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**BACKGROUND STUDY TO REVIEW THE EXTENT TO WHICH BIODIVERSITY  
CONCERNS ARE ADDRESSED IN EXISTING ASSESSMENTS**

*Note by the Executive Secretary*

1. The Executive Secretary is circulating herewith a background study to review the extent to which biodiversity concerns are addressed in existing assessments, for the information of participants in the Joint Expert Meeting on Addressing Biodiversity Concerns in Sustainable Fishery, being convened in Bergen, Norway, from 7 to 9 December 2011.
2. The research for this background study was undertaken with kind support from the United Nations Environment Programme Division of Environmental Policy Implementation (DEPI) and in collaboration with the Food and Agriculture Organization of the United Nations (FAO), regional fisheries management organizations (RFMOs), and the Fisheries Expert Group of the Commission on Ecosystem Management of the International Union for the Conservation of Nature (IUCN-FEG-CEM).

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## INTRODUCTION AND CONTEXT

This background paper is intended to address the request made by the Conference of the Parties in paragraph 53 of its decision X/29 to “to review the extent to which biodiversity concerns [...] are addressed in existing assessments”. This paper will be complemented by a separate background paper being prepared to focus on the specific part of this request to look in greater depth at “the impacts on marine and coastal biodiversity of pelagic fisheries on lower trophic levels”. Consistent with the request in that paragraph “where possible through existing assessment mechanisms” and “to collaborate with the Food and Agriculture Organization of the United Nations (FAO), the United Nations Environment Programme (UNEP), regional fisheries management organizations (RFMOs), as appropriate”. FAO, UNEP and all RFMOs (aside from those focusing exclusively on tuna and other large pelagic fisheries) currently operating or in development were contacted for input, and their websites were the main source of data for this review. Four classes of “biodiversity concerns” were sought in the documentation provided by these sources or available on their websites:

1. The extent to which predation on pre-recruit and recruited ages of exploited fish stocks was considered in accounting for the dynamics of those exploited stocks;
2. The extent to which assessments of the exploited stocks evaluated the degree to which those stocks were contributing top-down control as a predator over the dynamics of the food web of which the stocks were a part;
3. The extent to which bycatch mortality imposed on non-targeted (and often non-assessed) species was considered in stock assessments; and
4. The extent to which the impacts on seafloor habitats by gears used in the fisheries were considered in stock assessments.

Each of these issues was chosen based on field and/or modelling studies showing such interactions between components of marine biodiversity and fishing activities could occur. For concern 1 (predation impacts on stock dynamics), models predict the effects can be important for management (e.g. A’mar et al. 2010, Tyrrell et al. 2011). Also analyses of population data have suggested seal predation may be a factor in the failure of Canadian Atlantic cod to recover from fishery depletion, even when fishing mortality has been nearly eliminated (Swain and Chouinard 2008), and capelin in the Barents Sea may be a controlling factor on recruitment to some predator stocks, at least under some environmental conditions (Gjostæter et al. 2009, Lindstrom et al. 2009). For concern 2 (top down predation) a number of modelling studies have found that trophic cascades may result when the larger sizes of marine predators are reduced in abundance (Baum and Worm 2009, Andersen and Pedersen 2010, Shackell et al. 2010), and some field studies are producing results consistent with those models (Casini et al. 2009, Frank et al. 2011). For concern 3 (bycatch mortality), fishery bycatches have been documented to be a major source of mortality for a variety of marine mammals (e.g. Garrison 2007, Cramer et al. 2008), seabirds (e.g. Dietrich et al. 2009, Tuck 2011), reptiles (e.g. Wallace et al. 2010, Finkbeiner et al. 2011), and bony fish and elasmobranchs (e.g. Broadhurst et al. 2006, Zhou and Griffiths 2007, Dulvy et al. 2008). For concern 4 (habitat impacts of gears) many studies have documented that fishing gears, particularly mobile bottom-contacting gears, can cause serious harm to seafloor structures and benthic communities, if those habitats have features that make them vulnerable to physical damage, such as fragility or slow population recovery rates (e.g. Løkkeborg 2005, Hiddink et al. 2006, Tillen et al. 2006).

