2	*Sphyrna lewini*	Scalloped hammerhead*	Included in the CITES Animals Committee's Shark Working Group's list of species of concern. Unsuccessfully proposed for CITES listing in Appendix II at CoP15.
3	*Channa striata*	Striped snakehead	A freshwater fish, widespread in Asia and possibly introduced in other countries, although there is some confusion over species (Courtenay & Williams 2004). The species is reported as being cultivated in Pakistan and India and Sri Lanka. The species is considered to be Least Concern by IUCN and no threats have been identified. It would appear that the selection of this species on the basis of a medium vulnerability and high commodity value (with no violability score possible) has wrongly identified a species that is not in fact at risk. The high commodity value has skewed this.
3	*Cynoglossus microlepsis*	Smallscale tonguesole	A freshwater species from Asia. With a high (2) vulnerability and a high value, both of which had poor reliability. No information was available on the status of or threats to this species. Further research would be necessary to determine the current management of this species, its violability and the potential application of MEAs or regional management.
3	*Gymnarchus niloticus*	Aba	A freshwater species with a wide distribution in Africa, with no known major widespread threats and listed as Least Concern by IUCN (Azeroual et al 2009), however it could be regionally extinct within north Africa. This is a commercially important species in central Africa. The species is targeted in artisanal/small scale fisheries. Fisheries come under national jurisdiction, although it appears that there are no stock assessments, harvest, compliance or trade measures in place for this species and therefore it received a high score for violability on the basis of reliable information. It would be necessary to carry out further research to determine whether the species is being threatened by harvest and trade and whether regional or MEA measures are likely to benefit this species.
3	*Pangasius sanitwongsei*	Pangasid catfish	Pangasid catfish has been assessed by IUCN as Critically Endangered due to an estimated population decline of more than 99% over three generations (Jenkins et al 2007). Some stocks are managed, however, management appears to be inadequate and overfishing for food and to a lesser extent the aquarium trade, has depleted the natural population (Wang 1998). Understanding what proportion of harvest is in international trade and further research would be necessary to determine whether improved regional co-operation is necessary to improve management or whether CITES listing would provide any benefits to this species. A CMS listing may increase co-operation to tackle other threats to this species such as habitat modification affecting migratory patterns.
3	*Zungaro zungaro*	Gilded catfish	The gilded catfish was categorised as vulnerable in this study based on only one life history characteristic. No information was available on value or management. Further research would be

			necessary to determine what management was in place for this species and whether it required strengthening, and through what measures.
4	*Epinephelus aeneus*	White grouper	Targeted in artisanal/small scale fisheries in national waters. However these fisheries are unmanaged. This species had a very high-value score. The species is assessed as NT by IUCN, which notes that it has been heavily fished, particularly in its west African distribution area, and is most likely to have declined to close "to 30% throughout its range" (Thierry 2008). It would appear that management for this species is necessary. Further research would be necessary to determine whether regional management or MEAs would provide the necessary measures.
4	*Katsuwonus pelamis*	Skipjack tuna	Skipjack tuna is heavily commercially fished. The species was selected in the final 109 as a result of high catch volumes. It comes under the management jurisdiction of four tuna RFMOs. However, it is generally not managed hence its high violability score. According to this study, it has medium vulnerability (score: 1.57) and value scores. While it is caught in large volumes, it is regarded as quite a productive and abundant species.
4	*Thunnus thynnus*	Atlantic bluefin tuna	Atlantic bluefin tuna is considered the most expensive of all tuna species in the Japanese sashimi market and therefore it is surprising that it emerged with a medium value score. It is managed by the International Commission for the Conservation of Atlantic Tunas (ICCAT). Stocks are assessed and harvest, compliance and trade-related measures are in place. However, management has not been successful at maintaining the stock at sustainable levels and there is considerable non-compliance with management measures in place. This species was proposed for listing in CITES Appendix I at CoP15, which would have resulted in the halting of international trade for commercial purposes. However, the proposal was not adopted by the Parties. This study suggests listing in the CITES Appendices may potentially be of benefit, since it could help address the non-compliance issue through controls on trade.

The sharks in group 2 all scored very highly for vulnerability and although ex-vessel price was not high, they were scored as having particularly high commodity value. Thresher *Alopias vulpinus*, copper shark *Carcharhinus brachyurus*, dusky shark *Carcharhinus obscurus*, gulper shark *Centrophorus granulosus* and leafscale gulper shark *Centrophorus squamosus* are all caught in both target and non-target, industrial and artisanal/small scale fisheries. International trade is mainly in fins. Fins from different species are often lumped together in trade; identification is an issue. Some stocks are managed under RMFOs with stock assessments, harvest and compliance measures. None have trade measures in place.

Recorded catch is highest for the leafscale gulper shark, which is classified by IUCN as Vulnerable. Thresher, gulper shark and scalloped hammerhead *Sphyrna lewini* all have average catches of around 400 t/yr and are all considered threatened by IUCN.

Further species-specific research would be necessary to determine whether management could be improved through regional bodies and whether MEA listing would complement existing management. The questions in section 8.2.3 would need to be considered.

8.2.3 Further Information required for assessment of benefits from regional and MEA measures

For assessment of the benefits of regional co-operation, information required includes:

- The number of range States
- The number of flag States (both range and distant water States) that fish for the species
- The number of fishing flag States that are already members of a relevant RMFO
- A comprehensive understanding of existing management arrangements for the species concerned and compliance with those arrangements.
- Knowledge of whether any relevant RFMO is a competent management authority (has rigorous management and compliance measures in place) for target and/or non-target species
- Knowledge of whether any relevant RFMO has the mandate to manage species that are taken mainly in national waters

For assessment of the benefits of a CITES listing, the following questions should be answered:

- Are there States in the trade chain that are not members of any relevant RFMO?
- Is catch taken in freshwater bodies, national marine water and/or on the high seas?
- Is there more than one stock of the species?
- Do any relevant RFMOs cover each of those stocks?

