment, it was not assessed under violability (now M-Risk) in order to avoid double counting. However, the peer review of the method (Fleming *et al*., 2012) found that value did not merit being treated as a stand-alone indicator of risk and that it might be better included as part of the violability risk, because high value is likely to provide incentives to increase fishing effort and/or break management rules.

The explicit incorporation of value in the revised risk assessment process was considered. However, including value in the overall risk assessment suffers from difficulties, including that value data are:

- difficult to source and not widely available;
- generally of low reliability;
- rarely reported at a species-specific level;
- difficult to compare because they may relate to different points in the market chain.

For sharks, the problems identified above are exacerbated by the wide variety of shark species, differences in the market value of meat, fins and oil by species, variable use of the same species of shark for different purposes (i.e. in some fisheries both fins and meat may be retained for sale while in others only fins or only meat may be retained) and the poor specification of shark species and products in trade.

Further, as an indicator of the risk of non-compliance, commodity value is only one of several factors that influence decisions to undertake illegal, unreported and unregulated (IUU fishing). Others include the cost of fishing which, together with value, will determine profitability, the income producing alternatives available, the likelihood of detection and the sanctions in place.

Given the difficulties in acquiring reliable, consistent, species-specific price information for many marine species, and because the M-Risk assessment method

provides for assessment of other aspects of compliance, it was decided not to include the explicit value of fish products in the risk assessment.

However, where products are traded internationally and are considered to have a high product value, the international demand for the product is likely to act as a driver for increased catch of unmanaged stocks of the relevant species. Rather than attempt to incorporate the value of the product *per se* in the M-Risk assessment, a weighting has been applied to reflect whether the product is known to be traded internationally and whether it is considered to be of relatively high value. The level at which these weights are applied is not scientifically based. The weights simply reflect a consistent risk multiplier to reflect the impact of international demand / value across the species. It must also be noted that there remains an element of subjectivity around what constitutes a 'high value' seafood product. Further discussion of these issues is contained in Annex 2.

5.1.3 Conclusions on exposure risk

The Expert Workshop acknowledged that exposure risk had been envisaged as an integral component of this project. However it concluded that it was beyond the scope of the project to address exposure in a meaningful way particularly given the availability of data and problems with those. It was agreed that this would be better done as part of a separate research effort. Alternatively, this could be conducted as a more in-depth, second stage analysis of particular species / stocks highlighted by the M-Risk assessment process as of particular concern. As a result of the discussion on exposure risk at the Expert Workshop it was agreed that the risk assessment framework should focus on M-Risk but include a weighting to reflect the higher risk of species in international trade and species of high value as a proxy for some elements of exposure risk. Thus, while the assessment method developed is entitled M-Risk, it includes a component of exposure risk.

5.2 Management risk

It is the intention of the M-Risk assessment framework to identify the species / stocks of potential concern and the level of concern relative to other species. This allows for prioritization of those species / stocks for which closer scrutiny of management arrangements is warranted. M-Risk assessment also has the capacity to identify those stocks where improvements in specific aspects of management are required. This can facilitate efforts to improve management which may include a listing in the appendices of an MEA or, in fact, preclude the need for such a listing.

On the basis of the issues identified from the five case study assessments, the Expert Workshop provided some clear guidance for the development of the M-Risk framework. The Workshop concluded the following.

- The relevant MEAs for the project are CITES and CMS.
- All 46 medium to high intrinsic risk shark species, regardless of whether they were traded internationally, whether they were migratory or otherwise and whether they were already listed by CMS and CITES (e.g. Great White Shark *Carcharodon carcharias* and Basking Shark *Cetorhinus maximus*) should be included in the M-Risk assessment.

- The M-Risk assessment results could be used for the purposes of identifying where specific management improvements are required in addition to informing potential MEA listing decisions.
- For the purposes of developing the M-Risk framework it was appropriate that only medium to high risk sharks are assessed but this does not imply that low intrinsic risk species should not be subject to M-Risk assessment, since even those species can be overfished if not managed appropriately.
- M-Risk should encompass management of all anthropogenic sources of mortality (commercial, recreational, subsistence and artisanal).
- Given that species tend to be managed as stocks, or at least as management units, it would be more informative for M-Risk assessment to be conducted at stock / management unit level rather than species level.
- M-Risk should be assessed on the basis of stock status, adaptive management and generic management.
- An indication of the level of confidence in the scores should be provided.
- The M-Risk assessment framework should provide for 'override' of the assessment where strict application of the method does not reflect what is actually known. While such overrides should be exceptions, failure to allow for them leave the framework open to criticism and reduce its credibility.

These conclusions are reflected in the M-Risk Assessment Framework presented here. The template for the M-Risk Assessment Framework is provided in Annex 1. The template includes:

- Part A Management Context
- Part B M-Risk Assessment

The Guidance and Explanatory Notes for the M-Risk Assessment Framework are provided in Annex 2. The Notes describe the rationale for and approach taken to the assessment and are generally self-explanatory. However, some key decision points in the Assessment Framework warrant further discussion here (see sections 5.2.1 and 5.2.2).

5.2.1 Management context

The information collated in the Management Context (Part A) section of the Risk Assessment Framework underpins decisions on the number and nature of the management units and management bodies that should be assessed under Part B of the Framework and assists the assessor to interpret and score the available information on management. Part A also identifies whether products from the species are traded internationally and, if so, whether they are considered to be high value. This information determines the risk weighting for international trade / value that is ultimately applied to the M-Risk score.

Specific issues that warrant discussion here are:

- assessment of species, stocks or management units and management bodies; and
- classification of species.

Species, stocks, management units and management bodies

A meaningful assessment of M-Risk requires consideration of stocks, rather than just species. Most marine species will be comprised of one or more stocks or discrete populations. In the absence of good stock structure information, species will be managed as discrete management units, which may be identified as a specific fishery or a subset of fishery based on gear type or fishing entitlements. The understanding of stock structure will vary widely by species / species group. For example, given the generally low priority of sharks in fisheries management regimes, shark research, including on stock structure, is commonly limited. By and large, management of shark stocks, where it exists, is on the basis of 'management units'. In the absence of stock structure information it is considered to be precautionary to manage populations as separate entities rather than to manage a species as one entity, so consideration of these management units is an appropriate basis for M-Risk assessment. Where stocks have been differentiated and managed under a single management regime, these stocks should be used as the basis for M-Risk assessment. In the absence of such differentiation, management units should be identified and used as the basis of assessment.

It is the management applied by relevant management bodies to the management unit that is the subject of the assessment. In practice, therefore, it is the responsible management body or bodies that are the central focus of the assessment. Management bodies take a variety of forms. For highly migratory species or discrete high seas stocks, the relevant management body may be the relevant RFMOs. Alternatively, or in addition, the relevant management body might be a State / entity in which the species occurs and is fished, or a particular jurisdiction within that State / entity. For non-migratory species, the species may be taken in a range of different fisheries within a jurisdiction. As a result, there are potentially many management bodies involved in management of a species or even a stock.

Consideration was given to determining the overall M-Risk at the species rather than the stock level. Such an approach would assess the known stock / management units but would then aggregate the results to the species level. However, because it is unlikely that stocks of the same species can be differentiated in trade, the lowest score for any stock would need to be used to determine the overall species assessment for each criterion assessed. That is, the overall species score would be based on the lowest common denominator. This is likely to overstate the risk to the species as a whole.

An alternative approach, whereby the M-Risk to each stock is weighted by the proportional contribution to total reported catch of that stock, was considered but rejected. The overall shortcomings of the FAO Capture Production database (FAO Fisheries Department, 2013a), discussed above, are exacerbated where higher levels of resolution of the data are required. The weighting approach would require species catch data on an area or ocean, rather than global, basis and meaningful interpretation of the data at that level is problematic. For example, analysis of the FAO catch data for Scalloped Hammerhead Shark and Oceanic Whitetip Shark by ocean area reveal no catch of these species in the Indian Ocean, yet it is well known that both of these species are captured by tuna longliners fishing in the Indian Ocean (Indian Ocean Tuna Commission (IOTC), 2012). Proportional weighting based on these data is therefore considered inappropriate and potentially misleading.

As a result, the M-Risk assessment has been conducted only at a stock / management unit level. It is believed that, from a management perspective, this provides a meaningful basis to identify where significant improvements in management are required. It should be noted, however, that while it may be possible to say that product from one stock / management unit may be at lower risk than product from another, it will be difficult to discriminate between the two products in the trade chain in the absence of good traceability / chain of custody arrangements. Furthermore, improved management of one stock may lead to increased fishing pressure on a less well-managed stock. Thus, where it is considered necessary to place a stock under the protection of an MEA, in practice, the whole species may need to be listed.

As noted above, a single species can be subject to the management of a range of management bodies. Sharks provide a good example of this. Sharks are taken by vessels from over 150 countries and a wide range of species is usually taken across a number of fisheries both in national waters and on the high seas. For this reason, attempting to assess the likely effectiveness of the measures in place for a species, or even a stock, is extremely difficult. To make the M-Risk assessment both manageable and meaningful only the main management bodies involved in management of the species have been included in the assessments. This is consistent with the advice of Fleming *et al*. (2012) who noted that 'in order to reduce the amount of time and data needed to score these attributes it may be necessary to limit the analysis to States or other entities that account for a majority of the harvest (e.g. >75%)'.

Assessment of national management has been constrained to the main catching countries for that species identified in the FAO Capture Production database (FAO, 2013a). The main catching countries for the shark risk assessments have been identified as those responsible for 85% of the reported catch of the species. However, the appropriate cut-off may vary by species group. For example, 20 countries take more than 80% of the total catch of shark, therefore, on a species basis there are likely to be relatively few countries that take most of the catch. A high threshold is therefore appropriate. The high catch threshold also means that the scope of the assessment is kept within manageable time and cost bounds, while remaining meaningful. For other species, however, the catch profile might be significantly different and a lower threshold may be appropriate. It is acknowledged that this approach potentially fails to identify significant catching countries since the FAO data exclude catch of the species by countries that, either do not report catch data to FAO or do not report species-specific data on shark catch. Ultimately, however, the FAO database is the most comprehensive available.

Regional measures are relevant for highly migratory and deep sea stocks found on the high seas. Relevant RFMOs are identified based on the FAO areas in which the sharks are taken together with the fishing methods managed by the RFMO and the nature of the species (migratory status, deep sea) where relevant. Where an RFMO has a mandate to manage the species under assessment, either as bycatch or target catch, the management and compliance measures required by the RFMO have been assessed. However, where it is known that one or more of the main catching countries has stronger species-specific domestic management measures in place than the RFMO, those countries are assessed separately and in addition to the RFMO, in the M-Risk assessment framework.

Migratory status of species

The need to broadly identify species as being migratory[4] or localised arises from the need to determine the relevant management bodies that are required to be involved in order to minimize risk to the species. Species that occur only within single exclusive economic zones (EEZs) require only management by that country / entity. Species that move relatively short distances but cross other national boundaries may require bilateral cooperation between countries /entities. Species that have broader migratory patterns that include the high seas may require multilateral management, under one or more RFMOs for example. At one level it may, therefore, be considered sufficient to categorize stocks of sharks according to whether they are 'shared' or not. However since, ultimately, the outcomes of the risk assessment may be used to determine species suited to actions taken under different international conventions (e.g. the CMS) there is also value in determining whether these species are classified as migratory. Further, since the United Nations Convention on the Law of the Sea (UNCLOS) requires specific cooperation by its signatories in relation to highly migratory species, it is important to identify these species.

In relation to sharks, Annex 1 of UNCLOS identifies 'highly migratory' shark species as:

- Bluntnose Sixgill Shark *Hexanchus griseus*;
- Basking Shark *Cetorhinus maximus*;
- Whale Shark *Rhincodon typus*;
- Thresher sharks Family *Alopiidae*;
- Requiem sharks Family *Carcharhinidae;*
- Hammerhead sharks Family *Sphyrnidae;* and
- Mackerel sharks Family *Isuridae*[5].

However, there are a number of other shark species and families that may be regarded as 'migratory'. The Shark Specialist Group (SSG) of the International Union for the Conservation of Nature's (IUCN) Species Survival Commission has identified a list of 138 migratory and possible migratory Chondrichthyan species (SSG, 2007a, b) that had been assessed by the IUCN at that time. The 46 species to be assessed in the M-Risk assessment were considered against Annex 1 of UNCLOS and the SSG list and classified as highly migratory, migratory or non-migratory (see Annex 2 Attachment 1). This process identified 21 species as highly migratory (i.e. listed in Annex 1, UNCLOS), nine as migratory or possibly migratory (as classified by SSG 2007a, b) and 16 as non-migratory.

5.2.2 M-Risk Assessment

The M-Risk Assessment (Part B) is based on three elements:

- stock status;
- adaptive, species-specific management; and

[4] Issues surrounding the definition of 'migratory' were explored in Sant *et al*. (2012)

[5] Now *Lamnidae*

- generic management.

The indicators used to assess each of these elements are:

- Stock Status
  a) What is the status of each stock OR the status of the species in each management unit if stocks are not well-defined?
- Adaptive Management System
  b) Is information collected to inform the status of the stock?
  c) Have the available data been analysed to inform management decisions?
  d) How does the management unit manage the stock?
  e) Are the measures consistent with the species-specific advice for the stock?
  f) How comprehensive is the compliance regime in place to support these species-specific measures?
  g) What is the level of compliance with the reporting requirements for the stock?
  h) Is IUU fishing recognized as a problem for the stock (if it is a target) or for the fishery in which the stock is taken (if it is a bycatch)?
- Generic Fisheries Management
  i) Are the generic fisheries management measures in place likely to reduce the impact on the species / stock being assessed?
  j) How comprehensive is the compliance regime in place to support the generic management measures that are relevant to the species/stock being assessed?

Scores of 1-4 are attributed to each indicator, with the highest score reflecting the better management and the lowest risk. This approach was dictated by the need to weight the elements of M-Risk.

In scoring M-Risk these three elements are weighted by 2, 4 and 1 respectively. That is, adaptive, species-specific management is given the greatest emphasis in calculation of M-Risk.

Specific issues that warrant discussion here are:

- Adaptive management
- Species-specific and generic management
- Assessment of compliance
- Uncertainty in the assessment

Adaptive management

Adaptive management is increasingly recognized as an effective approach to management of natural resources. An example of an adaptive management approach is provided in Figure 2.