However, in all cases these impacts are case specific. There are many studies which document that even bycatch and habitat impacts of fisheries can be managed within safe ecological limits, if appropriate measures are taken. Simple gear modifications and/or care in the places or times of gear deployment can markedly reduce bycatches of marine mammals (Slooten and Dawson 2011), seabirds (Løkkeborg 2011, Melvin et al. 2011, Yokota et al. 2011), marine reptiles (Swimmer et al. 2010, Sala et al. 2011), fish (Favaro et al. 2010, Dunn et al. 2011, Lewison et al. 2011), elasmobranchs (Thorpe and Frierson 2009,

Piovano et al. 2010, Carruthers et al. 2011) and some habitat impacts of mobile gears (Løkkeborg 2005, Kaiser et al. 2006).

Because the interactions of fisheries with biodiversity components are case specific, it is important to be systematic and unbiased in the selection of assessments to review, in order to provide a representative picture of the degree to which these biodiversity concerns are taken into account in stock assessments. We decided to look at all RFMOs, because of the special role that CBD has in providing scientific and technical information and advice on biodiversity in areas beyond national jurisdiction. Annex I presents the acronyms used for all the RFMOs consulted in this review, and Annex II is a list of the URLs for the websites and documents consulted. We chose to exclude the tuna/large pelagic RFMOs and in part just to manage workload, but primarily because tuna fisheries tend not to use bottom-contacting gears and predation on pre-recruit tuna is particularly poorly quantified in many areas. Consequently we were concerned that assessments by tuna/large pelagic RFMOs would not provide information on two important classes of potential impacts of fisheries.

We acknowledge that stock assessments conducted by some States may be particularly thorough in the treatment of all of these biodiversity concerns during fishery assessments. However, it would not be possible to be comprehensive in the treatment of practices of all States, so any non-random subset of States would have a potential to be unrepresentative of practices globally, and if a random selection of States were made, the quantity and quality of information available would likely be so uneven that a bias towards practices of the most developed States would likely still be present. Other presentations planned for the meeting will cover the activities of a number of States with regard to how biodiversity considerations are taken into account in assessments and fisheries management at the national and local levels. Collectively these presentations will be a comprehensive review of global practice in areas within national jurisdiction.

## **APPROACH AND SOURCES OF INFORMATION**

A template was prepared for collecting information from the assessments done by RFMO/As (Table 1). This template was designed to systematically assemble information on whether an individual stock assessment mentioned each of the four biodiversity considerations listed above, and if the consideration was mentioned, exactly what was said or done regarding the consideration. A second template was also prepared for use with documents which were not stock-specific assessments, but rather were thematic assessments or expert reports on one or more of the biodiversity considerations (Table 2).

Use of the second template is a slight expansion of the request by COP 10 in the decision X/29, in that it goes beyond looking solely at stock assessments. However, it is in the spirit of the decision, wherein the concern is how biodiversity considerations are taken into account in fisheries management overall. Stock assessments were simply identified as a primary source of information relevant to that concern. Many bottom fisheries harvest more than a single species, such that considerations such as bycatches and habitat impacts of gears are associated with the fishery as a whole, and not with any single stock taken in the fishery. Therefore it was considered appropriate to include the thematic assessments and expert group reports in this review. Failure to do so would have overlooked many of the more focused treatments of biodiversity considerations by the RFMOs.

These templates were completed for all the stocks assessed by RFMOs over the past five years. For each RFMO, their websites were used to access their stock assessment reports. Starting with the 2011 assessments, Template 1 was completed for each stock assessment reported in Science Advisory Subcommittee Reports or their equivalents. Then the 2010 assessment reports for the RFMO were checked, and templates were completed for any stocks assessed in 2010, but not 2011. This was repeated back for five years for each RFMO, such that a template was available for the most recent assessment of every stock assessed by the RFMO in the recent half decade. For the few RFMOs whose 2011 assessments were not available, the five year review window was 2006-2010, rather than 2007-2011. In

addition, each RFMO website was examined for any expert group reports or thematic assessments of bycatches, habitat impacts of gears, or trophodynamic roles of harvested stocks, over the five year window being reviewed. For each such report or assessment, Template 2 was completed.