For assessment of the benefits of a CMS listing, the information required includes:

- The number of range States
- The number of flag States (both range and distant water States) that fish for the species
- The number of fishing flag States that are already members of the CMS
- A comprehensive understanding of existing management arrangements for the species concerned and compliance with those arrangements.

8.3 Common characteristics

The highest risk species identified in this study are a disparate group of species. The list includes a large proportion of sharks, a number of other finfish, freshwater and marine species and invertebrates. These species fall under a range of management jurisdictions including national, regional and international. For some of these species, the benefits of MEAs have already been identified through listing of these species in the Appendices of CITES and CMS. For others, lack of information effectively precluded any meaningful analysis of the potential benefits of CITES and CMS. For many others, the assessment of this study is that CITES and CMS offer potential benefits as supplementary management measures. As previously stated, no attempt has been made to assess the species against the listing criteria of these MEAs.

Of this group of species, the shark species emerge as a group that demonstrates a number of common characteristics. Most of these species are pelagic shark species which are predominantly taken as non-target catch in tuna fishing operations. Much of this catch appears in trade and, in particular, shark fins are of high value and are a highly traded commodity. The tuna fisheries in which these sharks are taken are under the management jurisdiction of five tuna RFMOs, none of which rigorously manage these non-target shark species.

Further, this study, suggests that, whether a species is target or non-target has little bearing on the quality of management and the subsequent need for management under MEAs. This study has identified the need for further research to confirm the potential benefits that CITES and CMS and regional co-operation, such as through RFMOs, may offer some high-risk species and the common set of information required to underpin that research.

8.4 Discussion

Most species identified in Table 16 require strengthened management. For most, further research would be necessary to determine whether an MEA listing would be beneficial, particularly for listing by CITES. Section 8.2.3 outlines some of the information that would be necessary to help determine this.

However, on the basis of available information, it would appear that listing of some species by an MEA could potentially benefit the management of those species. For instance, CITES listing could be of potential benefit to the two *Corallium* species, Patagonian toothfish, blue marlin *Makaira nigricans*, southern bluefin tuna, Atlantic bluefin tuna and all the shark species identified. The information available to this study for most of these species was highly reliable.

CMS offers the potential to encourage measures to address harvest for national consumption, by-catch, as well as other non-trade related threats for migratory species, and may have benefits for species such as largetooth/freshwater sawfish, narrowsnout sawfish, pangasid catfish, and aba. CMS could also potentially provide benefits to southern bluefin tuna, blue marlin and all the migratory shark species in the high-risk groups.

The framework developed in this study has seemingly resulted in misidentification of some species as high risk, it has resulted in some false positives. This is likely to have resulted from a number of different stages in the current project including:

- selection of species from the FAO catch list using a number of different criteria in order to represent: the range of species in trade; CITES and CMS listed species; migratory species; and threatened species;
- the necessary use of generic data for vulnerability and value where species-specific data were not available;
- lack of species specific data for some species;
- low reliability in the data available to score species; and
- the need to select a sub-set of species for violability assessment, which was primarily based on high vulnerability and value.

For similar reasons, it is likely that some high-risk species have not been detected by this methodology. While this study does not, therefore, provide a definitive list of high-risk species, it provides well-informed guidance as to which species should be further investigated to determine potential benefits from MEA listings.

9 Conclusions

This study has provided valuable insights into the range and extent of trade in fish species and of fisheries for migratory and non-migratory species. In doing so it has identified relevant data sources and developed approaches for dealing with many of the gaps and inconsistencies in the data available. The study has investigated the feasibility of developing a method for determining the risk posed, by trade, to the sustainability of commercially exploited and/or migratory species. In particular, the study has successfully applied a vulnerability, value and violability approach to assessing this risk. It is clear that, where the raw data are available, such an analysis can provide useful guidance to identification of the relative risk-level of species in trade and point to the nature of actions required to address that risk most effectively.

The study has identified a number of areas where further consideration and research is required to refine the method and review the validity of approaches adopted. Further, information on key characteristics of many species and particularly fisheries and management of these species is lacking. This in itself suggests these species could be at high risk of over-exploitation and should therefore be a focus for future investigations. Addressing data gaps and improving reliability of data may be both time consuming and expensive.

This study has effectively prioritized those species for which additional research might be a conservation priority and be most cost-effective. Key findings of the study are outlined below. Data constraints and specific aspects of the method that may warrant further consideration and refinement are also identified.

9.1 Key findings

1. The selection process resulted in 505 commercially traded and/or migratory fish species for which value and vulnerability assessments were carried out. Of these selected species, 44% were categorized as migratory and 18% were either listed or had been proposed for listing in CITES and/or listed on Appendix I and/or II of CMS.

2. The percentage of species assessed for vulnerability, value and violability at each scoring level is provided in Table 20.

Table 20. Species by category (%)

Score	Vulnerability (n=505)	Value (n=505)	Violability (n=109)
Low	41	59	14[1]
Medium	32	16	28
High	24	18	33[2]
No score	3	6	25

Note: [1] corresponds to very low and low and [2] very high and high.

3. The study has identified a set of core characteristics or attributes that should be considered in assessing vulnerability, value and violability (see Table 21). Further work could be done to refine or expand these characteristics.

Table 21. Variables used in assessing risk

Vulnerability	Value	Violability
Age at maturity—minimum (years)	Ex-vessel/landing prices	Scale of the fishery
Size at maturity—minimum (cm)	Expert judgement on species with high value commodities	Target or non-target catch
Maximum age/ longevity (years)		Fishery location
Average size—maximum (cm)		Management jurisdiction
Reproductive Strategy		Stock assessment
Fecundity (max litter size or no. of eggs)		harvest-related measures
Trophic level		Trade-related measures
		MCS measures

4. Twenty-four percent of all assessed species were identified as having a high priced commodity, which was not reflected in the ex-vessel price data used. The complexity of the trade chain and product prices has been discussed.