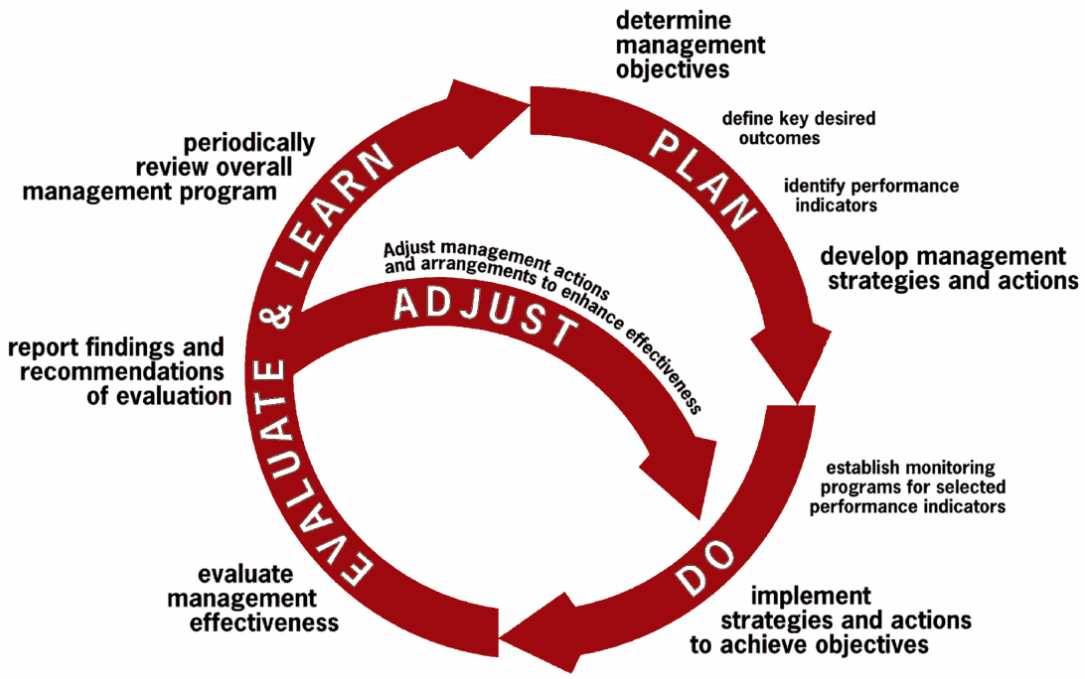

Figure 2: Adaptive management cycle (Source: Jones, 2005)

The ideal fisheries management regime is one that has effective, precautionary, adaptive management arrangements in place for the stock supported by good scientific advice and is effectively enforced. This implies that effective fisheries management arrangements should include monitoring, assessment and decision making processes that respond appropriately to feedback in the management system, including to non-compliance issues. Few fisheries management regimes will exhibit all of these characteristics. The M-Risk assessment considers the extent to which these characteristics are present in the management regimes implemented by the management bodies for the stocks under assessment.

Species-specific and generic management

Species-specific management measures are those that relate explicitly and directly to the species being assessed. Examples include a catch quota for a species, an effort control in a target fishery for a species and an area closure with the specific intent of protecting certain life cycle stages of the species.

For many species, particularly non-target species, the management measures in place may be generic rather than species-specific. A good example is provided by shark species that are commonly taken as non-target catch in many types of fisheries. A typical generic management measure for sharks, employed at both national and RFMO levels, is a ban on shark finning, which essentially means that it is illegal, at sea, to remove the fins of a shark and discard the carcass. Such measures usually apply to all shark species taken in the relevant fishery, regardless of the vulnerability of the species taken. Despite this generic approach, it is recognized (e.g. FAO, 2010) that such measures have mitigated, to some extent, the impact of fishing on sharks. Similarly, generic fisheries management measures such as limited entry or controls on the level of effort in a multi-species fishery are likely to have some management impact on individual species in the fishery. As a result, the analysis of M-Risk recognizes the potential contribution of generic management

measures, even though it may not be possible to make a definitive assessment of the impact of these measures on the individual species under assessment.

Compliance

Failure to ensure compliance with species-specific and generic management measures compromises the integrity of these measures and effectively wastes the investment in management, data collection and stock assessment. A strong compliance regime is an essential component of an effective fisheries management regime. The nature of the compliance regime required will vary according to the type of fishery and the range of management measures in place.

The compliance regime involves the regulation and supervision of fishing activity to ensure that national legislation and terms, conditions of access and management measures are observed. This activity is critical to ensure that resources are not over exploited, IUU fishing is minimized and management arrangements are implemented. The nature and extent of sanctions to deter non-compliance is an important element of the compliance regime.

Public information on compliance with fisheries management measures is generally lacking. Where a species is subject to some form of catch or effort quota, data may be available on whether these limits are complied with or not. However, where a range of input controls is used to manage a fishery, a species or a stock, information on compliance is generally difficult to obtain. This situation is exacerbated where the species under assessment is taken predominantly as bycatch. Even where compliance data are available, interpretation can be problematic. In particular, low levels of reported non-compliance may not necessarily mean a high level of compliance but may mean that the compliance regime in place is ineffective in detecting non-compliance.

Assessment of compliance at the RFMO level involves additional complexity. While management measures are established by the RFMO, implementation and enforcement are generally the responsibility of the flag State of the vessel. Even where a flag State implements domestic regulations in support of RFMO measures, it is not necessarily the case that the flag State has the capacity or the will to enforce the measures. Technically, from the RFMO's point of view, that flag State is compliant and RFMO reports on compliance will reflect this. However, in practice, the vessels of that flag State may not be compliant. Most RFMOs now have some form of subsidiary body that considers compliance issues. However, as identified during the shark species assessments, the detailed compliance record of RFMO members is often not in the public domain.

After consideration of these issues the Expert Workshop agreed that the M-Risk assessment should not attempt to assess the level of compliance, but should focus on assessing whether the nature of the compliance regime could be expected to enforce the particular management measures (species-specific and generic) in place for a stock. However, it was considered that M-Risk should include a specific assessment of whether there is a recognized IUU fishing problem for the stock itself or in the fishery in which the stock is taken as bycatch.

Where reliable data are available on compliance rates those data should be used to inform the M-Risk assessment. For example, in RFMOs it is sometimes possible to identify data on compliance with reporting requirements, or whether vessel

monitoring system (VMS) systems are being operated in accordance with requirements etc.

To assist the assessment, advice on the broad nature of compliance measures which might be considered appropriate for effective enforcement of particular management measures is provided in the Guidance Notes (Annex 2, Attachment 2).

Informing the assessment and uncertainty

Reliability of the information upon which assessments are based will determine the credibility of the findings. It is well known that data on shark catch and trade and information on the management measures in place and the extent to which those management measures are implemented and enforced is scarce. The M-Risk assessments for sharks have been based on material that the authors consider to be reliable. This necessarily involves some judgements to be made and the following criteria have been used in making those judgements:

- the standing of the authors of the work and confidence in the methods used;
- the referencing of source material used;
- the extent to which the material has been subject to peer review and other appraisal; and
- whether the work is presented in a balanced way.

The Guidance notes provide recommendations on appropriate sources of information. However, these will vary by species / species group and it is ultimately the responsibility of the assessor to identify credible sources of information.

Inevitably, there remains uncertainty about the scores attributed in the M-Risk assessment. This uncertainty can arise because the data necessary to inform the assessment are not collected, collated, current and/or publicly available. In many cases it is necessary to draw inferences from the data available.

It is also possible and, indeed, likely, that information relevant to the assessment exists that has not been identified by the assessor. In particular, language can act as a barrier to the information that is accessible by the assessor. For example, in this assessment of shark species the inability of the assessors to search for or access Spanish language documents was a constraint. However, noting that the M-Risk framework is intended to deliver a relative, rather than definitive, assessment of M-Risk for each stock, this should not necessarily be seen as a deficiency of the method.

The amount of time and effort devoted to discovering information to inform the M-Risk framework is a major determinant of the level of certainty attaching to the scores. In this respect it is important to note that the time allocation for this project necessarily constrained the amount of time that could be spent on assessment of each species. In effect, this has resulted in the development of a rapid M-Risk assessment method which is entirely in keeping with the objective of highlighting potential candidates for, rather than definitively identifying, species at highest risk.

The level of familiarity of the assessor with the species, stock or management body being assessed will also influence the level of certainty. In all likelihood, the allocation of more time, and the input of experts on specific species or stocks, to the assessment of the shark species / stocks assessed in this project, would uncover

additional information and/or more accurate interpretation of the information available and potentially change and increase the level of confidence in risk assessment scores.

A confidence rating has been given to each indicator score to reflect the level of certainty associated with the score (see Annex 2, Section C for further discussion).

6 M-Risk Assessment Results

6.1 Medium and high intrinsic risk shark species

A summary of the weighted and un-weighted scores for each species and stock assessed is provided in Annex 3 and full details of the assessments are provided in Annex 4 (separate Excel file). The outcomes of the M-Risk assessment for the 46 medium to high intrinsic risk shark species are shown in Table 1. One-hundred and seventy three management units or stocks were assessed for these 46 species. Of those, 150 (87%) were assessed as having high M-Risk and 23 as medium M-Risk. No shark management unit / stock was assessed to be at low M-Risk.

These results might be interpreted as suggesting that the assessment method is overstating M-Risk. However, the taxonomic group selected for the purposes of developing the M-Risk assessment framework is sharks, which is a group well-recognised as being particularly vulnerable to overfishing due to biological and life history characteristics (see for example, Dulvy *et al*., 2014). Further, the lack of data collected and the lack of management of shark stocks is also well documented and advocating for improvements has been a cornerstone of TRAFFIC's engagement in marine issues for nearly two decades (see for example, Lack and Sant 2009, 2011). In that context the results are not surprising. Further, the results of the M-Risk assessments are consistent with existing listings of shark species under CITES and CMS. Of the 53 management units / stocks of listed shark species assessed here, 48 were assessed as high risk (see Table 2). This supports the view of the Parties to these Conventions that additional management intervention is required for these species and provides some confidence that the assessment method is delivering meaningful outcomes.

It is recognized that a number of stocks assessed as being at high M-Risk are also reported as being taken in very low quantities. This may be a reflection of the deficiencies of the FAO data. Equally, it may indicate that the species are exposed to relatively low levels of fishing effort or mortality. This suggests the need for a fuller examination of the impact of 'exposure'.

Table 1 M-Risk of 46 medium and high intrinsic risk shark species

Scientific Name	**Common Name**	**Management Unit / Stock**	**M-Risk**
Squatina squatina	Angel Shark	GFCM	High
		NEAFC	High
		France	Medium
		Spain	Medium

Scientific Name	Common Name	Management Unit / Stock	M-Risk
Oxynotus centrina	Angular Rough Shark	GFCM	High
		NEAFC	High
Cetorhinus maximus	Basking Shark	GFCM	High
		IATTC	High
		ICCAT	High
		NEAFC	High
		New Zealand	Medium
Alopias superciliosus	Bigeye Thresher Shark	CCSBT	High
		GFCM	High
		IATTC	High
		ICCAT	High
		IOTC	High
		WCPFC	High
Centroscyllium fabricii	Black Dogfish	NEAFC	High
		France	High
Prionace glauca	Blue Shark	CCSBT	High
		IATTC	High
		ICCAT	Medium
		IOTC	High
		WCPFC	High
Hexanchus griseus	Bluntnose Sixgill Shark	ICCAT	High
		GFCM	High

Scientific Name	Common Name	Management Unit / Stock	M-Risk
		IOTC	High
		NEAFC	Medium
Echinorhinus brucus	Bramble Shark	NEAFC	High
		Portugal	High
Notorynchus cepedianus	Broadnose Sevengill Shark	New Zealand	High
		South Africa	High
Carcharhinus brachyurus	Bronze Whaler	ICCAT	High
		IOTC	High
		WCPFC	High
		Argentina	High
		New Zealand	High
		South Africa	High
Carcharhinus leucas	Bull Shark	CCSBT	High
		IATTC	High
		ICCAT	High
		IOTC	High
		WCPFC	High
		USA	Medium
Mustelus mustelus	Common Smoothhound	Croatia	High
		South Africa	Medium
		United Kingdom	High
Alopias vulpinus	Common Thresher Shark	CCSBT	High

Scientific Name	Common Name	Management Unit / Stock	M-Risk
		GFCM	High
		IATTC	High
		ICCAT	High
		IOTC	High
		WCPFC	High
		Spain	High
Pseudocarcharias kamoharai	Crocodile Shark	CCSBT	High
		IATTC	High
		ICCAT	High
		IOTC	High
		WCPFC	High
Centrophorus squamosus	Deepwater Spiny Dogfish	NEAFC	Medium
		France	High
		Portugal	High
		New Zealand	High
Carcharhinus obscurus	Dusky Shark	IATTC	High
		ICCAT	High
		IOTC	High
		Australia	Medium
		USA	Medium
Mustelus canis	Dusky Smoothhound	USA	High
Carcharodon carcharias	Great White Shark	CCSBT	High
		GFCM	High

Scientific Name	Common Name	Management Unit / Stock	M-Risk
		IATTC	High
		ICCAT	High
		IOTC	High
		WCPFC	High
		USA	High
Centrophorus granulosus	Gulper Shark	GFCM	High
		NEAFC	High
Dalatias licha	Kitefin Shark	NEAFC	High
		SPRFMO	High
		New Zealand	Medium
		Spain	High
Scymnodon ringens	Knifetooth Dogfish	NEAFC	Medium
		Portugal	High
Somniosus microcephalus	Large Sleeper Shark	NEAFC	Medium
Negaprion brevirostris	Lemon Shark	ICCAT	High
		USA	High
Somniosus rostratus	Little Sleeper Shark	GFCM	High
		NEAFC	High
Isurus paucus	Longfin Mako	CCSBT	High
		IATTC	High
		ICCAT	High
		IOTC	High
		WCPFC	High

Scientific Name	Common Name	Management Unit / Stock	M-Risk
Centrophorus lusitanicus	Lowfin Gulper Shark	Portugal	High
Ginglymostoma cirratum	Nurse Shark	Dominican Republic	High
		Mauritania	High
		Mexico	Medium
Scyliorhinus stellaris	Nursehound	NEAFC	High
		Portugal	High
Carcharhinus longimanus	Oceanic Whitetip Shark	CCSBT	High
		IATTC	High
		ICATT	High
		IOTC	High
		WCPFC	High
Somniosus pacificus	Pacific Sleeper Shark	Australia	Medium
Alopias pelagicus	Pelagic Thresher	IOTC	High
		WCPFC	High
Squalus acanthias	Piked Dogfish	New Zealand	High
		Northeast Atlantic	High
		Northwest Atlantic	Medium
Lamna nasus	Porbeagle Shark	CCAMLR	High
		CCSBT	High
		GFCM	High
		IATTC	High