As insurance that the review did not miss documents that a RFMO considered containing important information about how they addressed biodiversity considerations in their work, all RFMO Secretariats were contacted by email. They were provided with the full text of paragraph 53 of decision X/29, informed of the nature of the review being conducted, and invited to provide any references that they considered relevant to the review. Most RFMOs responded quickly and positively, and provided useful guidance on where to find relevant information. All references and reports provided by RFMO Secretariats were consulted and, if not already reviewed, the relevant information was included in the library of templates.

It has long been established that harvest strategies for exploited stocks need to include considerations of both predation mortality experienced by the stock and for important forage species, some form of allocation of a portion of annual production to “dependent predator” (for example, the CCAMLR Convention itself; see Annex I for the description of each RFMO acronym). Likewise the RFMO may have general policies and regulations for addressing bycatches and habitat impacts of fisheries, without necessarily linking these policies and regulations to individual fisheries. However, in the document review it was found that many assessments did not even state the exact target exploitation rate or control rule being used in determining advised harvest from the assessment of stock status. Nor in many cases did assessments reference general policies affecting fisheries on the individual stocks being assessed, unless the policy or regulation affected the specific assessment directly. Moreover, of the cases where the target exploitation rate or control rule was given in the assessment or in the perambulatory text for a set of assessments, few of them provided clear explanations of the derivation of those target rates or rules.

As a consequence of the frequent absence of information on sources of exploitation rates being applied, a second set of emails was exchanged with several of the RFMOs providing the most complete responses to the first inquiry. This exchange asked explicitly to be directed to documentation of the factors taken into account in these target rates or rules, and about generally applicable policies and regulations regarding bycatches and habitat impacts of gears. We followed all leads provided by RFMO/A Secretariats, and made efforts to check the overarching policies and regulations on the RFMO/A websites. However we acknowledge that only partial information is available on this aspect of the ways that biodiversity considerations are taken into account in fisheries assessments. Hence the discussion of this topic should be considered illustrative rather than a comprehensive treatment of the general state of practice.

## **RESULTS**

### *Consideration of Biodiversity in Stock Assessments – Recruitment, Natural Mortality and Growth in Individual Assessments*

In the review of individual stock assessments by RFMO/As, 24 assessments were found that provided sufficient information to complete Template 1 (Table 3). This number is slightly misleading, in that for some RFMOs a single template entry was made for a species, even though several geographic stocks of that species may have been assessed separately. When the assessment approaches were similar across stocks, one template entry captured the necessary information. This was the case, for example, with CCAMLR, which assesses a number of stocks of toothfish and icefish, and regional units of krill. However, since the approaches are similar across stocks (to the extent that available data are sufficient to allow the preferred analytical model to be applied), one template entry for the species captured the way that CCAMLR addressed the concerns relevant to this review.

It is noted that several of the RFMO/As are under development still, and have not progressed to doing full stock assessments. In the next few years a number of additional stock assessments by RFMO/As should

come available. This in itself would be a welcome development in terms of ensuring sustainability of fisheries in areas beyond national jurisdiction (ABNJ). Given the number of vessels fishing on the high seas and the diversity of ecosystems and populations being exploited, finding only two dozen stock assessments reporting adequate information to complete our Template 1 suggests strongly that even the impacts of fisheries on many target species are not being evaluated quantitatively on a regular basis. This in turn suggests that the sustainability of impacts of many fisheries on even their target species may be uncertain.

**Conclusion 1:** It appears that a number of stocks targeted by many fisheries in ABNJ are either not assessed on a regular basis, or the assessments are not reported fully in locations that are available to interested individuals and groups outside the RFMO/A.