5. The study concluded that meaningful assessment of violability required assessment of both the rigour of management and compliance with management. Overall, the nature and extent of the management arrangements are considered to be more important as an indicator of violability than the reported level of compliance. For example, low levels of infringements can reflect poor enforcement of the management measures rather than high compliance with those measures. It is also the case that, where investment has been made in rigorous management, investment is usually protected through investment in strong MCS regimes.

6. The analysis in this study clearly points to the need to assess violability of species at the stock level rather than the species level as different stocks are subject to different management jurisdictions and regimes.

7. Based on the assessment of 505 species (derived from >1,600 taxa) assessed for vulnerability and value, and 109 species assessed for violability, the study identified 34 species at high risk of over-exploitation, 12 species at potentially high risk and eight with high violability scores. The species identified are a disparate group of species comprising finfish and invertebrates, freshwater and marine species. Management of these species varies in both nature and rigour and the species are variously managed under national, regional and international management arrangements. Fifty-two percent of these 54 species are considered migratory.

8. Sharks are heavily represented in the highest risk group with sharks comprising 17 of the 54 species (31%). This is not surprising given they have common life history characteristics that make them vulnerable to over-exploitation and generally shark fins have high value. In addition, there is acknowledged paucity of management for these species globally.

9. Of the 54 species, 23 are listed by one or both of CITES and CMS. Our analysis of the potential for CITES and CMS to address the risk posed to the remaining species revealed that:
    - CITES could provide benefits to southern bluefin tuna, Atlantic bluefin tuna, Patagonian toothfish, leafscale gulper shark, gulper shark, dusky shark, copper shark, thresher shark, porbeagle and scalloped hammerhead shark;
    - further analysis of trade is required to determine the applicability of CITES to bluntnose sixgill shark *Hexanchus griseus*, longfin mako shark and blue marlin; and
    - CMS could provide benefits to southern bluefin tuna, blue marlin and all the migratory shark species in the high-risk groups.

- CMS could help to address harvest for national consumption, by-catch as well as other non-trade related threats for migratory species and may have benefits for species such as largetooth/freshwater sawfish, narrowsnout sawfish, pangasid catfish and aba.

10. The application of risk-based approaches to fish species has, until now, been restricted to the analysis of the risk posed by a fishery to particular species in, or associated with, that fishery. The development of appropriate methodology to undertake those analyses has required considerable time and resources and will continue to evolve. The scope of this project is significantly broader, given that it deals with the impacts of all fisheries on species throughout their global range as well as introducing the impact of trade on the species. It is not surprising, therefore that this first iteration of the methodology has identified a range of issues that require further refinement and analysis.

9.2 Findings on data and methodology

11. It is difficult to identify species in trade at the species level because there is a lack of species identification at the catching level and this is compounded by an inadequate range of species-based trade codes. This means that the species identified in this study may not necessarily be the most commercially significant species.

12. Compiling credible information for the full suite of biological characteristics requires the use of a wide range of source materials of varying quality and of some inconsistent information. Assessment of vulnerability therefore requires some judgements to be made about the most accurate information to use. For some species, basic biological information to inform the vulnerability characteristics does not exist and this introduces considerable uncertainty into these vulnerability scores.

13. This study has applied a common set of biological criteria for assessment of a wide range of taxonomic groups. CSIRO uses the same cut-off values and biological characteristics to assess aquatic fauna ranging from marine mammals to aquatic invertebrates and it has carefully tested this methodology and produced results to suggest that it is valid for assessing productivity. Given more time and resources, it may be valuable to investigate further the validity of using a ‘one size fits all’ scoring system.

14. A number of other possible methods of scoring species for high risk of over-exploitation could be considered in conjunction with this methodology. For example, investigating species declines, population size, extrinsic threats, etc. as is done in the IUCN Red List could be considered. It is possible there might be ways of incorporating such information into the vulnerability assessment. Additionally, one could investigate the possibilities of using different cut-off values and the number of categories for the scoring system.

15. Consistent, species-specific value data were not available for all the species assessed and ex-vessel data were used, rather than the more ideal use of data through the trade chain. This was due to availability of information, particularly to species level. However, there are still a number of problems with landings data, including where landings are not identified to species level and the variety of products that can be derived from a species and the range of values associated with these products; making the determination of an average value at the species level extremely difficult.

16. Determination of violability is complicated for many species by the need to consider information on management and compliance at the fishery and stock level, rather than at the species level, and to then use that information, which varies in availability, credibility and comprehensiveness, to determine a violability score for the species as a whole. The scoring system requires further refinement. Further development of the methodology for

assessing violability could more closely consider the approaches used in a range of other fishery sustainability assessment processes.

17. The analysis suggests that the combination of vulnerability and the rigour of management arrangements could provide a less complex and potentially, just as informative guide to the high-risk species in trade, than the 3V approach adopted here. If additional resources were to be devoted to refining the framework, consideration might be given to focusing on these two elements because of the complexity of value data.

18. It may be useful to devise a method of incorporating the reliability scores into the scores for each of value, vulnerability and violability. Furthermore, in some circumstances, a more precautionary approach could be taken, whereby species identified as having poor reliability might be regarded as being potentially highly vulnerable and/or highly violable and would indicate that further species-specific research should be carried out.

19. False positives (misidentification of high-risk species) have been identified, resulting from a number of different stages in the current project including:

- selection of species from the FAO catch list using a number of different criteria in order to represent: the range of species in trade; CITES and CMS listed species; migratory species; and threatened species;
- the necessary use of generic data for vulnerability and value where species-specific data were not available;
- lack of species-specific data for some species;
- low reliability in the data available to score species; and,
- the need to select a sub-set of species for violability assessment, which was primarily based on high vulnerability and value.

For similar reasons, it is likely that some high-risk species have not been detected by this methodology.