Scientific Name	Common Name	Management Unit / Stock	M-Risk
		ICCAT	High
		IOTC	High
		NAFO	High
		NEAFC	High
		WCPFC	High
		EU	High
		Canada	High
		New Zealand	Medium
Centroscymnus coelolepis	Portuguese Dogfish	NEAFC	High
		France	High
		Portugal	High
		United Kingdom	High
Oxynotus paradoxus	Sailfin Rough Shark	NEAFC	Medium
Carcharias taurus	Sand Tiger Shark	Argentina	High
		Australia	High
		Uruguay	High
		USA	High
Carcharhinus plumbeus	Sandbar Shark	IATTC	High
		ICCAT	High
		IOTC	High
		Australia	Medium
		USA	Medium
Sphyrna lewini	Scalloped Hammerhead	IATTC	High

Scientific Name	Common Name	Management Unit / Stock	M-Risk
		ICCAT	High
		IOTC	High
		NAFO	High
		WCPFC	High
Isurus oxyrinchus	Shortfin Mako	CCSBT	High
		IATTC	High
		ICATT	Medium
		IOTC	High
		WCPFC	High
		New Zealand	Medium
Deania calcea	Shovelnose Spiny Dogfish	NEAFC	High
		SPRFMO	High
		SEAFO	High
		New Zealand	High
		Portugal	High
Carcharhinus falciformis	Silky Shark	IATTC	High
		ICCAT	High
		IOTC	High
		WCPFC	High
Carcharhinus porosus	Smalltail Shark	ICCAT	High
		Guyana	High
Sphyrna zygaena	Smooth Hammerhead	CCSBT	High
		GFCM	High

Scientific Name	Common Name	Management Unit / Stock	M-Risk
		IATTC	High
		ICCAT	High
		IOTC	High
		WCPFC	High
Squatina californica	South Pacific Angel Shark	Mexico	High
		Peru	High
Mustelus lenticulatus	Spotted Smoothhound	New Zealand	Medium
Galeocerdo cuvier	Tiger Shark	ICCAT	High
		NEAFC	High
		Brazil	High
		Mexico	High
		Netherlands	High

Table 2 M-Risk assessment of CITES and CMS listed species

Scientific Name	Common Name	CITES (effective date)	CMS (listing date)	Management Unit / Stock	M-Risk
Cetorhinus maximus	Basking Shark	Appendix II (2005)	Appendix I/II (2002)	GFCM	High
				IATTC	High
				ICCAT	High
				NEAFC	High
				New Zealand	Medium

Scientific Name	Common Name	CITES (effective date)	CMS (listing date)	Management Unit / Stock	M-Risk
Carcharodon carcharias	Great White Shark	Appendix II (2003)	Appendix I/II (2005)	CCSBT	High
				GFCM	High
				IATTC	High
				ICCAT	High
				IOTC	High
				WCPFC	High
				USA	High
Isurus paucus	Longfin Mako		Appendix II (2008)	CCSBT	High
				IATTC	High
				ICCAT	High
				IOTC	High
				WCPFC	High
Carcharhinus longimanus	Oceanic Whitetip Shark	Appendix II (2014)		CCSBT	High
				IATTC	High
				ICATT	High
				IOTC	High
				WCPFC	High
Squalus acanthias	Piked Dogfish		Appendix II (2008) Northern hemisphere populations	Northeast Atlantic	High
				Northwest	Medium

Scientific Name	Common Name	CITES (effective date)	CMS (listing date)	Management Unit / Stock	M-Risk
				Atlantic	
Lamna nasus	Porbeagle Shark	Appendix II (2014)	Appendix II (2008)	CCAMLR	High
				CCSBT	High
				GFCM	High
				IATTC	High
				ICCAT	High
				IOTC	High
				NAFO	High
				NEAFC	High
				WCPFC	High
				EU	High
				Canada	High
				New Zealand	Medium
Sphyrna lewini	Scalloped Hammerhead	Appendix II (2014)		IATTC	High
				ICCAT	High
				IOTC	High
				NAFO	High
				WCPFC	High
Isurus oxyrinchus	Shortfin Mako		Appendix II (2008)	CCSBT	High
				IATTC	High
				ICATT	Medium
				IOTC	High

Scientific Name	Common Name	CITES (effective date)	CMS (listing date)	Management Unit / Stock	M-Risk
				WCPFC	High
				New Zealand	Medium
Sphyrna zygaena	Smooth Hammerhead	Appendix II (2014)		CCSBT	High
				GFCM	High
				IATTC	High
				ICCAT	High
				IOTC	High
				WCPFC	High

6.2 Traded and high value species

The M-Risk assessment method includes weightings to reflect the impact of international trade and value. It is instructive, therefore, to consider the M-Risk profiles of species based on whether they are traded internationally and whether products from these species are considered to be high value. While the assessments show no impact of international trade alone on M-Risk, the incorporation of high value into the assessment suggests that there is a significant impact on M-Risk arising from the value of the species traded. Ninety percent of management units/stocks of species considered to produce high value products traded internationally were assessed as at high risk (see Table 3).

To test the influence of the weight for internationally traded and high value species (i.e. a weight of 0.8) on the M-Risk rating, the stocks of the 32 species (141 stocks) assessed as traded and high value were reassessed without any weighting. The results indicated that a further 40 stocks would have been assessed as at medium, rather than high, M-Risk in the absence of the weighting and one stock would have been assessed as at low rather than medium risk.

6.3 Migratory shark species

The impact of the migratory status of shark species has also been explored through the M-Risk assessments (see Table 4). The percentage of highly migratory stocks / management units considered to be at high risk is higher than for migratory or non-migratory species. This is consistent with the lack of focus of RFMOs on most shark species.

Table 3 M-Risk by trade status

Trade Class	Number of species	Number of management units/stocks	M-Risk by management unit/stock	
			High (% management units/stocks)	Medium (% management units/stocks)
Not traded internationally	7	14	11 (79)	3 (21)
Traded internationally (but not high value)	7	18	12 (67)	6 (33)
Traded internationally and high value	32	141	127 (90)	14 (10)
Total	46	173	150	23

Table 4 M-Risk by migratory status

Migratory status	Number of species	Number of management units/stocks	M-Risk by management unit/stock	
			High No. and % management units/stocks	Medium No. and % management units/stocks
Highly migratory	21	110	98 (89)	12 (11)
Migratory or possibly migratory	9	24	19 (79)	5 (21)
Non-migratory	16	39	33 (85)	6 (15)
Total	46	173	150	23

6.4 Confidence in the assessment

As discussed above, the level of confidence in the assessments conducted varies. However, it is worth noting that in only one case, for Dusky Shark (*Carcharhius obscurus*) was an override of the method used in order to reflect the availability of alternative, but more reliable, information than the source dictated by the Guidance to the method.

For the majority (53%) of management units / stocks assessed, assessors had a mid-range level of confidence in the scores attributed. A high level of confidence was felt for 42% of the assessments. Assessors rated their confidence as 'low' in relation to only 5% of assessments. This suggests that despite the rapid assessment method adopted, sufficient information was found in relation to 95% of the stocks to support a mid-range to high level of confidence in the results.

6.5 Messages for improving management

The deficiencies in management, and in compliance with management, of the 46 shark species assessed can be identified on a management unit / stock basis from the M-Risk species assessments in Annex 4. It is not within the scope of this report to analyse the species-specific risk assessments and identify areas of key management deficiencies on a species or stock basis. It is, however, possible to make some general observations.

The three central elements of the assessments relate to stock status, adaptive species-specific management and generic management. The average (un-weighted) scores for each of these elements for high risk and medium risk management units / stocks are presented in Table 5. The area of greatest management deficiency (as measured by the difference between average score for high risk and medium risk species) for high risk stocks is in relation to stock status with medium M-Risk stocks scoring 34% higher on average for this category. However, medium M-Risk stocks also scored 33% higher on average than high risk stocks in relation to adaptive management shark stocks this result is not unexpected since it is well recognised that the stock status of sharks stocks is poorly understood and that management of most shark stocks is poor. Medium M-Risk stocks also scored around 32% higher on average in relation to stock status. Again, the lower score for stock status for stocks assessed at high M-Risk reflects the lack of knowledge about the status of most shark stocks.

Table 5 Average scores[1] for high risk and medium risk management units/stocks

M-Risk Rating	Stock status	Adaptive management	Generic Management
High risk	1.12	1.82	2.50
Medium risk	1.70	2.70	2.91

1. Low scores reflect highest risk

7 Combining intrinsic risk and M-Risk

Intrinsic risk and M-Risk scoring systems are summarized in Table 6. Intrinsic risk is scored such that high risk equates to the highest score. M-Risk is scored such that good management (and therefore lower risk) equate to the highest scores. Further, the scoring scales of intrinsic risk and M-Risk vary markedly. The much broader scoring scale for M-Risk reflects the wider range of management attributes assessed under M-Risk, the need for a range of scores to reflect the variability in management approaches, the need to weight the various components of M-Risk and the incorporation of differential scores for species not traded internationally, traded internationally and traded internationally and of high value.

Table 6 Intrinsic and M-Risk scoring schedules

Intrinsic Risk		**M-Risk**	
Risk level	**Score**	**Risk Level**	**Score**
High Risk	3 to 2.5	High	6-13
Medium risk	<2.5 to 2.00	Medium	>13-20
Low risk	<2.00	Low	>20-28

The differences in the scoring systems make it difficult to present the combined intrinsic and M-Risk assessment by graphically plotting intrinsic risk against M-Risk. In addition, intrinsic risk is scored on a species basis whereas M-Risk has been scored on a stock basis. This does not present a problem in assigning overall risk since each stock of a species will have the same intrinsic risk score. However, it does influence the way in which results are presented. Rather than presenting results for the 46 medium to high risk species identified in the intrinsic risk assessment, the M-Risk assessment presents results for 173 stocks. As a result, a tabular rather than a graphical approach to result presentation has been adopted.

Since it is not possible to combine the two scoring elements quantitatively in a meaningful way, the risk ratings for shark stocks for intrinsic risk and M-Risk have been combined in a qualitative way using a traffic light system. Under that system an overall risk finding of Red reflects higher risk, Orange reflects medium risk and Green reflects lower risk. This qualitative approach is similar to that adopted in Sant *et al*. (2012).

The nine possible combinations of risk scores are presented in Table 7. It should be noted that for the shark species assessed in this report no sharks fall into categories 3, 6, 7, 8 or 9 since only medium to high intrinsic risk sharks were assessed in this study and no shark species assessed were found to be at low M-Risk. However, for completeness, the full range of scoring combinations is considered here.

Table 7 Traffic light system combining intrinsic and M-Risk

	Intrinsic Risk	**M-Risk**	**Overall Risk**
1	High	High	Red
2	Medium	High	Red
3	Low	High	Orange
4	High	Medium	Orange
5	Medium	Medium	Orange
6	Low	Medium	Orange
7	High	Low	Orange
8	Medium	Low	Green
9	Low	Low	Green

If intrinsic risk and M-Risk are weighted equally and both intrinsic and M-Risk scores are the same, it is relatively straightforward to assign these overall risk categories. That is, for categories 1, 5 and 9 in Table 7, the overall risk finding is clear, i.e. red, orange and green respectively. However, where the scores are a combination of high, medium or low (categories 2, 3, 4, 6, 7 and 8), a judgement needs to made about the appropriate overall risk category. Where the combinations are of low and high scores, equal weighting might therefore suggest an overall risk rating of orange. However, where combinations are medium and high, or medium and low, a judgement on the relative weighting of intrinsic and M-Risk is required. The relative intrinsic risk of marine species is pre-determined and is not influenced by the extent of fishing mortality. Intrinsic risk has been used as the mechanism for identifying the shark species to be subjected to M-Risk assessment. Given that the purpose of the M- Risk assessment is to identify those species where intervention through MEAs or other management mechanisms can reduce the risk posed by fishing mortality it is considered appropriate that, where the intrinsic and M-Risk ratings diverge, the default overall risk rating is the M-Risk rating. This approach has been adopted in arriving at the overall risk classifications in Table 7. It should be noted, however, that the effect of this approach is that M-Risk dictates the overall risk ratings for the shark species assessed here since all those species fall into categories1, 2, 4 and 5 (see Table 8).

Table 8 Overall risk rating for 46 shark species by management unit / stock[1]

Scientific Name	Common Name	Management Unit / Stock	Intrinsic risk	M-Risk
Squatina squatina	Angel Shark	GFCM	Medium	High
		NEAFC	Medium	High
		France	Medium	Medium
		Spain	Medium	Medium
Oxynotus centrina	Angular Rough Shark	GFCM	Medium	High
		NEAFC	Medium	High
Cetorhinus maximus	Basking Shark	GFCM	High	High
		IATTC	High	High
		ICCAT	High	High
		NEAFC	High	High
		New Zealand	High	Medium
Alopias superciliosus	Bigeye Thresher Shark	CCSBT	High	High
		GFCM	High	High
		IATTC	High	High
		ICCAT	High	High
		IOTC	High	High
		WCPFC	High	High
Centroscyllium fabricii	Black Dogfish	NEAFC	Medium	High
		France	Medium	High
Prionace glauca	Blue Shark	CCSBT	High	High
		IATTC	High	High
		ICCAT	High	Medium

Scientific Name	Common Name	Management Unit / Stock	Intrinsic risk	M-Risk
		IOTC	High	High
		WCPFC	High	High
Hexanchus griseus	Bluntnose Sixgill Shark	ICCAT	High	High
		GFCM	High	High
		IOTC	High	High
		NEAFC	High	Medium
Echinorhinus brucus	Bramble Shark	NEAFC	Medium	High
		Portugal	Medium	High
Notorynchus cepedianus	Broadnose Sevengill Shark	New Zealand	Medium	High
		South Africa	Medium	High
Carcharhinus brachyurus	Bronze Whaler	ICCAT	High	High
		IOTC	High	High
		WCPFC	High	High
		Argentina	High	High
		New Zealand	High	High
		South Africa	High	High
Carcharhinus leucas	Bull Shark	CCSBT	High	High
		IATTC	High	High
		ICCAT	High	High
		IOTC	High	High
		WCPFC	High	High
		USA	High	Medium

Scientific Name	Common Name	Management Unit / Stock	Intrinsic risk	M-Risk
Mustelus mustelus	Common Smoothhound	Croatia	Medium	High
		South Africa	Medium	Medium
		United Kingdom	Medium	High
Alopias vulpinus	Common Thresher Shark	CCSBT	High	High
		GFCM	High	High
		IATTC	High	High
		ICCAT	High	High
		IOTC	High	High
		WCPFC	High	High
		Spain	High	High
Pseudocarcharias kamoharai	Crocodile Shark	CCSBT	Medium	High
		IATTC	Medium	High
		ICCAT	Medium	High
		IOTC	Medium	High
		WCPFC	Medium	High
Centrophorus squamosus	Deepwater Spiny Dogfish	NEAFC	Medium	Medium
		France	Medium	High
		Portugal	Medium	High
		New Zealand	Medium	High
Carcharhinus obscurus	Dusky Shark	IATTC	High	High
		ICCAT	High	High