When these fisheries are being prosecuted under formal exploratory fishery protocols, it is expected that stock assessments will only commence once several years of information have been collected. However, relatively few stocks were identified by their competent RFMO/A as being fished under formal exploratory fishing protocols. If fishing under formal exploratory fishing protocols is a widespread practice, it would be valuable for RFMO/As to identify that more conspicuously on their websites, as well as linking the provisions required by those protocols to the species being harvested under the protocols.

**Conclusion 2:** Information on which stocks are being exploited under Exploratory Fishing protocols, and the provisions of the protocols, is relevant to how biodiversity considerations are being addressed by RFMO/As, but is often hard to find on RFMO/A websites.

Of the 24 stock assessments that were reviewed, just over half (13) do not report a stock-specific recruitment estimate in the assessment. In those cases either the assessment only evaluated current standing stock of the population, or some long-term average annual input of new biomass or individuals was assumed. Of the 11 stock assessments for which some recruitment estimate was found, none of those estimates was linked analytically to either predator impacts on pre-recruits or their food availability. In only one case, sole by GPMC, did the state of the physical environment directly influence computations leading to the recruitment estimate.

More of the assessments, 15 of 24, included some estimate of natural mortality. However, aside from NAFO Shrimp in 3LNO and NEAFC herring, the natural mortality estimates were some recent average value, and only in those two stocks was a multispecies model used to provide estimates of natural mortality that took into account the size of the predator populations for the stocks. None of the values of natural mortality used in any assessment took food supply of the population or state of the physical environment directly into account. None of the assessments considered the role of the stock as a predator contributing to top-down control on ecosystem dynamics.

Again nearly half of the assessments (12) had no specific growth parameter in the assessments. It is inferred either some average weight at age was used for age-structured assessments or the annual estimates of biomass / abundance of the stock did not use methods that “grew” survivors from the previous year into the population on the succeeding year. When growth was modeled in the assessment, only for NEAFC herring, it was the result of a multispecies model, which in this case included both impacts of predators and water temperature.

**Conclusion 3:** The dynamic parameters of stock assessment models – recruitment, natural mortality and growth – are often not estimated directly in assessments of stocks in ABNJ, and when they are estimated, it is rare that the estimates take direct account of the impacts of predators, food support, or environmental conditions on the population parameter.

*Consideration of Biodiversity in Stock Assessments – Treatment of Harvest Rates, Bycatches and Habitat Impacts in Assessments*

Although we found that the individual assessments of stock dynamics by RFMO/As rarely took biodiversity considerations into account directly, the more general information about the stocks and fisheries, and the harvesting strategies for the stocks more commonly did include some consideration of biodiversity issues. CCAMLR, NAFO and NEAFC each had harvest strategies for krill, shrimp and herring respectively, that took consumption by predators into account. This was modelled dynamically for krill and herring, using multispecies trophodynamic models, and made as an *a priori* allowance ahead of harvesting needs for shrimp. All three of these species are considered “forage species”, where such accommodation of predator requirements may be particularly important. This issue will be explored in depth in a separate background paper for this workshop.

Two of the stocks assessed by SEAFO are explicitly designated as being fished in exploratory fisheries, with a series of regulations applied to ensure the fishery does not become unsustainable as it develops. Most of the RFMO/As, in fact, had policies and guidelines for exploratory fisheries, with the guidelines addressing effort levels, spatial extent of operations, gear restrictions, monitoring and reporting and other factors. These guidelines were not examined in depth, but an evaluation of the degree to which exploratory fishery protocols actually reduce risk to biodiversity, and produce outcomes of healthy stocks and ecosystems, might be a part of further investigation of how effectively fisheries take biodiversity considerations into account in management.

In a few cases, particularly in the case of NAFO, target harvest levels were supported by Management Strategy Evaluations (MSE) of some complexity. These MSEs might not model the impacts of predators, prey and habitat quality on stock dynamics explicitly. However, MSEs are intended to evaluate the robustness of management strategies to all major uncertainties, and uncertainties about environmental conditions and species interactions are supposed to be captured at least in the distributions of recruitments, natural mortalities, and growth rates sampled in the simulations (A’mar et al. 2009, Bunnfeld et al. 2011). The preferred strategies from such MSE investigations should be management strategies which have a high likelihood of sustainability of at least the target stocks, even if predation mortality is on the high end of the distribution of historically observed levels and food supply and environmental conditions are at plausible unfavourable values. This brings consideration of biodiversity *implicitly* into development of the management strategies. However, since MSEs require a model of the dynamics of the ecosystem in which the exploited species is found, there is no impediment to having such MSEs provide more *explicit* information on how risks to biodiversity are affected by alternative management strategies, should there be a request for such information.