20. The possibility of deriving a single overall score for a combination of the three categories (value, vulnerability and violability) could be further investigated and may be useful for identifying the **most** high-risk species. If this were to be considered, a system of weighting for the relative importance of each of the categories might be required. More work could be done to investigate the usefulness of such an approach. Even if a system were developed to do this, it would be advisable to maintain an individual score for each of the categories, to ensure that species-specific conservation issues were not missed.

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Glossary

CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CDS	Catch Documentation Scheme
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CMS	Convention on Migratory Species
CPUE	Catch per unit effort
CSIRO	Commonwealth Scientific and Industrial Research Organisation
EEZ	Exclusive economic zone
FAO	Food and Agriculture Organization of the United Nations
GROMS	Global Register of Migratory Species
ITQ	Individual transferable quota
IUCN	International Union for the Conservation of Nature
IUU	Illegal, unreported and unregulated (fishing)
LEMIS	Law enforcement Management Information System
MCS	Monitoring, control and surveillance
MEA	Multilateral Environmental Agreement
MoU	Memorandum of Understanding
NDF	Non-detriment findings (CITES)
NMFS	National Marine Fisheries Service (USA)
NOAA	National Oceanic and Atmospheric Administration
PSA	Productivity-susceptibility Analysis
RFMO	Regional fisheries management organization
TAC	Total allowable catch
TDS	Trade documentation scheme
UBC	University of British Columbia
UNFSA	United Nations Fish Stocks Agreement
UNCLOS	United Nations Convention on the Law of the Sea
VMS	Vessel monitoring system

JNCC Report
No 453 Addendum

Fish and Multilateral Environmental Agreements (MEAs): developing a method to identify high risk commercially-exploited aquatic organisms in trade and an analysis of the potential application of MEAs

Report of an expert review workshop
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Contents

1 Introduction

1.1 Background

In September 2010, the Joint Nature Conservation Committee[1] (JNCC) commissioned TRAFFIC to develop a process of risk assessment to identify commercially exploited aquatic organisms in trade which were at highest risk of over-exploitation and to consider whether those species identified as being at highest risk would benefit from measures under Multi-lateral Environmental Agreements (MEAs), especially CITES (Convention on International Trade in Endangered Species) and CMS (Convention on Migratory Species). The approach sought to assess risk under three categories, namely the three 'Vs' of vulnerability, value and violability, (which were derived from a report appraising "*the suitability of the CITES criteria for listing commercially-exploited aquatic species"* [2]) or, in other words, ecological, economic and compliance risk. In undertaking this study, TRAFFIC identified a number of difficulties in undertaking a first iteration of the approach (see Sant *et al* 2012) and, accordingly, it was felt that it would be useful to subject the report and the approach to expert peer review which could also inform any future steps with this study. JNCC and TRAFFIC also felt such an expert peer review was warranted given the sensitive nature of determining the usefulness of a method which could potentially be used in the future to identify species in trade that may warrant higher levels of management intervention. The expert review would help ensure the method was critiqued before being released publicly for wider consideration.

Accordingly, a peer review workshop was organised and held in Aberdeen in September 2011 (for agenda see Annex A); this report summarises the outcome. Workshop participants (see Annex B) included experts from a variety of backgrounds, including fishery risk-based assessments, modelling, certification, and policy makers along with relevant TRAFFIC and JNCC staff (See Annex B); written comments were also received from the Secretariat of the FAO (Food & Agriculture Organisation of the United Nations) which were distributed to participants and introduced at relevant parts of the meeting. In addition to assessing the various risks separately and the merits of the approach collectively, approaches to risk-based assessments taken by other participants were also discussed.

1.2 Aims

The workshop aimed to enable critical expert review of a report, commissioned by JNCC from TRAFFIC; specifically it:

i. considered the validity, merit and benefit of the approach taken;
ii. critically appraised the method and data sources used for the analysis; and
iii. recommended improvements to the method and approach and how (or if) it might be taken forward in future.

1.3 Principles

The workshop participants agreed to the following principles to guide the approach taken during the meeting:

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[1] http://www.jncc.defra.gov.uk/

[2] FAO. 2000. *An appraisal of the suitability of the CITES criteria for listing commercially-exploited aquatic species*. FAO Fisheries Circular No. 954. Rome, FAO.

- the meeting was held under the equivalent of Chatham House rules – comments made would not be attributed to individuals (unless specifically requested to the contrary);
- any aspect of the report or method was open to challenge and participants were encouraged to be frank in their criticisms;
- participation was not seen, and was not taken, to be giving any kind of endorsement, whether by individuals or organisations, to the approach or concept;
- individuals were invited as experts rather than as organisational representatives.

2 Workshop presentations

After an introduction to the aims of, and background to, the study, the group heard presentations from the following participants.

Will Le Quesne (CEFAS[3]) outlined an approach to conduct rapid vulnerability assessments of all fish species in a community based on life-history information and only minimal 'local' data, to support rapid risk assessments (Le Quesne & Jennings 2011). The approach was demonstrated with a case study of the Celtic Sea (in the North East Atlantic) demersal fish assemblage. Based on the assumption of equal catchability between all species the analysis was extended to consider the extent of potential trade-offs between yield and conservation objectives and to demonstrate the desire of fisheries and management to decouple the mortality applied to commercially targeted stocks and species of conservation concern.

Tony Smith (CSIRO[4]) summarised Australia's Ecological Risk Assessment for the Effects of Fishing (ERAEF).This is a hierarchical set of methods involving sequential screening (triage) of low risk activities and successive focus with more quantitative methods on higher risk species, habitats and communities (Hobday *et al* 2011). It has been applied to over 30 fisheries in Australia with over 2,000 species and 200 habitat types screened. The three stage process moved from a qualitative Scale Intensity Consequence Analysis (SICA), through a semi-quantitative Productivity-Sensitivity Analysis (PSA) to a quantitative Sustainability Assessment for Fishing Effects (SAFE) method that estimates mortality rates and associated sustainability reference points.