Scientific Name	Common Name	Management Unit / Stock	Intrinsic risk	M-Risk
		IOTC	High	High
		Australia	High	Medium
		USA	High	High
Mustelus canis	Dusky Smoothhound	USA	Medium	High
Carcharodon carcharias	Great White Shark	CCSBT	High	High
		GFCM	High	High
		IATTC	High	High
		ICCAT	High	High
		IOTC	High	High
		WCPFC	High	High
		USA	High	High
Centrophorus granulosus	Gulper Shark	GFCM	Medium	High
		NEAFC	Medium	High
Dalatias licha	Kitefin Shark	NEAFC	Medium	High
		SPRFMO	Medium	High
		New Zealand	Medium	Medium
		Spain	Medium	High
Scymnodon ringens	Knifetooth Dogfish	NEAFC	Medium	Medium
		Portugal	Medium	High
Somniosus microcephalus	Large Sleeper Shark	NEAFC	High	Medium
Negaprion brevirostris	Lemon Shark	ICCAT	High	High

Scientific Name	Common Name	Management Unit / Stock	Intrinsic risk	M-Risk
		USA	High	High
Somniosus rostratus	Little Sleeper Shark	GFCM	Medium	High
		NEAFC	Medium	High
Isurus paucus	Longfin Mako	CCSBT	High	High
		IATTC	High	High
		ICCAT	High	High
		IOTC	High	High
		WCPFC	High	High
Centrophorus lusitanicus	Lowfin Gulper Shark	Portugal	Medium	High
Ginglymostoma cirratum	Nurse Shark	Dominican Republic	Medium	High
		Mauritania	Medium	High
		Mexico	Medium	Medium
Scyliorhinus stellaris	Nursehound	NEAFC	Medium	High
		Portugal	Medium	High
Carcharhinus longimanus	Oceanic Whitetip Shark	CCSBT	Medium	High
		IATTC	Medium	High
		ICATT	Medium	High
		IOTC	Medium	High
		WCPFC	Medium	High
Somniosus pacificus	Pacific Sleeper Shark	Australia	High	Medium

Scientific Name	Common Name	Management Unit / Stock	Intrinsic risk	M-Risk
Alopias pelagicus	Pelagic Thresher	IOTC	High	High
		WCPFC	High	High
Squalus acanthias	Piked Dogfish	New Zealand	Medium	High
		Northeast Atlantic	Medium	High
		Northwest Atlantic	Medium	Medium
Lamna nasus	Porbeagle Shark	CCAMLR	High	High
		CCSBT	High	High
		GFCM	High	High
		IATTC	High	High
		ICCAT	High	High
		IOTC	High	High
		NAFO	High	High
		NEAFC	High	High
		WCPFC	High	High
		EU	High	High
		Canada	High	High
		New Zealand	High	Medium
Centroscymnus coelolepis	Portuguese Dogfish	NEAFC	High	High
		France	High	High
		Portugal	High	High
		United Kingdom	High	High
Oxynotus paradoxus	Sailfin Rough	NEAFC	Medium	Medium

Scientific Name	Common Name	Management Unit / Stock	Intrinsic risk	M-Risk
	Shark			
Carcharias taurus	Sand Tiger Shark	Argentina	Medium	High
		Australia	Medium	High
		Uruguay	Medium	High
		USA	Medium	High
Carcharhinus plumbeus	Sandbar Shark	IATTC	Medium	High
		ICCAT	Medium	High
		IOTC	Medium	High
		Australia	Medium	Medium
		USA	Medium	Medium
Sphyrna lewini	Scalloped Hammerhead	IATTC	High	High
		ICCAT	High	High
		IOTC	High	High
		NAFO	High	High
		WCPFC	High	High
Isurus oxyrinchus	Shortfin Mako	CCSBT	High	High
		IATTC	High	High
		ICATT	High	Medium
		IOTC	High	High
		WCPFC	High	High
		New Zealand	High	Medium
Deania calcea	Shovelnose Spiny Dogfish	NEAFC	Medium	High
		SPRFMO	Medium	High

Scientific Name	Common Name	Management Unit / Stock	Intrinsic risk	M-Risk
		SEAFO	Medium	High
		New Zealand	Medium	High
		Portugal	Medium	High
Carcharhinus falciformis	Silky Shark	IATTC	High	High
		ICCAT	High	High
		IOTC	High	High
		WCPFC	High	High
Carcharhinus porosus	Smalltail Shark	ICCAT	Medium	High
		Guyana	Medium	High
Sphyrna zygaena	Smooth Hammerhead	CCSBT	High	High
		GFCM	High	High
		IATTC	High	High
		ICCAT	High	High
		IOTC	High	High
		WCPFC	High	High
Squatina californica	South Pacific Angel Shark	Mexico	Medium	High
		Peru	Medium	High
Mustelus lenticulatus	Spotted Smoothhound	New Zealand	Medium	Medium
Galeocerdo cuvier	Tiger Shark	ICCAT	Medium	High
		NEAFC	Medium	High
		Brazil	Medium	High

Scientific Name	Common Name	Management Unit / Stock	Intrinsic risk	M-Risk
		Mexico	Medium	High
		Netherlands	Medium	High

1. Red shading depicts high overall risk and orange shading depicts medium overall risk.

8 Conclusions and recommendations

8.1 Findings

The development of the M-Risk assessment method and its application to the shark taxa has significantly improved the assessment of the impact of management in mitigating the inherent risks faced by species subject to fishing mortality. The method developed is transparent and repeatable, providing the opportunity for the assessment framework to be used to monitor change in management and M-Risk status over time. Subject to further validation (see section 8.2.1), it is expected that the method will be applicable to any fished species.

From a fisheries management perspective the M-Risk framework allows for easy identification of the key areas of management that need to be addressed in relation to a particular species or stock. Further, the approach adopted allows for the main stocks / management units from which catch is taken to be identified as a basis for prioritising stocks most in need of improved management. The risk assessment outcomes in relation to sharks appear to be consistent with the assessments of CITES and CMS on the management risk faced by listed shark species, suggesting that the framework is delivering meaningful outcomes. However, the shark assessment findings in themselves are not the focus of this report. Rather, the focus is the M-Risk method and its refinement.

The method takes a precautionary approach to risk assessment. In particular where information is not available a low score (i.e. high risk) is attributed. This is consistent, for example, with the approach taken by Hobday *et al*. (2007). While this approach may mean that the method generates a higher number of false positives, it is considered that this is preferable than potentially masking risks. False positives can be investigated and overridden, if required, on the basis of additional information. However, a false negative may mean that a species does not attract the attention it requires.

There remain a number of important qualifications in relation to the application of the M-Risk assessment framework to the shark species assessed in this report. These include:

- it is essentially a rapid risk assessment method to guide more detailed investigation;
- identification of the main management units and stocks that are subject to fishing is based on the best available, but flawed, data on global catch and on major catching countries;

- the shark species risk assessments should not be considered definitive assessments of the risk for each species/stock, since
    - the assessments were deliberately time constrained (on average one day/species assessment) and the application of more time and effort will likely deliver different M-Risk assessment outcomes on a stock basis; and
    - the application of the framework by experts on specific stocks / management units is likely to result in refined and more confident M-Risk assessment outcomes. Definitive assessments would require the involvement of scientific and management experts with specific knowledge of the stocks and of the fisheries and management regimes that apply to them.

The authors believe that there is real value, in terms of the accuracy of M-risk assessment outcomes, in investing further time and effort providing technical input to the species / stock M-Risk assessments. However, users of the M-Risk framework should not lose sight of the fact that the framework was developed as a rapid M-Risk assessment method and it is not intended to be a substitute for a full risk assessment of a stock. A point of diminishing marginal returns to further investment in refining the M-Risk species assessments may be reached quite quickly and time and effort might then be more productively expended on addressing identified management issues.

8.2 Recommendations for further development

On the basis of the development of the M-Risk framework the authors believe that there is scope to refine and improve confidence in the outcomes through further work on validation, sensitivity testing, combining M-Risk and intrinsic risk and assessing exposure risk. Suggestions for further work in these areas are provided below.

8.2.1 Validation

The Expert Workshop identified the need for validation of the method. It was proposed that this could be conducted as follows:

- Around 10 non-shark species, for which there was a well-informed consensus on the level of M-Risk, should be identified by independent experts (i.e. experts not closely involved in the development and application of the method). These species should reflect diverse taxa and a range of high and low biological vulnerability and management rigor.
- The method should then be applied to these species by those responsible for the method without knowledge of the level of M-Risk ascribed to each species by the independent experts.
- If application of the method results in M-Risk levels consistent with the expectations of the independent experts this would provide confidence that the method was delivering logical and reliable outcomes.

Consideration was given to incorporating this validation process in the current project. However, neither the financial resources nor the time available allowed for this additional step to be completed. It is strongly recommended that the method be subjected to validation through the approach proposed above or an alternative mechanism.

8.2.2 Sensitivity testing

The scoring bands that determine High, Medium and Low Risk are obviously an important factor in the determination of M-Risk. These bands (set out in Table A2.4 of Annex 2) are based on the minimum and maximum possible scores for each trade/value category (not traded internationally, traded internationally, traded internationally and high value). The range between the lowest and high score for each category has been distributed as equally as possible across the High, Medium and Low Risk categories. There would be merit in considering how sensitive the risk category results for M-Risk are to the scoring bands selected. This sensitivity analysis was not possible within the time constraints of the current project but it is considered to be a useful next step in refining the method.

8.2.3 Aligning scoring systems for intrinsic and M-Risk

As discussed above, it has not been possible to combine intrinsic risk and M-Risk scores quantitatively. While a qualitative approach has been selected here, this approach has limitations. For example, it requires a judgement to be made on the relative importance of M-Risk and intrinsic risk where the risk findings diverge markedly, for example where intrinsic risk is low and M-Risk is high. In addition, the qualitative approach precludes the application of different weights to intrinsic risk and M-Risk should this be considered appropriate. It is recommended that consideration be given to how the two scoring systems could be better aligned and/or meaningfully combined in a quantitative manner. For example, it is believed that there would be considerable value in combining the results of the intrinsic and M-Risk analyses so that overall risk could be considered. Development of a mathematical solution to presenting the disparate scoring systems graphically would be well worthwhile.

8.2.4 Uncertainty

Uncertainty is an inherent characteristic of both intrinsic vulnerability and M-Risk. It can result from a lack of research, inadequacies in data collection or a failure to identify existing information. The M-Risk method has adopted a precautionary approach to uncertainty arising from lack of information, regardless of the cause. In relation to sharks, in particular, TRAFFIC has been canvassing the need for improved data collection and reporting and the need for improved management for over a decade. Despite this, species-specific data on catch and trade remains sorely lacking and management remains inadequate. This project has confirmed and highlighted these deficiencies. Closer interrogation of the species / stock assessments could provide insights into the main areas of uncertainty that are influencing high risk scores for sharks. Identifying those areas where lack of data or information, for example, was the primary reason for high risk ratings would be a valuable means of prioritising management responses to the findings.

8.2.5 Exposure

As discussed in Section 5.1, exposure risk had been envisaged as an integral component of this project. However the conclusion of the expert workshop was that meaningful analysis of exposure was beyond the scope of the project. It was agreed that this would be better done as part of a separate research effort or conducted as a more in-depth, second stage analysis for particular species / stocks highlighted by the M-Risk assessment process as of particular concern. Nevertheless, the M-Risk framework presented here does attempt to account for the influence of the trade and value elements of exposure risk by including risk weightings for these factors.

As noted above, some shark stocks are assessed as high M-Risk despite the fact that they had very low average reported catch levels. While catch is not necessarily a good indicator of exposure (see section 5.1.1), this may suggest that, without an exposure risk component, the M-Risk assessment may overstate the level of risk. The authors are of the view that, ultimately, it would be preferable to include an assessment of exposure risk (based on fishing effort by gear type) as a middle step between intrinsic and M-Risk assessment. This would potentially filter out species / stocks that may not warrant M-Risk assessment. Consideration of exposure would also enhance M-Risk assessment by allowing for more targeted examination of the likely effectiveness of management measures against the most predominant gear types to which the species / stock is exposed. While incorporation of the exposure assessment would involve additional effort, it may also, therefore, streamline the M-Risk assessment process.

Acronyms

CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CCSBT	Commission for the Conservation of Southern Bluefin Tuna
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMS	Convention on the Conservation of Migratory Species
CSIRO	Commonwealth Scientific and Industrial Research Organization
Defra	Department for Environment, Food and Rural Affairs
EEZ	Exclusive Economic Zone
FAO	Food and Agriculture Organization of the United Nations
GFCM	General Fisheries Commission for the Mediterranean
IATTC	Inter-American Tropical Tuna Commission
ICCAT	International Commission for the Conservation of Atlantic Tunas
IOTC	Indian Ocean Tuna Commission
IUCN	International Union for the Conservation of Nature
IUU fishing	Illegal, unreported and unregulated fishing
JNCC	Joint Nature Conservation Committee
MEA	Multilateral Environmental Agreement
MoU	Memorandum of Understanding
M-Risk	Management Risk
MSC	Marine Stewardship Council
NEAFC	Northeast Atlantic Fisheries Commission
NOAA	National Oceanic and Atmospheric Administration
PSG	Project Steering Group
RECOFI	Regional Commission for Fisheries
RFMO	Regional fisheries management organization
SEAFO	South East Atlantic Fisheries Organisation
SIOFA	Southern Indian Ocean Fisheries Agreement
SPRFMO	South Pacific RFMO
SSG	Shark Specialist Group
TRAFFIC	The Wildlife Trade Monitoring Network
UNCLOS	United Nations Convention on the Law of the Sea of 10 December 1982
VMS	Vessel monitoring system
WCPFC	Western and Central Pacific Fisheries Commission

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Annex 1 M-Risk Assessment Framework

M-RISK ASSESSMENT		**[Species common name and *scientific name]***		
Date				
A. Management Context			**References**	**Notes**
1	Reported average global annual catch of the species (2007-2011)			
2	What is the distribution of the species?			
3	Known stocks/populations			
4	Main catching countries:			
5	Main gear types by which the species is taken			
6	IUCN Red List status, if assessed, and year of assessment			
7	Nature of the species			
7a	If the species is 'migratory' or 'non-migratory' and the stocks are shared across countries, identify the countries fishing the shared stocks.			
7b	If the species is highly migratory or if it is found on the high seas what are the relevant RFMOs?			
8	Identify any main catching countries that are not members of the relevant RFMOs (if applicable)?			
9	What are the main management bodies			

A. Management Context			References	Notes
10	Is the species listed in the Appendices of either CITES or the CMS?			
10a	Are the main catching countries issuing expert-permits for the species if it is listed in Appendix II of CITES?			
10b	Have any of the main catching countries taken out a reservation against the CITES listing?			
10c	Are the main catching countries signatories to any CMS Agreement or Memorandum of Understanding relating to the species			
11	Main products from the species that are internationally traded			
12	Which, if any, of these products are considered to be of high value?			
12a	Weight for trade/value			

B. Risk Assessment					
Assessment	**Basis for assessment**	**Score**	**Confidence**	**References**	**Notes**
Stock Status					
1. What is the status of each stock OR the status of the species in each management unit if stocks are not well-defined?					
[management bodies]					
Adaptive management system					
Monitoring and Analysis					
2. Is information collected to inform the status of the stock?					