The large majority of the remaining stock assessments (12 of 16) included harvest strategies derived from single species models of the dynamics of the harvested population’s abundance and/or productivity. These models rarely included predation, role as a predator, food supply, or environmental conditions explicitly. Rather they assumed average stock productivities and mortalities would continue into the near future. These “averages” implicitly included the “typical” effects of predation, food supply, and environment on the stock. However, across assessments averages were taken over quite different numbers of years. If the ecological factors vary greatly from year to year and are hard to predict in advance, then the most robust strategy is to average over a large number of years to smooth out noise. If the factors are showing directional trends, then averaging over the most recent few years is the appropriate strategy. In addition, in a precautionary framework it can be argued that a more risk-averse option than an “average” should be used for productivity and mortality parameters. This would equate to assuming in the absence of better information that the stock should be managed to be robust to less than the 50<sup>th</sup> percentile of historical recruitments and growth rates, and more than the 50<sup>th</sup> percentile of predation (and other natural) mortality. We did not find these biodiversity issues discussed in any of the assessments.

**Conclusion 4:** Harvest strategies have been adopted for most stocks reviewed. For all the clearly forage species, these harvest strategies considered the role of the stock as food in the ecosystem explicitly.

Otherwise the management strategies rarely treated any biodiversity considerations explicitly in deriving the harvest strategy being applied to the stock. However, the biodiversity considerations did contribute implicitly and indirectly to the harvest strategies, with a wide range of computational support, from sophisticated Management Strategy Evaluations to simply assuming “average” biodiversity associations would continue.

**Conclusion 5:** Aside from the few cases where harvest strategies are the result of multispecies modelling and / or Management Strategy Evaluations, the robustness of the harvest strategies at taking biodiversity considerations into account has not been tested.

In 21 of the 24 assessments reviewed, there was some mention of bycatch either in the assessment or in documents closely linked to the assessment. However, fewer than half (9) of those reported anything more than the lists of species typically taken as bycatches in fisheries for the stock. Of those nine, all reported some form of bycatch cap or other management rule intended to manage bycatch levels in the fishery. RFMO/As tended to be consistent in their treatment of bycatches across stocks. NAFO and SEAFO generally set a cap for aggregate bycatch as a percentage of total catch for its fisheries, CCAMLR actually set caps for allowable bycatch of certain non-target species, and the others generally just reported the composition and general magnitude of bycatches. Although any measures to manage bycatches are likely to be considered potentially valuable in addressing biodiversity concerns, caps specific to particular bycatch species are generally considered the approach likely to provide greater protection than other forms of limit. Prosecuting fisheries with gears and in ways that keep bycatch very low to begin with are also compatible with biodiversity objectives, and are featured in the NEAFC reporting in assessments.

Unlike bycatches, habitat impacts of fisheries were much less likely to be considered in individual assessments. CCAMLR was the only RFMO/A to report directed spatial measures to manage impacts of gears at the stock assessment level, with assessments by the other RFMO/As at most including brief narratives of the possible impacts of the gears used to harvest the assessed stocks. NEAFC, in particular, did highlight in assessments of redfish and blue whiting that the fisheries were prosecuted by gears which were unlikely to contact the seafloor during normal fishing operations, suggesting they gave some priority to this aspect of the impact of fisheries on biodiversity.

**Conclusion 6:** Although most RFMOs give some attention to bycatches even in individual stock assessment documentation, in the majority of cases the consideration seems to be little more than a reporting the composition and general level of bycatch. From the assessment reports, bycatch appears to be actively managed in the minority of cases, and often with methods that may be incompletely effective.