Wes Patrick (NOAA[5]) provided an overview of their agency's modification of the PSA with examples of its application to six of its fisheries (representing 162 stocks) in the United States (Patrick *et al* 2010). Stocks were scored against a range of indicators with data quality also being scored to avoid inaccurate assessments of risk. Additionally, an extension of the approach to deal with data poor stocks through an Only Reliable Catch Stocks (ORCS) analysis (Berkson *et al* 2011) was outlined along with Climate Change Vulnerability Assessments (CCVA).

Dan Hoggarth (MSC[6]) outlined the risk-based framework taken for data deficient fisheries being assessed for MSC certification. The approach includes a qualitative SICA and, where scores from the previous analysis warrant it, a semi-quantitative Productivity-Sensitivity Analysis (PSA). Assessments at lower levels of certainty focus on the 'main species' retained – determining these depends upon expert judgement.

Zeb Hogan (CMS Scientific Councillor) presented his approach (Hogan 2011) to identifying migratory freshwater fish that might meet the criteria for inclusion on the Appendices of

[3] Centre for Ecology, Fisheries & Aquaculture Science
[4] Commonwealth Scientific and Industrial Research Organisation
[5] National Oceanic & Atmospheric Administration
[6] Marine Stewardship Council

CMS. Using FishBase and the IUCN Red List as a starting point, 30+ species meet all criteria: migratory, transboundary freshwater fish with unfavourable conservation status. An additional 10+ species were added to this list based on information from other sources including an additional 3,000 IUCN Red List assessments (completed in 2010 and 2011), CMS scientific councillors, the Global Registry of Migratory Species (GROMS) and published primary research. This preliminary review identified several species assemblages that would probably benefit from listing on CMS. These are groups of fish that contain many threatened species, occur in areas with many transboundary issues, or both. As knowledge of this group of species is incomplete, this must be considered a work in progress and reviewed and updated regularly.

3 Workshop discussion

The following sections summarise key points made by participants at relevant stages of the review.

3.1 General comments - overview

The original analysis was seen by participants as being a valuable exercise and well worth undertaking, even though some difficulties were encountered. The workshop, as well as providing a critique of the risk assessment under review, had also stimulated participants to reflect upon their own approaches to the various productivity-susceptibility and/or risk-based analyses with which they were involved.

Participants felt that the analysis demonstrated a clear and positive convergence between methods used by fisheries management and their application to conservation management, which in turn might help with broader acceptance of the approach. The analysis, as undertaken, and with revisions to the method should feed into, and contribute to, wider discussions on the application of risk-based assessments to fisheries and conservation.

CITES and CMS differ in their aims and objectives. Accordingly, it was felt that it would be more useful to apply different approaches for each Convention rather than trying to combine them into one risk assessment. However the aim of the study was to identify commercially-exploited species of highest risk and, therefore, the initial starting point was a selection of species known to be in trade. Whilst such an approach was relevant to CITES, CMS might provide benefits as a mechanism for species regardless of whether they are in trade.

With respect to CMS, there were also, as noted in the study report, difficulties defining which species were, and were not, migratory (an issue not restricted to this analysis) and how to deal with species which were sedentary for parts of their life cycle but mobile, if not migratory, in others (e.g. corals). This difficulty is not unique to this study; the concept of shared stocks, for example, might be a better approach for marine species. However, whether a species is migratory or not is one of the two “criteria” for listing species under CMS and so cannot be ignored when investigating the applicability of that Convention to species.

The generation of lists of priority species as a final output of the process, was seen to fit uncomfortably with the original stated objective to avoid providing a ‘shopping list’ of species that may warrant consideration for listing under an MEA. In other words, any such risk assessment was, by definition, going to identify species at *potentially high risk*, a list of which might then be used to prioritise species for consideration for listing under an MEA or for other remedial measures to reduce risks. Indeed, generation of such a list of high risk species was seen by many participants as a positive and necessary output, without which it is difficult to understand and critique the process.

Participants felt that parts of the method as described in the report were insufficiently transparent such that it would be difficult for others to repeat the exercise independently. More detail on the individual steps taken was essential (perhaps through flowcharts) and it was particularly important to develop a more transparent and repeatable scoring process for 'violability', especially as this assessment involved greater use of expert judgement to determine whether management interventions were taking place and the adequacy of these. By contrast, assessments for 'vulnerability' and 'value' were based on more readily available and populated quantitative datasets making assessments simpler and less reliant on expert judgement.

The generation of 'false positives' by the method was not seen to be a weakness; the aim of the process was to provide a sifting mechanism whereby any putative priority species could be subject to further scrutiny. At each stage in the sifting process, more information is likely to be required which would then enable false positives to be removed. False negatives were of greater concern but these could be reduced by setting more precautionary thresholds (a consequence of this would be an increased number of false positives).

Finally, the introduction to the report seemed to imply that fisheries management had failed; participants felt, rather, that it was not fisheries management which had failed but it was the failure to implement and achieve compliance with recommended management. In other words it was the lack of effective governance which was largely responsible for the poor state of many of the world's fisheries.

3.2 Vulnerability

The approach to assessing vulnerability as a risk, and the number and type of biological characteristics or attributes used, had much in common with the approach taken by CSIRO, NOAA and others in identifying indicators of productivity in PSA; indeed, the approach was derived from these methods. Participants welcomed the extent to which different datasets had been used to derive as full a dataset as possible for biological characteristics.

However, it was recognised that some of the attributes used in the analysis may be correlated with others; this was supported by analyses undertaken separately by some of the workshop participants. The number of attributes used in the analysis could therefore possibly be reduced (when they correlate with others) making the vulnerability scoring process less time consuming. Reducing the number of attributes could also help overcome problems where data were more readily available for some of the attributes than for others. It would be desirable to determine which of the attributes are likely to be the most informative.