[management bodies]					
3. Have the available data been analysed to inform management decisions?					
[management bodies]					
Species/stock-specific management					
4. How does the management unit manage the stock?					
[management bodies]					
5. Are the measures consistent with the species-specific advice for the stock?					
[management bodies]					
Compliance					
6. How comprehensive is the compliance regime in place to support these species-specific measures?					
[management bodies]					
7. What is the level of compliance with the reporting requirements for the stock?					
[management bodies]					
8. Is IUU fishing recognized as a problem for the stock, if it is a target stock, or for the fishery in which it is taken in association with, if it is a bycatch?					
[management bodies]					
Generic management					
9. Are the generic management measures in place likely to reduce the impacts on the species being assessed?					
[management bodies]					
10. How comprehensive is the compliance regime in place to support the generic management measures that are relevant to the stock?					
[management bodies]					

C. SCORING					
	Stock Status	**Adaptive management (Average score)**	**Generic management (average score)**		**Total Un-weighted Score**
Un-weighted scores					
[management bodies]					
Weighted scores	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**	**Total weighted score**
[management bodies]					

Annex 2 Guidance and Explanatory Notes for M-Risk assessment framework

Overview of M-Risk Assessment Framework

The M-Risk assessment framework has two components:

A. information on the management context of the species and its stocks

B. a risk assessment process that includes:

   a. assessment criteria and indicators;

   b. weighting;

   c. scoring;

   d. risk classification; and

   e. confidence.

Each of these elements is described below together with explanatory material on terminology, guidance on how to assess and score the indicators and potential sources of information.

In completing Sections A and B of the framework it is critical that all sources of information are cited in the 'source' column and that a complete list of references is provided for each assessment.

A. Management context

Advice on the nature and potential sources of information used to compile information on the management context of the species and its stocks are provided in Table A2.1.

Table A2.1 Guidance on Management Context

	Species data	Guidance and Explanatory notes	Source
	Species name	Scientific and Common names. Identify the Fishbase/FAO common name first and also include the common name used in the intrinsic vulnerability assessment, if different. Not all the common names used in the list of medium-high risk species in the intrinsic vulnerability assessment correspond to the common names in the FAO database or Fishbase so there is a need to check these. For example, *Carcharhinus brachyurus* is referred to as Bronze whaler in the Intrinsic vulnerability assessment yet it is called copper shark by FAO and Fishbase.	Use Fishbase http://www.fishbase.org/
1	Reported global catch of	Average annual catch in tonnes for the last 5 year period (currently 2007-	Use FAO Capture Production (FAO

	Species data	Guidance and Explanatory notes	Source
	the species	2011).	Fisheries Department, 2013a) database for other species http://www.fao.org/fishery/statistics/global-capture-production/en Note that FAO Capture Production data used in the assessment should include only species-specific data and not include general catch categories in which the species under assessment may be included. For example, use only data for scalloped hammerhead. Do not include data for 'hammerhead shark nei'
2	What is the species' distribution?	Insert map if available and/or provide a description.	Fishbase
3	Known stocks / populations	Describe what is known about the stock structure of the species. Stock structure species may or may not be known, or may be partially known. i.e. some stock delineation may have been determined. For the purpose of M-Risk assessment it is the management unit/s under which the stock is managed (and hence the management bodies responsible for that management) that is of primary interest.	Sources of information include Fishbase, IUCN Red List assessment http://www.iucnredlist.org/, CITES proposals, RFMO assessments, national assessments etc.
4	Main catching countries	The aim of the exercise is to make assessment of management risk practical by assessing the risk in those countries that are known to have the largest impact on the species and the stocks. At the species level identify those countries responsible for taking the	Use FAO Capture Production data available at: http://www.fao.org/fishery/statistics/global-capture-production/en

	Species data	Guidance and Explanatory notes	Source
		bulk of the reported global catch based on FAO Capture Production data over the most recent five years. For sharks a cut off of 85% of the catch has been used, however this may need to be reviewed on a species basis (depending on the spread of the catch). At the stock/population level apply the same principles using oceanic breakdown of the FAO data as a guide.	See notes under 3 above.
5	Main gear types by which the species is taken	Information on gear types used to catch the species can be used to identify relevant RFMOs. Many species are susceptible to a range of fishing gears. Use available information to identify the main gear types by which the species is taken. Ultimately gear type is a key component of exposure risk and this information is valuable should exposure risk be calculated for the species.	Sources include Fishbase, IUCN Red List assessment, CITES proposals, RFMO assessments, national assessment etc.
6	IUCN Red List status (if assessed) and year of assessment	This is useful background information and, in the absence of any other advice on stock status could be used to inform management decisions. Provide both the IUCN global and population/stock assessments where available.	IUCN Red List assessment
7	Nature of the species (Highly migratory, migratory or non-migratory)	The nature of the species can determine the nature of the necessary management arrangements e.g. an RFMO should be in place for highly migratory species and straddling stocks should be subject to cooperative management by the countries fishing the stocks.	For all species classify as' highly migratory' if listed on UNCLOS Annex 1. For sharks classify as 'migratory' if identified as migratory or possibly migratory by SSG (2007a, b) and classify as 'non-migratory' if not listed on UNCLOS Annex 1 or identified by SSG (2007a, b).

	Species data	Guidance and Explanatory notes	Source
7a	If the species is 'migratory' or 'non-migratory' and the stocks are shared across countries what countries are fishing the shared stocks?	For non-highly migratory species that are shared across exclusive economic there exists an obligation under UNCLOS for the countries fishing the stock to cooperate to manage these stocks.	FAO Capture production database by sub-ocean provides an indication of the likely relevant countries in the absence of more specific information.
7b	If the species is highly migratory or if it is found on the high seas what are the relevant regional fisheries management organizations (RFMOs)	Those RFMOs identified by FAO as having a management mandate, whose areas of competency overlap with the species distribution and for which there is some reliable information that the species is taken in fisheries managed by the RFMO. Where reliable information is available on the main RFMO fisheries likely to have an impact on the species this should be used to reduce the number of relevant RFMOs included in the assessment. Assessment of whether a main catching country should be a member of the relevant RFMOs involves an assessment of whether it is eligible to be a member and whether it has exercised that right.	See FAO Regional Fisheries Bodies http://www.fao.org/fishery/rfb/search/en
8	Identify any main catching countries that are not members of the relevant RFMOs (if applicable)	If any of the main catching countries are not members of any relevant RFMO but they have stronger management measures in place for the stock than the RFMO those measures should be considered in assessing the stock managed by the RFMO.	See RFMO website addresses and membership at http://www.fao.org/fishery/rfb/search/en
9	What are the main management bodies?	For the purpose of M-Risk assessment it is the management unit/s responsible for management of the stocks that are of primary interest. Based on the information above on stock structure, main catching countries and relevant RFMOs the main management bodies should be identified. For highly	

	Species data	Guidance and Explanatory notes	Source
		migratory species for which one or more relevant RFMOs exist, those RFMOs will be the relevant management bodies and any stronger management measures in place for the stock by main catching countries taken into account when assessing the management unit. Since it is possible that more than one management body (more than one RFMO and/or more than 1 main catching country) may be relevant to a particular 'stock' it is important that the relevant stock or stocks for each management body are identified.	
10	Is the species listed in the appendices of CITES or the CMS? If so: a. are the main catching countries issuing expert permits for a CITES-listed species? b. have any of the main catching countries taken out a reservation c. are the main catching countries signatories to any CMS Agreements or MoU relevant to the species?	A listing may indicate the need to confirm what if any, management measures are in place as a result of these listings.	For CITES reservations see http://www.cites.org/eng/app/reserve.php For CMS agreements / memoranda of understanding see http://www.cms.int/species/index.htm

	Species data	Guidance and Explanatory notes	Source
11	What are the main products from the species that are traded internationally?	This question contributes to the weighting applied to reflect the extra risk posed to species by international trade	Information may be gleaned from: • the FAO Fisheries Commodities and Trade database (FAO Fisheries Department, 2013b): http://www.fao.org/fishery/statistics/global-commodities-production/en • National online trade databases, including the Eurostat http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database • Other FAO publications, IUCN assessments etc.
12	Which, if any of these products are considered to be of high value compared to similar products from other species?	This question contributes to the weighting applied to reflect the extra risk posed to species by their relatively high value. There is no consistent basis for determination of high value marine products in trade. Where available species specific information should be used as a basis for a judgement on whether a species is high value. If there is no information on which to make such a judgement the answer to this question should be unknown.	Species/marine products that are commonly regarded as high value include shellfish, oysters, scallops, crustaceans, sea urchins, sea cucumber, abalone, shark fin, tuna, swordfish, salmon, sturgeon, shark liver oil and toothfish.
	a) What is the appropriate weight for trade/value?	Identify weight of 1, 0.9 or 0.8	See Guidance notes section D

B. Risk assessment

M-Risk assessment is based on three main criteria:

1. Stock status
2. Adaptive management system
3. Generic fisheries management measures

The Stock Status is determined on the basis of the most recently available information from the relevant management entities (e.g. RFMO or national fisheries management agency) using the indicator:

a) the status of each stock OR the status of the species in each management unit if stocks are not well-defined?

The Adaptive Management System is assessed on the basis of indicators related to:

- Monitoring and Analysis
  b) Is information collected to inform the status of the stock?
  c) Have the available data been analysed to inform management decisions?
- Species/stock-specific management
  d) How does the management unit manage the stock?
  e) Are the measures consistent with the species-specific advice for the stock?
- Compliance
  f) How comprehensive is the compliance regime in place to support these species-specific measures?
  g) What is the level of compliance with the reporting requirements for the stock?
  h) Is illegal, unreported and unregulated (IUU) fishing recognized as a problem for the stock (if it is a target) or for the fishery in which the stock is taken (if it is a bycatch)?

Generic Fisheries Management Measures are assessed using the indicators:

i) Are the generic fisheries management measures in place likely to reduce the impact on the species/stock being assessed?

j) How comprehensive is the compliance regime in place to support the generic management measures that are relevant to the species/stock being assessed?

Advice on the interpretation of the questions and the scoring model for each question is provided in Table A2.2.

Table A2.2 Interpretative notes and scoring

M-RISK ASSESSMENT	
Scoring	**Explanatory notes**
Stock Status	
1. What is the status of each stock OR the status of the species in each management unit if stocks are not well-defined?	
If information is available on both biomass and mortality score OR if no information is available score as follows: **Status** — **Score** Overfished and overfishing occurring — 1 Uncertain — 1 Unknown — 1 Overfished: Overfished but fishing impact is not causing overfishing. Stock may be rebuilding. — 2 Overfishing occurring: Stock at sustainable level but overfishing is occurring. — 3 Sustainable: Catch is considered to be at sustainable levels. — 4	Wherever possible utilize the advice on the status of the stocks available from the relevant scientific or management body. In some cases it may be necessary to interpret the information available. Notes are provided below to assist that interpretation. Information on Biomass or level of depletion will inform whether the stock is overfished. Information on fishing mortality will inform whether overfishing is occurring. *Overfished:* A stock is considered 'overfished' when exploited beyond an explicit limit beyond which its abundance is considered 'too low' to ensure safe reproduction. In many fisheries fora the term is used when biomass has been estimated to be below a limit biological reference point that is used as the signpost defining an 'overfished condition'. The stock may remain overfished (i.e. with a biomass well below the agreed limit) for some time even though fishing pressure might be reduced or suppressed (FAO, 2013b). *Overfishing*: A term used to refer to the state of a stock subject to a level of fishing effort or fishing mortality such that a reduction of effort would, in the medium term, lead to an increase in the total catch. Often referred to as overexploitation and equated to biological overfishing, it results from a combination of growth overfishing and recruitment overfishing and occurs often together with ecosystem overfishing and economic overfishing (FAO, 2013b). *Uncertain*: The best available scientific advice concludes that the status is uncertain or concludes that there is insufficient information to assess the stock. *Unknown*: No information to inform an assessment of the status of the stock has been identified by the assessor. Note that it is the status of the stock in a biological rather than an ecological sense that is being assessed here.
If information on only biomass or level of depletion is available score as follows: **Status** — **Score** Overfished — 1 Uncertain — 1 Not Overfished — 3	Where the stock is not overfished but there is no mortality data available, it is not scored at the lowest risk level since there is still a risk that overfishing is occurring. Additional information may be available to inform this answer (i.e. override)

M-RISK ASSESSMENT	
If information on only the level of fishing mortality is available score as follows: Is the exploitation rate excessive? **Status** **Score** Exploitation rate is excessive 1 Uncertain 1 Exploitation rate is not excessive 2	Where the exploitation rate is not excessive but where biomass data is not available, the risk is not scored at the lowest level, since it is possible that the stock is overfished (and for this reason the risk level is higher than for the situation above). Additional information may be available to inform this answer (i.e. override)
Adaptive management system	
Monitoring and Analysis	
2. Is information required to be collected to inform the status of the stock?	
Information available **Score** No data required or unknown 1 Landings data required 2 Landings and effort data required 3 Comprehensive data required (Species specific landings, discards, life status, effort, abundance, catch rates (ideally fishery independent surveys), length, age etc.) 4	Consider what level of information availability most closely reflects the data collection requirements of the management system. Information must be species-specific. For example, a requirement to simply record 'shark' catch would not inform assessment of the status of a particular shark species. Where retention of a species is prohibited scoring references to 'landings data' should be replaced by 'discard data'.
3. Have the available data been analysed to inform management decisions?	
Data analysis **Score** No analysis 1 Some data analysis undertaken 2	