**Conclusion 7:** The majority of assessments do not consider habitat impacts in the assessments directly. Only in the case of CCAMLR are habitat protection measures linked to particular fisheries in the assessments of the targeted stocks.

#### *Consideration of Biodiversity in Stock Assessments – Thematic Assessments and Reports*

Most RFMO/As had separate documents assessing – or in some way evaluating – biodiversity considerations directly (Table 4). This was particularly the case for bycatches in fisheries. Only on the SEAFO website did we not find a recent expert report on some aspects of bycatches. In many cases (7 of the 11 other RFMO/As) the documentation was primarily a narrative about the scale and nature of bycatch in fisheries under the jurisdiction of the RFMO/A. In most cases the reports also presented explanations of the policies they were either considering or actively developing to deal with bycatches in their fisheries. The specific technical provisions that planned (or at least contemplated) policies were rarely specified, but the desired outcomes of reduced bycatches and sustainable impacts on bycatch species were usually explained clearly.

In the cases of GFMC, NAFO and NEAFC, recent working group reports and technical documents reported on research underway to gain more information on bycatches in specific fisheries. These reports consistently focused on practical management issues. Sometimes they were trying to scope out the scale of a poorly quantified bycatch concern and sometimes they went on to evaluate and provide technical guidance on options to address problems that were better understood. In all cases those RFMOs agreed on actions to take with regard to measures (usually gear related) to reduce unwanted bycatches, although in the case of GFMC, implementation of the measures is by States and not the RFMO itself. CCAMLR, NAFO and SPRFMO also had documents presenting analyses of levels and trends in bycatches in specific fisheries, and/or on specific monitoring requirements for those fisheries.

Documentation on efforts by RFMO/As to record and manage impacts of fishing gears on marine habitats was less common. No documents specifically considering habitat issues were found for four of the RFMO/A; each very new or still in development. For four others documentation was available on their websites, but the discussion of habitat impacts was largely general and speculative. In each of those four cases, however, there were clear recommendations for future work on habitat – fishery interactions. In the RFMO/As with longer histories, however, including CCAMLR, GFMC, NAFO, NEAFC and SPRFMO, there were documents specifying specific management measures for addressing potential impacts of fishing gears on seafloor habitats, that were to be applied in their regulatory areas. In each of these cases the documentation made clear that such measures – whether spatial measures or restrictions on gear configuration – had evolved over time as information accumulated. This suggests that the other RFMO/As still early in the process of examining habitat issues in their fisheries may also add measures to manage these impacts, as more information becomes available on their nature and scale in each specific regulatory area. Depending on the rate of development of fisheries in the regulatory areas of the new RFMO/As, however, adding habitat protection measures only after fisheries have fully developed allows substantial habitat impacts to accumulate, and is not consistent with the precautionary approach or the FAO Deep-sea Fishery Guidelines.

**Conclusion 8:** RFMO/As are aware of the need to take bycatches into account in managing fisheries sustainably. Although only the minority of RFMO/As appear to have fishery-specific measures in place to address bycatch issues, almost all of them are at least in the process of developing bycatch policies and acquiring the information needed to implement policies to manage bycatch sustainably.

**Conclusion 9:** There is less documentation that RFMO/As are actively addressing habitat impacts of fisheries. However all the longer-functioning RFMOs do have documents addressing the sustainability of habitat impacts of specific fisheries, and at least half the new or developing RFMOs have documents illustrating that they consider this topic a priority for work in the near future.

#### *Policies, Regulations and Provisions of Conventions*

In many of the stock assessments and related documents reviewed in the preceding sections of these Results, relevant biodiversity provisions were justified relative to the overarching policies and provisions in the RFMO Conventions, or by the regulations adopted by the Councils of the RFMOs. Moreover, in the correspondence with RFMO Secretariats, they consistently pointed to those high-level documents as important guidance in how RFMOs dealt with biodiversity considerations. Hence we considered it necessary to conduct an initial review of how biodiversity considerations are addressed in the overall activities of fisheries management in areas beyond national jurisdiction. Although we did not conduct an exhaustive and detailed review of all policy documents of all RFMO/As, we looked carefully at those documents indicated by RFMO/A Secretariats to be of particular relevance. If it is concluded that these high level policies and Conventions and the Regulations adopted to implement them are an important part of how Parties to CBD view the adequacy with which biodiversity considerations are addressed by RFMOs, then such a more complete analysis might be appropriate.