For example, the use of taxonomic class (Osteichthyes or Chondrichthyes) and maximum size (L_{max}) was proposed by one participant as a good indicator of vulnerability to mortality for fish species, although the life-history relationships applied for the L_{max} study were predominantly based on temperate shelf species and additional analysis would be desirable if this approach were extended to tropical or deep water species. Re-running the analysis using this as a single indicator might be a useful test, for fish at least, and might be tested separately between teleost and elasmobranch fish. Other participants felt that multiple indices of productivity were likely to be more reliable than individual indicators such as L_{max}.

Although both CSIRO and NOAA's approaches also included trophic level in their assessments, on reflection participants felt it was not clear why this attribute would correlate with vulnerability and the value of the use of this attribute was questioned.

Likewise, there was doubt, which is also supported by some literature (e.g. see Reynolds *et al* 2005), over the value of using fecundity as a risk factor. In the case of European eel, this species would have emerged as high risk if it had not been for its high fecundity (and other evidence suggests it is high risk). It is possible that low fecundity may indicate higher risk, but that high fecundity did not necessarily correspond to low risk (in other words, the inverse of the subsequent discussions on value – see next section). The group suggested that use of breeding strategy (information for which is generally available) or stock recruitment parameters (less likely to be available especially in data poor situations) may be more valuable as an indicator than fecundity even though information on fecundity is generally available.

With respect to age at maturity, this was considered to be a good indicator of risk of the stocks productivity or vulnerability. However, it was suggested that rather than take minimum age at maturity (used in this approach and by CSIRO), it would be better to take age at 50% maturity or, alternatively, use generation time because minimum age at maturity could be skewed by a single incorrect value or aberrant individual, whereas 50% maturity was typically based on a large number of measurements. This depends, of course, on suitable data being available.

All taxa approach vs taxonomic or other sub-sets

Most of the above considered the application of the method to fish species. However, it was clear that many of the attributes under consideration may not apply as readily to aquatic invertebrates, such as clams and corals. This gave rise to discussion over whether a 'one size fits all' approach to all taxa, despite the benefit of its relative simplicity, was in fact realistic (noting that the invertebrates under consideration were distributed across several Phyla).

For corals or sea cucumbers, for example, there were particular difficulties in applying the various attributes that worked well for fish. In the case of corals and sea cucumbers, other factors such as reproductive mode, dispersal and settlement / recruitment rates, colony longevity (for corals) and geographic range may be more appropriate attributes to consider, yet data on these and other attributes are limited, for corals especially. If using different attributes, different thresholds are likely to be required. Overall, it was concluded that it was probably not suitable to take a 'one size fits all' approach for all fish and aquatic invertebrates together.

Similarly, different approaches between freshwater and marine species might be appropriate. In the latter, over-exploitation is likely to be a major risk factor whereas, in freshwater systems, other factors, such as water extraction, diffuse and acute pollution and obstacles to migration, are likely to be of greater relevance. The current method is strongly linked to the risk of over-exploitation, which may thus be more relevant to marine species.

Applying the method to single taxonomic groups or other groupings of species may also be desirable as may analysis at stock rather than at species level. Sharks emerge as a group with a number of high risk species (and also with high commodity prices) for which good data and recent Red List assessments are available. Applying the method to such a group may enable prioritisation within groups by adjusting the thresholds to appropriate levels for that group. However, a focus on those groups with good data availability may simply result in assessing risks for species for which the risks are already known and poorly known taxa may, in fact, be at equal or greater risk (and so are perhaps more worthy of assessment). It was also noted that part of the purpose of the process was to try and pick up on the little considered species that would otherwise have been overlooked.

3.3 Value

The initial impression of using value to assess risk was positive in that it could be used as a proxy for susceptibility or exposure of a species to fisheries. However, value data were found to be: a) difficult to source and not widely available; b) generally of low reliability; c) rarely reported at a species-specific level; and d) difficult to compare, if they exist at all, as they could be derived from several different points along a trade chain (from ex vessel prices to retail). Businesses are likely to be unwilling to share price data for a variety of reasons (e.g. commercial confidentiality/taxes). Average price per kilogram is calculated on the basis of the whole fish whereas some species are targeted for specific high value parts and derivatives (or ‘commodities’).

Average price per kilogram was not found to be a useful indicator of value or risk. However, by contrast, individual “high commodity” prices (e.g. for caviar or shark fins) were more useful; many species with high value commodities (ca. 50%) had low value unit prices. Using an approach based on high commodity required consultation on prices with experts but this was not viewed negatively.

The group felt that it was likely that high value commodities increased the risk for those species or stocks but that the converse was not so; that is, low value did not necessarily mean low risk. Along the same lines, sudden and steep increases in price are also likely to increase risk – these may need to be flagged by some kind of ‘alert’ system.

If value is to be included as a factor in risk assessments, it may, therefore, be preferable to use a defined upper percentile of value/price, or change in value over time, as an indicator of high risk, rather than comparing values over ranges (such as low, medium, high).

An analysis by one participant, from a sample of data, found that there was a significant difference ($P<0.001$) between unit price figures and the likelihood of stocks being over-exploited, although this analysis was solely based on data from a single well managed jurisdiction. But the overlap in unit prices between sustainable and over-exploited stocks caused false-negatives to occur frequently (that is >20% of the time). Similar findings were observed using the overall value of the fishery. Therefore, the use of either unit prices or overall value of the fishery was not recommended by the expert reviewers as a stand-alone indicator. Further analyses could be undertaken, for example, into correlations between value and, say, prosecutions or confiscations (per unit police effort – cf. abalone in South Africa). In other words, the indicator should first be validated against the risk with which we are most concerned (for example, over-fishing).

In summary, value as a risk factor might better be included as part of the violability risk (or an all encompassing ‘exposure’ factor) because high value is likely to provide incentives to increase fishing effort and/or break management rules, in other words it increases the risk of non-compliance and over-fishing. Value is thus a useful complementary indicator (with the caveats above) but it does not merit being treated as a stand-alone indicator of risk.