M-RISK ASSESSMENT		
Full stock assessment	4	
Species/stock-specific management		
4. How does the management unit manage the stock?		
Species-specific, adaptive management	**Score**	Species-specific management measures are those that relate explicitly and directly to the species being assessed e.g. a catch quota for the species, an effort control in a target fishery for the species or an area closure specifically designed to protect life cycle stages of the species. A list and description of commonly used fisheries management methods is provided at Attachment 2. This indicator is looking for evidence-based decision making, including taking a precautionary approach in the absence of scientific advice or responding to experience in other fisheries for the species or similar species. For highly migratory species, where any of the main catching countries identified in A4 are considered to have stronger management measures in place than the relevant RFMO, these countries should be assessed as separate management units. For shared stocks (other than highly migratory) the risk to the stock will be **increased** if there is not cooperation between the relevant management bodies. Consider the extent to which such cooperation exists.
No species-specific management	1	
Species specific management but not adaptive/no evidence of feedback loop	2	
Species-specific management in place with some evidence of feedback loop	3	
Species-specific adaptive management in place	4	
5. Are the management measures in place consistent with the scientific advice?		
Consistent with scientific advice	**Score**	Do the measures implemented respond appropriately to the needs identified by the available scientific advice OR do they reflect the specific management advice provided by the scientific advisory body. The intent of this question is to get a sense of whether the management measures are likely to address the 'problem' identified by the scientific advisory body.
Not consistent	1	
No scientific advice on management identified	2	
Scientific advice partially implemented	3	
Consistent	4	
Compliance		
6. How comprehensive is the compliance regime in place to support these species-specific measures?		
Compliance Regime	**Score**	Assess the nature of the compliance regime against the species-specific management measures in place. Relevance of compliance measures should be determined on the basis of their appropriateness to enforcing the species specific management measures identified above.
No relevant compliance measures in place OR no	1	

<table>
<tr><th colspan="2">M-RISK ASSESSMENT</th></tr>
<tr><td>information on the nature of the compliance OR no species specific management in place
Very limited relevant compliance measures in place regime 2
Limited relevant compliance measures in place 3
Comprehensive relevant compliance measures in place 4</td><td>For highly migratory species, the compliance regime in both the main catching countries and any relevant RFMOs should be assessed if possible. If information on the main catching countries' compliance regime is not available rely on the information available for the RFMO. See Attachment 2 for guidance on the nature of the key elements of compliance measures required.
'Very limited relevant compliance' measures means that more than one of the key elements of the compliance regime required to enforce the relevant measures are not in place
'Limited relevant compliance measures' means that one of the key elements of the compliance regime required to enforce the relevant measures is not in place
Comprehensive relevant compliance measures' means that all of the key elements of the compliance regime required to enforce the relevant measures are in place</td></tr>
<tr><td colspan="2">7. What is the level of compliance with the reporting requirements for the stock?</td></tr>
<tr><td>Compliance with reporting Score
There is no information available on the level of compliance with reporting requirements OR information to inform the assessment could not be identified OR there are no reporting requirements for the stock 1
Information available supports a conclusion that there is ongoing low compliance 2
Information available supports a conclusion that compliance is generally acceptable (e.g. concerns have not been 3</td><td>Identify what, if any, reporting requirements are in place for the species.
Information available on compliance with these requirements is variable in terms of its public availability. However there may be some information available at the national and/or RFMO level on the status of the data for the species. This information might be contained in the reports of scientific bodies responsible for assessing stock status, compliance bodies responsible for monitoring compliance with management measures of management bodies concerned with implementation of management measures.</td></tr>
</table>

M-RISK ASSESSMENT	
identified about lack of compliance) Information available supports a conclusion that there is ongoing high level of compliance 4	
8. Is illegal, unreported and unregulated (IUU) fishing recognized as a problem for the stock (if it is a target) or for the fishery in which the stock is taken (if it is bycatch)?	
IUU fishing **Score** Ongoing recognized problem 1 Has been a recognized problem some measures in place to address it but not clear whether measures are successful 2 Has been a recognized problem but measures to address it appear successful 3 Not a recognized problem 4	A recognized IUU fishing problem equates to an acknowledgement by the management regime or others that there is some ongoing and significant level of IUU fishing on the stock, despite the introduction of measures to address the problem. A low level of minor non-compliance issues should not be equated to a recognized IUU fishing problem. IUU fishing includes all forms of illegal, unreported and unregulated fishing, as defined by the International Plan of Action on IUU Fishing (FAO, 2001) http://www.fao.org/docrep/003/y1224e/y1224e00.HTM, by both domestic and foreign vessels.
Generic management	
9. Are the generic management measures in place likely to reduce the impacts on the species being assessed?	
Generic fisheries management **Score** No relevant generic measures OR the nature of the generic fisheries management arrangements are unknown 1 Reduction in impact unlikely/unknown 2	Generic fisheries management measures are those in place to manage overall effort or catch in a fishery that are not specific to the species being assessed but may have some benefit to that species (e.g. limited entry or catch controls on other target species or controls on species groups (e.g. shark finning controls). A list and description of commonly used fisheries management methods is provided at Attachment 2.

M-RISK ASSESSMENT		
Some reduction likely	3	
Significantly reduction likely	4	
10. How comprehensive is the compliance regime in place to support the generic management measures that are relevant to the stock?		
Compliance regime	**Score**	Assess the nature of the compliance regime against the species-specific management measures in place. Relevance of compliance measures should be determined on the basis of their appropriateness to enforcing the species specific management measures identified above. For highly migratory species, the compliance regime in both the main catching countries and any relevant RFMOs should be assessed if possible. If information on the main catching countries' compliance regime is not available rely on the information available for the RFMO. See 6 above for interpretation of terms Guidance on the nature of the key elements of compliance measures required to enforce generic management measures is provided in Attachment 2.
No relevant compliance measures in place or no information on the nature of the compliance	1	
Very limited compliance relevant measures in place regime	2	
Limited relevant compliance measures in place	3	
Comprehensive relevant compliance measures in place	4	

C. Dealing with Uncertainty

There remains considerable uncertainty in the M-Risk assessment. This uncertainty can arise because the data necessary to inform the assessment are not collected, are not collated, are not publicly available and/or have not been identified by the assessor. In relation to the latter, it should be noted that the M-Risk framework is not intended to deliver a definitive assessment of management risk for each stock. It is intended to provide guidance as to which stocks are likely to be at greatest risk and which may require further attention, including more rigorous investigation of the M-Risk criteria and indicators. The amount of time and effort devoted to discovering information to inform the M-Risk framework reflects this. In all likelihood more dedicated investigation of each species and stock and the input of experts on those stocks would uncover additional information and/or improve the level of confidence in the information used in the application of the framework.

In order to reflect this uncertainty a confidence rating has been given to each indicator score. The ratings are:

- Rating 3: High Confidence (Information available from authoritative sources with little or no extrapolation or inference required)
- Rating 2: Medium Confidence (Some reliable information available but inference and extrapolation required)
- Rating 1: Low Confidence (Scoring based on very limited information)
- Rating 0: No information

The overall confidence level for the final aggregated risk score for the species/stock is based on the total confidence score across the nine indicators. A maximum confidence score is 30 and the minimum score is zero. Overall confidence has been assessed as follows:

- a score of >24 indicates high confidence in the risk rating
- a score of 13-24 indicates some confidence in the risk rating
- a score of 1-12 indicates low confidence in the risk rating
- a score of 0 indicates no confidence in the risk rating

D. Weighting

Assessment Criteria

The contribution of each of the three assessment criteria to the level of risk is not equal. The weights have been determined on the basis that:

- the presence of an adaptive management system should make the greatest contribution to mitigating risk;
- the current status of the stock should have a major bearing on the total risk posed to the stock by fishing;
- generic fisheries management is regarded as having a neutral impact relative to adaptive management and stock status.

The criteria are weighted as follows:

Adaptive management system 4

Stock status	2
Generic management	1

International demand/value

While there is no definitive information on which to determine whether a species, or products from it, is of high value it is considered reasonable to assume that 'high value' marine products are at greater risk than lower value products, particularly from IUU fishing. Since there is no consistent benchmark against which marine products can be considered to determine their relative value the inclusion of value in the risk assessment needs to be based on the best available information for the species, similar products for other species and information on generally recognized high value seafood products.

Similarly, it is considered that products in international trade are at greater risk than products that are produced and consumed only in local, domestic markets.

The following weights are applied to reflect the impact of international trade and the value of a species. Given that the scoring system rates high risk with a low M-Risk score, the impact of the weight must be to reduce the risk score. The weights are as follows.

- a weighting of 1 for species from which products are not traded internationally (i.e. trade has no impact on risk)
- a weighting of 0.9 for species from which products are traded internationally but are not considered to be of high value;
- a weighting of 0.8 for species from which products are traded internationally and are considered to be of high value.

E. Scoring

There are seven steps involved in arriving at the total score and overall M-Risk classification for each stock and associated level of confidence in the finding.

1. ***Calculate the average score for each of the three criterion (to two decimal places)***
    - for Stock Status the average score equals the score for Q. 1 since there is only 1 indicator
    - for Adaptive Management the average score equals the total of the scores for Indicators 2-8 divided by 7
    - for Generic Management the average score equals the total of the scores for Questions 9-10 divided by 2
2. ***Apply the relevant weight for each criteria***
    - Weight average score for Stock Status by 2
    - Weight average Score for Adaptive Management by 4
    - Weight average score for Generic Management by 1
3. ***Sum the weighted average scores for the three criteria***
4. ***Weight the total according to whether the species is in international trade and whether it is of high value***

- weight by 1 if the species is not traded internationally
- weight by 0.9 if the species is trade internationally but not of high value
- weight by 0.8 if the species is traded internationally and of high value

5. Attribute risk classification

- In order to determine the risk rating of the stock, risk categories have been determined based on the minimum and maximum weighted scores across the three groups of species (not traded internationally, traded internationally and traded internationally and of high value). These minimum and weighted scores are provided in Table A2.3. The range of these scores (from 6 to 28) has then been divided into three overall risk categories (see Table A2.4).

Table A2.3 Minimum and maximum weighted risk scores

Criterion	**No. of indicators**	**Criterion Weight**	**Minimum weighted score**	**Maximum weighted score**
Stock status	1	2	2	8
Adaptive management	7	4	4	16
Generic management	2	1	1	4
Total minimum and maximum (un-weighted)			**7**	**28**
Total minimum and maximum - not traded internationally (weight 1)			7	28
Total minimum and maximum - traded internationally (weight 0.9)			6	25
Total minimum and maximum - traded internationally and high value (weight 0.8)			6	22

Table A2.4 Risk categories

Risk category	**Score range**
High risk	6-13
Medium risk	>13-20
Low risk	>20-28

6. Attribute a confidence rating

- Calculate the overall level of confidence associated with the risk score for each stock summing the score for each of the 10 questions.
    - a score of >24 indicates high confidence in the risk rating
    - a score of 13-24 indicates some confidence in the risk rating
    - a score of 1-12 indicates low confidence in the risk rating
    - a score of 0 indicates no confidence in the risk rating

The confidence level score does not affect the risk rating but is provided for interpretative purposes only.

Attachment 1 Migratory status of medium and high risk fished shark species

Species	Intrinsic risk	Migratory status
Alopias pelagicus **Pelagic Thresher**	High	Highly Migratory (UNCLOS)
Alopias superciliosus **Bigeye Thresher Shark**	High	Highly Migratory (UNCLOS)
Alopias vulpinus **Common Thresher Shark**	High	Highly Migratory (UNCLOS)
Carcharhinus brachyurus **Bronze Whaler**	High	Highly Migratory (UNCLOS)
Carcharhinus falciformis **Silky Shark**	High	Highly Migratory (UNCLOS)
Carcharhinus leucas **Bull Shark**	High	Highly Migratory (UNCLOS)
Carcharhinus longimanus **Oceanic Whitetip Shark**	Medium	Highly Migratory (UNCLOS)
Carcharhinus obscurus **Dusky Shark**	High	Highly Migratory (UNCLOS)
Carcharhinus plumbeus **Sandbar Shark**	Medium	Highly Migratory (UNCLOS)
Carcharhinus porosus **Smalltail Shark**	Medium	Highly Migratory (UNCLOS)
Carcharias taurus **Sand Tiger**	Medium	Migratory (or possibly migratory)
Carcharodon carcharias **Great White Shark**	High	Highly Migratory
Centrophorus granulosus **Gulper Shark**	Medium	Non-migratory
Centrophorus lusitanicus **Lowfin Gulper Shark**	Medium	Non-migratory

***Centrophorus squamosus* Deepwater Spiny Dogfish**	Medium	Non-migratory
***Centroscyllium fabricii* Black Dogfish**	Medium	Non-migratory
***Centroscymnus coelolepis* Portuguese Dogfish**	High	Non-migratory
***Cetorhinus maximus* Basking Shark**	High	Highly Migratory (UNCLOS)
***Dalatias licha* Kitefin Shark**	Medium	Non-migratory
***Deania calcea* Shovelnose Spiny Dogfish**	Medium	Non-migratory
***Echinorhinus brucus* Bramble Shark**	High	Non-migratory
***Galeocerdo cuvier* Tiger Shark**	Medium	Highly Migratory (UNCLOS)
***Ginglymostoma cirratum* Nurse Shark**	Medium	Non-migratory
***Hexanchus griseus* Bluntnose Sixgill Shark**	High	Highly Migratory (UNCLOS)
***Isurus oxyrinchus* Shortfin Mako**	High	Highly Migratory (UNCLOS)
***Isurus paucus* Longfin Mako**	High	Highly Migratory (UNCLOS)
***Lamna nasus* Porbeagle Shark**	High	Highly Migratory (UNCLOS)
***Mustelus canis* Dusky Smoothhound**	Medium	Migratory (or possibly migratory)
***Mustelus lenticulatus* Spotted Smoothhound**	Medium	Non-migratory
***Mustelus mustelus* Common Smoothhound**	Medium	Migratory (or possibly migratory)
***Negaprion brevirostris* Lemon Shark**	High	Highly Migratory (UNCLOS)
***Notorynchus cepedianus* Broadnose Sevengill Shark**	Medium	Migratory (or possibly migratory)

***Oxynotus centrina* Angular Rough Shark**	Medium	Non-migratory
***Oxynotus paradoxus* Sailfin Rough Shark**	Medium	Non-migratory
***Prionace glauca* Blue Shark**	High	Highly Migratory (UNCLOS)
***Pseudocarcharias kamoharai* Crocodile Shark**	Medium	Migratory (or possibly migratory)
***Scyliorhinus stellaris* Nursehound**	Medium	Non-migratory
***Scymnodon ringens* Knifetooth Dogfish**	Medium	Non-migratory
***Somniosus microcephalus* Large Sleeper Shark**	High	Migratory (or possibly migratory)
***Somniosus pacificus* Pacific Sleeper Shark**	High	Migratory (or possibly migratory)
***Somniosus rostratus* Little Sleeper Shark**	Medium	Non-migratory
***Sphyrna lewini* Scalloped Hammerhead**	High	Highly Migratory (UNCLOS)
***Sphyrna zygaena* Smooth Hammerhead**	High	Highly Migratory (UNCLOS)
***Squalus acanthias* Piked Dogfish**	Medium	Migratory
S*quatina californica* South Pacific Angel Shark	Medium	Non-migratory
***Squatina squatina* Angel Shark**	Medium	Migratory (or possibly migratory)

(Sources: UNCLOS; Oldfield *et al*., 2012; SSG, 2007a, b; Last and Stevens, 2009)

Attachment 2 Indicative fisheries management measures and associated compliance measures

A wide range of management techniques are used to manage fish stocks. Broadly, these measures relate to controlling the quantity of catch, the nature of the catch, the amount of fishing effort, where and/or when fishing can occur and/or controls on trade of the species. Effective application of such measures requires a framework of data collection, scientific assessment of fishing operations and fish stocks, and monitoring, control and surveillance of regulations. An indicative, but not necessarily comprehensive, list of the management measures and the compliance measures that might be considered effective in enforcing them is provided below.