Socio-economic issues

The need to consider socio-economic issues within value assessments was also discussed. It was considered that there were many socio-economic factors at play that were probably directly or indirectly affecting the overall risk to species and driving over-exploitation (for example, through subsidies). The group felt that socio-economic issues were part of a broader range of factors that governments considered when making management decisions on fisheries and other matters. The group agreed that these socio-economic issues were important but they should be analysed and considered separately from the current approach.

3.4 Violability

None of the participants liked the term ‘violability’ and thought this was best expressed in the future as ‘Management and Compliance Risk’ (M-Risk) or similar.

It was agreed that it was also necessary to look at the appropriateness of any management and not just to equate high levels of regulation with good management.

Violability was considered to be a more difficult risk to score than the others considered here. For example, vulnerability can be assessed at the species level; the biological characteristics of a species that increase its vulnerability generally do not change with time or location. Likewise, value data can be collated at a whole species level for those species in international trade. However, governance data vary between countries and regions and can change rapidly with time; different stocks of the same species may be subject to different management. Such data are also difficult to collate and in order to be able to assess more, or all, species fully, considerably more time and staff capacity would be required (only 109 spp. were scored in this assessment). It was noted that the availability of information skews judgements on the adequacy of management,

Furthermore, the approach to scoring violability lacked transparency and would be hard for others to replicate. Some of the scoring was necessarily subjective which could lead to legitimate criticism. Some high violability scores for species subject to management through RFMOs (Regional Fisheries Management Organisations) seemed surprising. The rationale for such scores needed either to be explained in the final report or in any future work.

An alternative approach was suggested, namely to score for ‘exposure’ by looking at the scale of the fishery as well as at the value (and other related factors) and then combine that score in a meaningful (weighted) way with a score for the M-Risk. This approach addresses what many of the participants recognised as the failure of fisheries management, namely the gap between scientific advice and management is often linked to a lack of political will and this is difficult to influence even through or despite MEAs. It is also difficult to score. To address these issues, six factors were suggested as being suitable for assessing the management 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 IUU fishing?
- Are harvest rates reduced appropriately at low stock sizes?
- Are landings monitored?

These might each then be scored separately on a 3 or 5 point scale, where data were available (with Marine Stewardship Council data being an additional source of information for some stocks). However, one then also needs to know the extent to which any fishery overlaps with the stock (spatially and by depth). A list of prompts could be developed to inform scoring.

As this approach is aimed at determining which species are at risk of over-exploitation and, therefore, where governance can be used effectively to lower that risk, it would be best to first assess vulnerability and then exposure. This approach should identify the problems (M-Risk) with existing management and compliance arrangements (or lack thereof) for the species and hence logically draw attention to what management and compliance solutions may be used to reduce risk for a species through risk management. Another or additional option to reduce the amount of time and data needed to score these attributes is to limit the analysis to States or other entities that account for a majority of the harvest (e.g. >75%). For example, a highly vulnerable species may be wide-ranging but the majority of the harvest is taken by only two States. In such a case, only those two States would be evaluated for management and compliance risk, while the remaining States (which may number many) do not need to be evaluated.

It was questioned by some whether a score for management risk could be done at all? Analyses by some of the participants on stocks with good information found contrasting results between the effectiveness as management measures of the use of, for example, ITQs (individual transferable quotas) versus TACs (total allowable catch). Regardless, the best indicator of management performance was at a regional level and this may be the best basis on which management risk should be assessed.

However, because of the difficulties identified above, M-Risk could be conducted as a secondary step subsequent to the vulnerability/productivity and exposure assessments. It was further suggested that each step should be conducted in turn with the outcomes of each step being independently reported. While the vulnerability assessments will remain generally static, and are essentially globally applicable, the other steps (exposure and M-risk) are spatially and temporally variable and are also more resource intensive to undertake (that is, it is harder to find the relevant information). Thus the vulnerability assessment could be conducted as a one-off global exercise, with risks that will remain largely unchanged, but other factors (exposure and M-risk assessments) may change spatially and temporally (e.g. on a regional basis) and so could be assessed (and subsequently updated) as required or as opportunities allowed.

It was suggested that FAO's overall assessments of fisheries (whether fully exploited etc.) could be used to validate any regional assessments. Likewise, the IUCN Red List assessments, where available, could also be used to validate any approach, although in the study under review they were used in the initial selection criteria. However, it was noted that one aim of this risk assessment is also to identify those species not already known to be at risk.

In the report, it was not clear that in the final stage of the analysis, only a proportion of species were assessed against the violability criterion. The report should make it clear that the final analysis was done on only a sub-set of the overall data, which might then explain why, for example, only one sturgeon emerged as a high risk species (because not all sturgeon were assessed). The ultimate goal would be to apply the method to all species and the report simply presents a test of its application.

3.5 Data sources

A number of issues relating to data sources, gaps and how to deal with uncertainty were addressed within the discussions on the specific risk attributes. However, some additional points emerged.

It was felt that information was increasingly being collated globally on fisheries management and this may become publicly available in time. This exercise had itself contributed to the greater availability of such information (with the main dataset to be made available through the JNCC website). However, as noted above, management may change rapidly and one-off assessments quickly become out of date. How to interpret management data is also contentious.

It was felt that a more harmonised approach to the collection of data globally would enable future assessments, such as these, to be done more readily. However, it was not clear where or what the final repository of such data should be - FAO was suggested as a possible option.

It was suggested that the FAO's FishFinder publications were a more comprehensive source of information on commercially exploited aquatic organisms (with detailed information on 8000 species, >10 times as many as FAO factsheets) than FishBase & CSIRO data (which were used as a source for much of the data regarding the biological characteristics used in the vulnerability assessment). However participants noted that FishFinder was not an open access source of information, nor were its data available in the form of a database. One participant noted that FishBase correlated well with other data sources with few outliers and thus seemed a reliable source of information.

4 Conclusions

Participants were asked to summarise their views on the process and identify the most appropriate next steps. Their combined views are as follows.

The workshop, and original analysis, was seen as being a valuable first step to assessing species at risk from commercial exploitation globally; further, the analysis had enabled participants to share their own approaches to various productivity-susceptibility and/or certification analyses and to identify areas where these could collectively be improved.

There was a clear and positive convergence between methods used by fisheries management and their application for conservation management which might then reduce political sensitivities. Nevertheless, it was recognised that the subject of suggesting high risk species, which might then be considered as candidates for listing under MEAs, was politically sensitive. Some participants felt that once the method had been refined and tested further, it should be applied with the aim of identifying potentially high risk species (a 'shopping list') which might be subject to further measures to reduce the risks – whether through fisheries management and/or MEAs.

Nevertheless, the development and application of the original method has identified areas that could be improved, even if the issues were ones of fine tuning. The process needs to be made more transparent and hierarchical/step-wise in its approach – beginning with an assessment of vulnerability (i.e. a measure of sensitivity and resilience) and then followed with an assessment of exposure that measures management and compliance risk. To make this process explicit, it is recommended that the use of a flow-chart and better explanation of how attributes are scored (so that the process can be repeated by others) be provided. This two step process allows lower risk species to be eliminated making subsequent management and compliance analyses less onerous, especially as the latter are more difficult to assess and would need to be re-assessed more regularly. Additionally, trend analyses (e.g. from trade data) could be used to flag changes in risk.

The range of vulnerability and value attributes which are assessed should be re-considered and tested to see which are correlated with one another and which are correlated with wider outcomes (e.g. over-fishing). For example, maximum length could be used as indicator of vulnerability within a species group or ecological guild (e.g. elasmobranchs, shelf teleosts, deepwater teleosts etc). Within these or other (taxonomic) groups, different thresholds might be needed. It is likely that invertebrates need to be addressed separately from fish and require different sets of attributes and thresholds.

The approach as originally conceived (the three Vs) was more appropriate for assessing the benefits from CITES and, indeed, resulted from discussions on CITES listing criteria. However, future analyses with respect to identifying species which might potentially benefit from CMS needed a different approach and the starting point of identifying species in international trade should be amended to focus specifically on migratory species.

Next steps suggested by the group included, subject to available resources, applying and testing the refined method (and variations on it) on a smaller sub-set of species, perhaps specific taxonomic groups or ecological guilds. These case studies could test different approaches to scoring and use different attributes to build as robust an approach as possible. The revised method could then be applied to larger datasets.

It was agreed that for the purposes of refining the three "V" approach to risk assessment the first step should assess vulnerability, and move the value assessment into an overarching exposure assessment that also includes management and compliance risk. This would then broadly form a two-step risk assessment. As part of the exposure assessment, management solutions may inherently become obvious as tools to lower risk and the reporting of these during this process may inform well any risk management process (Figure 1).

If the full risk assessment and risk management process for a number of species was to be conducted, but constrained by time, one option could be to assess vulnerability and then take the highest risk species from that assessment through an exposure assessment and the highest risk species from that assessment would give you the overall species at highest risk. These would then form a smaller group of species at highest risk that could be taken through a risk management process (Figure 1).

It was agreed that the results of this workshop should be written up and annexed to the JNCC report produced by TRAFFIC; any future work should make the method more transparent and take account of other relevant comments from the peer review. Participants will be given the opportunity to comment on the draft workshop report.

It was also agreed that a short paper reporting the outcome of the study and workshop, with the participants as co-authors (if they wished), would be a good means of getting this work into the peer-reviewed literature. JNCC will look at options for obtaining resources to take this forward along with testing the revised method through case studies.

Finally, participants also discussed how the work might best be presented externally, noting that the focus of the work was on testing a method for a risk assessment and that it did not automatically mean that any species identified as being of high risk would, or should, be candidates for listing by an MEA, rather that this was a means of narrowing the focus to help judge where MEAs might complement fisheries management.

5 Acknowledgements

JNCC and TRAFFIC are grateful to all the workshop participants for sharing their time and expertise to contribute to this study.

6 References

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Annex A Workshop programme

Day 1 (Chair: Mark Tasker, JNCC)

0930 Welcome – Mark Tasker

0940 Purpose and objectives of the meeting, general principles and background – Vin Fleming (JNCC)

1000 Fish & MEA review – TRAFFIC (Thomasina Oldfield, TRAFFIC)

1045 COFFEE

1100 Other risk-based approaches to fisheries and their relevance

- Will le Quesne (CEFAS) - *Predicting conservation reference points and species vulnerability with minimal data to support rapid risk assessment of fishing impacts on biodiversity and associated management tradeoffs*
- Tony Smith (CSIRO) - *Ecological Risk Assessment for fisheries in Australia*
- Wesley Patrick (NOAA) – *NOAA Fisheries Vulnerability Assessments: PSA, CCVA, and ORCS*[7]
- Dan Hoggarth (MSC) - *Risk Based Framework for MSC data deficient fisheries*
- Zeb Hogan (CMS Scientific Councillor) – *CMS review of migratory freshwater fish*

1300 LUNCH

1400 Assessment of the approach overall – general discussion on validity, merit, risks and benefits – lessons from other approaches

1530 COFFEE

1545 Value (economic risk) – issues associated with assessing this risk (Vicki Crook, TRAFFIC)

1700 Close – day 1 – brief resume of progress on the day

Day 2 (Chair: Vin Fleming, JNCC)

0900 Vulnerability (biological risk) – issues associating with assessing this risk (Gemma Goodman, TRAFFIC)

1045 COFFEE

1100 Violability (compliance risk) – issues associated with assessing this risk (Glenn Sant, TRAFFIC)

1245 LUNCH

1330 Other issues including: Taxonomic sub-sets versus an ‘all taxa’ approach

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[7] PSA - Productivity Susceptibility Analysis, CCVA - Climate Change Vulnerability Assessment, and ORCS - Only Reliable Catch Stocks

Annex B Workshop participants

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