Measure	**Aim/s and Implementation**	**Relevant Compliance Measures**
Limited entry	Aim: to limit access to the fishery to a specific group or number of operators as the first step in controlling fishing effort Implementation: typically through the issue of some form of fishing right such as a fishing permit or licence	Sound licensing system in place At sea and in-port inspections of vessel and authorizations to fish. Vessel lists used by RFMOs: • White lists identify vessels authorized to fish in the area of the RFMO and black lists identify vessels considered or determined to have been fishing in breach of RFMO measures. • Black lists are used as a basis for imposing restrictions on the access of the listed vessels to ports through the introduction of port State measures.
Fishing time restrictions	Aim: to limit fishing effort by restricting the number of days that fishers can operate	Vessel monitoring system 100% observer coverage or E-monitoring (on board

Measure	Aim/s and Implementation	Relevant Compliance Measures
	Implementation: through adoption of fishing seasons (e.g. fishery open from May to September and closed from October to April) Aim: to increase selectivity of fishing operations so as to minimize the take of certain segments of the target stock, or of non-target species Implementation: through implementation of time restrictions (e.g. fishing only between dusk and dawn)	cameras)
Fishing gear restrictions	Aim: to limit fishing effort by controlling the quantity of gear that can be deployed or the type of gear that can be used Implementation: through controls on the number of hooks, length of net or prohibition on use drift nets, use of light sticks, etc. Aim: to improve the selectivity of the gear so as to avoid catching particular sizes/life stages of target species or non-target species Implementation: through restrictions on net mesh size, mouth opening of traps, etc.	In port and at sea inspections of gear
Permanent area closures	Aim: To protect a certain segment of the target species population (e.g. spawning grounds, nursery area) Implementation: through spatial closure	Vessel monitoring system
Sanctuaries	Aim: to minimize fishing mortality of one or more species or to protect certain habitat/ecosystem types Implementation: through prohibitions on all fishing in an area (e.g. through declaration of a marine protected area in which no fishing is allowed) or the prohibition on the retention of certain species (e.g. via the declaration of so-	Vessel monitoring system

Measure	Aim/s and Implementation	Relevant Compliance Measures
	called shark sanctuaries)	
Total allowable catch (TAC)	Aim: to limit fishing mortality on a species or a group of species Implementation: through the establishment of a species/species group catch limit for the fishery as a whole in relation to a defined period (e.g. a fishing season or year)	Catch documentation scheme Real time or near real time catch reporting Controls on transhipment at sea
Individual quota (IQ)	Aim: To provide individual fishers or community groups with security of access to a specific portion of the TAC. The right to catch the quantity of fish associated with the IQ is often, especially under national schemes, tradable, either seasonally (leased) or permanently (sold). Implementation: Allocation of the TAC across eligible fishers or countries, usually expressed as a percentage of the TAC but sometimes in terms of quantities of fish	Appropriate level of observer coverage Landings inspections Catch documentation scheme or paper trail of documentation to track fish through catch, disposal, processing etc. Controls on transhipment at sea
Fishing trip limits	Aim: To control mortality of target or non-target species Implementation: a per vessel limit on the quantity of fish that can be landed at the end of a fishing trip	In port inspections
Prohibited Retention	Aim: To minimize fishing mortality of a certain species Implementation: Through prohibitions on the landing of a specified species and often the requirement to ensure that any incidental catch of the species is immediately returned to the sea without further harm in order to maximise the chances of post-capture survival	Logbooks or other formal recording mechanisms to record discards and life status Observer coverage of 20% or above (European Commission, 2013) to estimate post-release survival i.e. mortality and to monitor compliance Ban on unobserved transhipments at sea and random in-port inspection of

Measure	Aim/s and Implementation	Relevant Compliance Measures
		transhipment and unloading Provision for at-sea inspection of vessels. In relation to sharks, needs to be associated with a requirement to land trunks of any retained sharks intact, including with fins attached, in order to provide for identification of any retained specimens of the prohibited species. e-monitoring systems (e.g. on board cameras) could be used to augment or replace observer coverage and at-sea inspections
Fish size limits	Aim 1: To prevent growth over-fishing by ensuring that the market value of fish is maximized and/or to prevent recruitment over-fishing by allowing each fish to spawn at least once prior to capture Implementation: through imposing minimum legal size limits on retained fish Aim 2: to maximize the contribution of individuals to the stock Implementation: through maximum size limits that preclude the retention of mature individuals beyond a certain size (usually associated with age)	In-port and at-sea inspections
Gender-based restrictions	Aim: to protect spawning females in order to minimize the impact of fishing on recruitment to the stock Implementation: through prohibition on retention of females or females bearing eggs	In-port and at-sea inspections
Product form	Aim: to reduce fishing mortality on a species	Observers required for transhipment

Measure	Aim/s and Implementation	Relevant Compliance Measures
restrictions	Implementation: through requirements that a species can be landed only in a certain form, on the assumption, or knowledge, that this will provide a disincentive to retention of the species, e.g. requirements for sharks to be landed with fins attached or that shark fins can only be landed with the associated trunks.	Landings inspections
Move-on provisions	Aim: To minimize fishing mortality of a certain species, usually a non-target species Implementation: through requiring fishers to move a specified distance from a fishing ground when catch rates of a species reach a specified level	High level of observer coverage
Bycatch reduction devices (BRDs)	Aim: To reduce fishing impacts on a non-target species Implementation: through the use of specified by-catch mitigation devices such as turtle excluder devices, seal excluder devices, seabird scaring lines, circle hooks, etc.	In-port and at-sea inspection to ensure BRDs are being used and used correctly

(Sources: Sant *et al*., 2012; Bergh and Davies, 2002)

Annex 3 M-Risk Assessment Scores

A summary of the M-Risk assessment scores for each of the 46 shark species assessed is provided in Table A3.1. The full assessments of each species are contained in Annex 4 (see separate Excel workbook Annex 4 Rapid M-Risk Assessment 46 Shark Species).

Table A3.1 M-Risk Assessment Scores

1	***Alopias pelagicus***		**Pelagic Thresher**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			IOTC	1.00	2.43	2.00	5.43
			WCFPC	1.00	1.86	2.00	4.86
		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			IOTC	10.97	High	24.00	Some
			WCFPC	9.15	High	26.00	High
2	***Alopias superciliosus***		**Bigeye Thresher**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			CCSBT	1.00	2.00	2.50	5.50
			IATTC	1.00	1.29	3.00	5.29
			ICCAT	1.00	2.71	3.00	6.71
			IOTC	1.00	2.57	2.50	6.07
			WCPFC	1.00	1.71	2.50	5.21
			GFCM	1.00	2.14	2.50	5.64
		Weighted	**Management**	**Total**	**Risk Category**	**Confidence**	**Confidence**

		score	**unit/stock**	**weighted score**		**Score**	**rating**
			CCSBT	10.00	High	20.00	Some
			IATTC	8.11	High	21.00	Some
			ICCAT	12.69	High	20.00	Some
			IOTC	11.83	High	21.00	Some
			WCPFC	9.09	High	24.00	Some
			GFCM	10.46	High	19.00	Some
3	***Alopias vulpinus***		**Common Thresher**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			CCSBT	1.00	2.00	2.50	5.50
			IATTC	1.00	1.43	3.00	5.43
			ICCAT	1.00	2.29	3.00	6.29
			IOTC	1.00	2.57	2.50	6.07
			WCPFC	1.00	1.71	2.50	5.21
			GFCM	1.00	1.71	2.00	4.71
			Spain	1.00	2.14	2.00	5.14
		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			CCSBT	10.00	High	22.00	Some
			IATTC	8.57	High	19.00	Some
			ICCAT	11.31	High	21.00	Some
			IOTC	11.83	High	22.00	Some
			WCPFC	9.09	High	25.00	High
			GFCM	8.69	High	21.00	Some
			Spain	10.06	High	18.00	Some

4	***Carcharhinus brachyurus***		**Bronze Whaler**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			IOTC	1.00	1.57	2.00	4.57
			WCFPC	1.00	1.57	2.00	4.57
			ICCAT	1.00	1.86	2.50	5.36
			South Africa	1.00	1.71	2.50	5.21
			Argentina	1.00	1.71	1.50	4.21
			New Zealand	1.00	1.71	3.00	5.71
		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			IOTC	8.23	High	22.00	Some
			WCFPC	8.23	High	15.00	Some
			ICCAT	9.54	High	9.00	Low
			South Africa	9.09	High	23.00	Some High
			Argentina	8.29	High	9.00	Low
			New Zealand	9.49	High	17.00	Some
5	***Carcharhinus falciformis***		**Silky Shark**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			ICCAT	1.00	2.43	2.50	5.93
			IATTC	2.00	2.00	3.00	7.00
			IOTC	1.00	1.57	2.50	5.07
			WCPFC	1.00	2.14	2.50	5.64
		Weighted score	**Management unit/stock**	**Total weighted**	**Risk Category**	**Confidence Score**	**Confidence rating**

				score			
			ICCAT	11.37	High	20.00	Some
			IATTC	12.00	High	23.00	Some
			IOTC	8.63	High	22.00	Some
			WCPFC	10.46	High	26.00	High
6	***Carcharhinus leucas***		**Bull Shark**				
			Management unit/stock	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
		Unweighted scores	CCSBT	1.00	1.86	2.50	5.36
			IATTC	1.00	1.29	2.50	4.79
			ICCAT	1.00	1.71	2.50	5.21
			IOTC	1.00	1.71	2.00	4.71
			WCPFC	1.00	1.43	2.00	4.43
			USA	3.00	2.57	2.00	7.57
			Management unit/stock	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
		Weighted score	CCSBT	9.54	High	23.00	Some
			IATTC	7.71	High	22.00	Some
			ICCAT	9.09	High	25.00	High
			IOTC	8.69	High	21.00	Some
			WCPFC	7.77	High	13.00	Some
			USA	14.63	Medium	11.00	Low

7	***Carcharhinus longimanus***		**Oceanic Whitetip**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			CCSBT	1.00	2.29	2.50	4.79
			IATTC	1.00	2.29	3.00	5.29
			ICATT	1.00	2.43	3.50	5.93
			IOTC	1.00	2.14	2.00	4.14
			WCPFC	1.00	2.29	2.50	4.79
		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			CCSBT	10.91	High	23.00	Some
			IATTC	11.31	High	18.00	Some
			ICATT	12.17	High	25.00	High
			IOTC	10.06	High	26.00	High confidence
			WCPFC	10.91	High	22.00	Some
8	***Carcharhinus obscurus***	**Dusky Shark**					
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			ICCAT	1.00	2.00	3.00	6.00
			IOTC	1.00	1.57	3.00	5.57
			IATTC	1.00	1.86	2.50	5.36
			Australia	2.00	3.29	2.50	7.79
			USA	1.00	3.29	2.50	6.79
		Weighted	**Management**	**Total**	**Risk Category**	**Confidence**	**Confidence**

		score	**unit/stock**	**weighted score**		**Score**	**rating**
			ICCAT	10.00	High	24.00	Some
			IOTC	9.03	High	23.00	Some
			IATTC	9.54	High	24.00	Some
			Australia	15.71	Medium	26.00	High
			USA	14.11	Medium	23.00	Some
9	***Carcharhinus plumbeus***		**Sandbar Shark**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			ICCAT	2.00	1.71	2.50	6.21
			IATTC	1.00	2.14	3.00	6.14
			IOTC	1.00	1.71	2.50	5.21
			Australia	2.00	2.86	2.00	6.86
			USA	2.00	3.00	2.50	7.50
		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			ICCAT	10.69	High	24.00	Some
			IATTC	10.86	High	24.00	Some
			IOTC	9.09	High	21.00	Some
			Australia	13.94	Medium	24.00	Some
			USA	14.80	Medium	23.00	Some

10	***Carcharhinus porosus***		**Smalltail Shark**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			ICCAT	1.00	1.86	2.50	5.36
			Guyana	1.00	1.43	1.00	3.43
		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			ICCAT	9.54	High	17.00	Some
			Guyana	6.97	High	17.00	Some
11	***Carcharias taurus***	**Sand Tiger**					
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			USA	1.00	1.86	2.50	5.36
			Uruguay	1.00	1.43	1.50	3.93
			Argentina	1.00	1.57	1.50	4.07
			Australia	4.00	3.00	3.00	10.00
		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			USA	9.54	High	18.00	Some
			Uruguay	7.37	High	7.00	Low
			Argentina	7.83	High	14.00	Some
			Australia	11.77	High	24.00	Some

12	***Carcharodon carcharias***		**Great White Shark**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			CCSBT	1.00	1.86	2.00	4.86
			IATTC	1.00	1.29	2.50	4.79
			ICCAT	1.00	1.71	2.50	5.21
			IOTC	1.00	1.71	2.00	4.71
			WCPFC	1.00	1.71	2.00	4.71
			GFCM	1.00	1.57	2.50	5.07
			USA	1.00	2.14	2.50	5.64
		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			CCSBT	9.14	High	24.00	Some
			IATTC	7.71	High	22.00	Some
			ICCAT	9.09	High	25.00	High
			IOTC	8.69	High	25.00	High
			WCPFC	8.69	High	25.00	High
			GFCM	8.63	High	25.00	High
			USA	10.46	High	15.00	Some
13	***Centrophorus granulosus***		**Gulper Shark**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			NEAFC	1.00	2.00	3.00	6.00
			GFCM	1.00	1.43	3.00	5.43
		Weighted score	**Management unit/stock**	**Total weighted**	**Risk Category**	**Confidence Score**	**Confidence rating**

				score			
			NEAFC	11.77	High	23.00	Some
			GFCM	8.57	High	27.00	High
14	***Centrophorus lusitanicus***		**Lowfin Gulper Shark**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			Portugal	1.00	1.14	2.00	4.14
		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			Portugal	6.86	High	28.00	High
15	***Centrophorus squamosus***		**Deepwater Spiny Dogfish**				
		Unweighted scores	**Management unit/stock**	Stock Status	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			Portugal	1.00	2.00	2.00	5.00
			France	1.00	1.71	2.00	4.71
			New Zealand	1.00	1.43	2.50	4.93
			NEAFC	2.00	2.57	3.00	7.57
		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			Portugal	9.60	High	27.00	High
			France	8.69	High	27.00	High
			New Zealand	8.17	High	25.00	High
			NEAFC	13.83	Medium	28.00	High

16	***Centroscyllium fabricii***		**Black Dogfish**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			NEAFC	1.00	2.57	3.00	6.57
			France	1.00	2.14	1.50	4.64
		Weighted score		**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			NEAFC	12.23	High	25.00	High
			France	9.66	High	16.00	Some
17	***Centroscymnus coelolepis***		**Portuguese Dogfish**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			Portugal	1.00	2.57	1.50	5.07
			France	1.00	2.29	1.50	4.79
			United Kingdom	1.00	2.14	2.00	5.14
			NEAFC	1.00	2.57	3.00	6.57
		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			Portugal	11.03	High	30.00	High
			France	10.11	High	30.00	High
			United Kingdom	10.06	High	30.00	High
			NEAFC	12.23	High	28.00	High

18	***Cetorhinus maximus***		**Basking Shark**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			ICCAT	1.00	1.86	2.50	5.36
			IATTC	1.00	1.57	2.50	5.07
			NEAFC	1.00	2.00	2.50	5.50
			GFCM	1.00	1.57	2.50	5.07
			New Zealand	1.00	2.86	3.00	6.86
		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			ICCAT	9.54	High	21.00	Some
			IATTC	8.63	High	18.00	Some
			NEAFC	10.00	High	25.00	High
			GFCM	8.63	High	20.00	Some
			New Zealand	13.14	Medium	21.00	Some
19	***Dalatias licha***		**Kitefin**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			NEAFC	1.00	2.00	3.50	6.50
			SPRFMO	1.00	1.57	2.50	5.07
			Spain	1.00	1.14	1.00	3.14
			New Zealand	1.00	2.29	3.50	6.79
		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**

			NEAFC	12.80	High	27.00	High
			SPRFMO	10.29	High	27.00	High
			Spain	7.37	High	16.00	Some
			New Zealand	13.94	Medium	25.00	High
			New Zealand	13.14	Medium	21.00	Some
20	***Deania calcea***		**Shovelnose Spiny Dogfish**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			NEAFC	1.00	2.71	3.00	6.71
			SPRFMO	1.00	1.14	2.50	4.64
			SEAFO	1.00	1.57	3.50	6.07
			Portugal	1.00	2.86	2.00	5.86
			New Zealand	1.00	2.29	3.00	6.29
		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			NEAFC	12.69	High	26.00	High
			SPRFMO	7.26	High	30.00	High
			SEAFO	9.43	High	21.00	Some
			Portugal	12.34	High	24.00	Some
			New Zealand	11.31	High	23.00	Some
21	***Echinorhinus brucus***		**Bramble Shark**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			Portugal	1.00	1.14	2.00	4.14
			NEAFC	1.00	1.43	3.00	5.43

		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			Portugal	6.86	High	22.00	Some
			NEAFC	8.57	High	23.00	Some
22	***Galeocerdo cuvier***		**Tiger Shark**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			NEAFC	1.00	1.57	2.50	5.07
			ICCAT	1.00	1.71	2.50	5.21
			Netherlands	1.00	1.71	2.00	4.71
			Brazil	1.00	1.14	3.00	5.14
			Mexico	1.00	1.43	2.00	4.43
		Weighted score	Management unit/stock	Total weighted score	Risk Category	Confidence Score	Confidence rating
			NEAFC	8.63	High	23.00	Some
			ICCAT	9.09	High	24.00	Some
			Netherlands	8.69	High	22.00	Some
			Brazil	7.66	High	18.00	Some
			Mexico	7.77	High	22.00	Some
23	***Ginglymostoma cirratum***		**Nurse Shark**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			Dominican Republic	1.00	2.29	2.00	5.29
			Mexico	1.00	2.71	3.50	7.21

			Mauritania	1.00	2.43	2.50	5.93
		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			Dominican Republic	11.83	High	9.00	Low
			Mexico	13.76	Medium	15.00	Some
			Mauritania	12.79	High	9.00	Low
24	***Hexanchus griseus***		**Bluntnose Sixgill**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			ICCAT	1.00	2.00	2.50	5.50
			NEAFC	1.00	2.57	3.00	6.57
			GFCM	1.00	1.57	2.50	5.07
			IOTC	1.00	1.86	1.00	3.86
		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			ICCAT	11.25	High	22.00	Some
			NEAFC	13.76	Medium	29.00	High
			GFCM	9.71	High	30.00	High
			IOTC	9.39	High	24.00	Some
25	***Isurus oxyrinchus***		**Shortfin Mako**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			CCSBT	1.00	2.00	2.50	5.50

			IATTC	1.00	1.29	3.00	5.29
			ICCAT	3.00	2.57	3.00	8.57
			IOTC	1.00	1.86	2.50	5.36
			WCPFC	1.00	1.86	2.50	5.36
			New Zealand	1.00	2.86	3.50	7.36
		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			CCSBT	10.00	High	23.00	Some
			IATTC	8.11	High	26.00	High
			ICCAT	15.43	Medium	21.00	Some
			IOTC	9.54	High	28.00	High
			WCPFC	9.54	High	26.00	High
			New Zealand	13.54	Medium	19.00	Some
26	***Isurus paucus***		**Longfin Mako**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			CCSBT	1.00	2.00	2.50	5.50
			IATTC	1.00	1.29	3.00	5.29
			ICCAT	1.00	1.86	3.00	5.86
			IOTC	1.00	1.86	2.50	5.36
			WCPFC	1.00	1.71	2.50	5.21
		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			CCSBT	10.00	High	22.00	Some
			IATTC	8.11	High	25.00	High
			ICCAT	9.94	High	25.00	High

			IOTC	9.54	High	26.00	High
			WCPFC	9.09	High	26.00	High
27	***Lamna nasus***		**Porbeagle**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			CCAMLR	1.00	1.43	3.00	5.43
			CCSBT	2.00	1.71	2.50	6.21
			GFCM	2.00	2.00	3.00	7.00
			IATTC	1.00	1.29	3.00	5.29
			ICCAT	2.00	2.14	3.00	7.14
			IOTC	1.00	1.71	2.50	5.21
			NAFO	2.00	1.29	3.50	6.79
			NEAFC	2.00	1.86	3.00	6.86
			WCPFC	1.00	1.43	2.50	4.93
			EU	2.00	2.00	1.50	5.50
			Canada	2.00	1.86	3.00	6.86
			New Zealand	1.00	2.86	3.50	7.36
		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			CCAMLR	8.57	High	27.00	High
			CCSBT	10.69	High	24.00	Some
			GFCM	12.00	High	26.00	High
			IATTC	8.11	High	28.00	High
			ICCAT	12.46	High	27.00	High
			IOTC	9.09	High	28.00	High
			NAFO	10.11	High	27.00	High
			NEAFC	11.54	High	27.00	High
			WCPFC	8.17	High	24.00	Some
			EU	10.80	High	18.00	Some

			Canada	11.54	High	24.00	Some
			New Zealand	13.54	Medium	26.00	High
28	***Mustelus canis***		**Dusky Smoothhound**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			USA	1.00	1.86	1.00	3.86
		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			USA	8.34	High	27.00	High
29	***Mustelus lenticulatus***		**Spotted Smoothhound**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			New Zealand	1.00	3.14	3.00	
		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			New Zealand	15.81	Medium	25.00	High
30	***Mustelus mustelus***		**Common Smoothhound**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			Croatia	1.00	**1.43**	**2.00**	**4.43**
			South Africa	3.00	**2.29**	**2.00**	**7.29**
			United Kingdom	1.00	1.14	2.00	4.14

		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			Croatia	7.77	High	27.00	High
			South Africa	13.71	Medium	30.00	High
			United Kingdom	6.86	High	29.00	High
31	***Negaprion brevirostris***		**Lemon Shark**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			ICCAT	1.00	1.57	2.50	5.07
			USA	1.00	2.86	2.50	6.36
		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			ICCAT	8.63	High	26.00	High
			USA	12.74	Medium	24.00	Some
32	***Notorynchus cepedianus***		**Broadnose sevengill**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			New Zealand	1.00	2.29	3.00	6.29
			South Africa	1.00	1.57	2.50	5.07
		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			New Zealand	12.73	High	25.00	High

			South Africa	9.71	High	27.00	High
33	***Oxynotus centrina***		**Angular Roughshark**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			NEAFC	1.00	1.43	3.50	5.93
			GFCM	1.00	1.43	3.00	5.43
		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			NEAFC	11.21	High	23.00	Some
			GFCM	10.71	High	28.00	High
34	***Oxynotus paradoxus***		**Sailfin Rough Shark**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			NEAFC	1.00	2.57	3.00	6.57
		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			NEAFC	15.29	Medium	26.00	High
35	***Prionace glauca***		**Blue Shark**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			CCSBT	1.00	1.86	2.50	5.36
			IATTC	3.00	1.57	3.00	7.57
			ICCAT	3.00	1.71	3.50	8.21

			IOTC	1.00	1.71	2.00	4.71
			WCPFC	3.00	1.57	2.50	6.93
		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			CCSBT	9.54	High	24.00	Some
			IATTC	12.23	High	26.00	High
			ICCAT	13.09	Medium	28.00	High
			IOTC	8.69	High	29.00	High
			WCPFC	11.83	High	25.00	High
36	***Pseudocarcharias kamoharai***		**Crocodile Shark**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			CCSBT	1.00	1.86	2.50	5.36
			IATTC	1.00	1.29	3.00	5.29
			ICCAT	1.00	1.71	3.50	6.21
			IOTC	1.00	1.71	2.00	4.71
			WCPFC	1.00	1.57	2.50	5.07
		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			CCSBT	11.93	High	26.00	High
			IATTC	10.14	High	25.00	High
			ICCAT	12.36	High	27.00	High
			IOTC	10.86	High	29.00	High
			WCPFC	10.79	High	25.00	High

37	***Scyliorhinus stellaris***		**Nursehound**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			NEAFC	1.00	1.43	3.50	5.93
			Portugal	1.00	1.71	2.00	4.71
		Weighted score		**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			NEAFC	10.09	High	22.00	Some
			Portugal	9.77	High	24.00	Some
38	***Scymnodon ringens***		**Knifetooth Dogfish**				
		Unweighted scores	**Management unit/stock**	Stock Status	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			NEAFC	1.00	2.71	3.00	6.71
			Portugal	1.00	2.29	2.00	5.29
		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			NEAFC	14.27	Medium	25.00	High
			Portugal	11.83	High	21.00	Some

39	***Somniosus microcephalus***		**Large Sleeper Shark**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			NEAFC	1.00	2.57	3.00	6.57
		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			NEAFC	15.29	Medium	25.00	High
40	***Somniosus pacificus***		**Pacific Sleeper Shark**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			Australia	2.00	3.00	3.00	8.00
		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			Australia	19.00	Medium	20.00	Some
41	***Somniosus rostratus***		**Little Sleeper Shark**				
		Unweighted scores	**Management unit/stock**	Stock Status	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			NEAFC	1.00	1.43	3.00	5.43
			GFCM	1.00	1.43	3.00	5.43
		Weighted score	**Management unit/stock**	**Total weighted**	**Risk Category**	**Confidence Score**	**Confidence rating**

				score			
			NEAFC	10.71	High	21.00	Some
			GFCM	10.71	High	27.00	High
42	***Sphyrna lewini***		**Scalloped Hammerhead**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			IATTC	1.00	1.14	3.00	5.14
			ICCAT	1.00	2.43	3.50	6.93
			IOTC	1.00	1.71	2.00	4.71
			NAFO	1.00	1.43	3.50	5.93
			WCPFC	1.00	1.43	2.50	4.93
		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			IATTC	7.66	High	27.00	High
			ICCAT	12.17	High	23.00	Some
			IOTC	8.69	High	28.00	High
			NAFO	8.97	High	27.00	High
			WCPFC	8.17	High	26.00	High
43	***Sphyrna zygaena***		**Smooth Hammerhead**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			CCSBT	1.00	2.00	2.50	5.50
			IATTC	1.00	1.57	3.00	5.57
			ICCAT	1.00	2.71	3.00	6.71
			IOTC	1.00	1.86	2.00	4.86
			WCPFC	1.00	1.71	2.50	5.21

			GFCM	1.00	2.14	2.50	5.64
		Unweighted scores	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			CCSBT	10.00	High	24.00	Some
			IATTC	9.03	High	25.00	High
			ICCAT	12.69	High	24.00	Some
			IOTC	9.14	High	27.00	High
			WCPFC	9.09	High	27.00	High
			GFCM	10.46	High	23.00	Some
44	***Squalus acanthias***		**Piked dogfish**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			Northeast Atlantic	3.00	1.43	2.00	6.43
			Northwest Atlantic	4.00	2.57	3.00	9.57
			New Zealand	1.00	2.29	3.00	6.29
		Weighted score	**Management unit/stock**	**Total weighted score**		**Confidence Score**	**Confidence rating**
			Northeast Atlantic	10.97	High	16.00	Some
			Northwest Atlantic	17.03	Medium	17.00	Some
			New Zealand	11.31	High	20.00	Some

45	***Squatina californica***		**South Pacific Angel Shark**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			Peru	1.00	1.71	2.00	4.71
			Mexico	1.00	1.71	2.50	5.21
		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			Peru	10.86	High	11.00	Low
			Mexico	11.36	High	12.00	Low
46	***Squatina squatina***		**Angel Shark**				
		Unweighted scores	**Management unit/stock**	**Stock Status**	**Adaptive management (Average score)**	**Generic management (average score)**	**Total**
			GFCM	1.00	1.86	2.50	5.36
			NEAFC	1.00	1.43	2.50	4.93
			France	1.00	2.57	3.00	6.57
			Spain	1.00	2.57	3.00	6.57
		Weighted score	**Management unit/stock**	**Total weighted score**	**Risk Category**	**Confidence Score**	**Confidence rating**
			GFCM	10.74	High	24.00	Some
			NEAFC	9.19	High	29.00	High
			France	13.76	Medium	24.00	Some
			Spain	13.76	Medium	24.00	Some