Here, as well, the years that an RFMO/A has been in place clearly affected the completeness with which biodiversity considerations are addressed in policies, Convention provisions, and regulations (Table 5). For the relative new RFMO/As and those still under development, the treatment of biodiversity tends to be fairly generic. This is the case for APFIC, SEAFO, and WECAFC. For these new or developing RFMO/As their overarching policies present commitments to ecosystem approach, precautionary approach and sustainable use of the harvested species. In the case of WECAFC, their policies show a further step in development. In the Scientific Working Group Reports and Council reports one finds specific reference to accounting for trophic relationships, in particular to the possible changes in abundance of some key exploited species as a result of changes in abundance of large predatory fish and sharks. There is also concern about the need to manage the multispecies fisheries in the area to take account of the differential productivities of the species being harvested together.

In the longer established RFMO/As, the policies and regulations take much more complete consideration of biodiversity issues. Over the past decade, APFIC has not undertaken assessments within the RFMO/A itself, but has worked to improve practices of the States in the Asian Pacific. In addition, through targeted workshops on issues like harvests of “trash fish” for aquaculture, APFIC is clearly promoting awareness of biodiversity concerns among members, and improving the ability of the individual States to conduct assessments of these issues and develop corresponding policy responses at the national scale.

CCAMLR has specific Conservation Measures to address trophic relationships both in overall harvest level and in the spatial distribution of catches, bycatches of marine mammals, seabirds, and vulnerable fish and elasmobranches, and habitats both through identification and protection of VMEs, and in general ensuring any increase in spatial extent of fisheries is done slowly and with effective monitoring and assessment of biodiversity effects. The CCAMLR Conservation measures include a specific commitment to comply with the voluntary FAO Deep-Sea Fishery Guidelines.

NAFO also has explicit policies and regulations for all three major biodiversity considerations. Although all current target exploitation rates are derived from single-species assessments, the Scientific Working Group is exploring multispecies models of trophic interactions, with intent to add them, as appropriate, to the Management Strategy Evaluations being used to set management benchmarks for NAFO stocks. There are explicit management measures requiring gear modifications to mitigate bycatches, and restricting bycatches to a specified percentage of total catch on a tow by tow and trip by trip basis, with lower tolerances for depleted stocks such as cod and some redfish stocks, and exploited stocks for which quotas have already been taken for the year. NAFO has also charged its Scientific Working Group and a Scientist-Management working group to apply the VME criterion for fragile and vulnerable habitats in the NAFO zone, resulting in the closure of five seamounts to fishing and several areas characterised by large extents of corals and/or sponges.

NEAFC also has generic provisions in its Convention to apply the precautionary approach and ecosystem approach, and take due account of the impact of fisheries in the regulatory area on other species, ecosystems and biodiversity in general. There is a requirement to monitor and report bycatches in all fisheries, and past reports have resulted in additional measures to reduce bycatch mortality of deep-water sharks. NEAFC has also closed three large areas and several smaller ones and seamount tops to bottom fishing. In addition NEAFC recently met jointly with OSPAR to apply both the CBD’s ecologically or biologically significant marine areas (EBSAs) criteria and the FAO’s vulnerable marine ecosystems (VMEs) criteria to the area within their joint jurisdictions, with a commitment to take appropriate measures within their respective competences to protect areas identified as special at that meeting.

SPRFMO is actually a new RFMO, and its policies and regulations are correspondingly still developing. However, the development phase has extended over several years, and the provisions in the Convention show many similarities to provisions in the conventions and policies of RFMOs that have been functioning for two decades or more. The Convention includes provisions to safeguard the ecosystems in which its fisheries occur, and to take into account impacts on non-target species and marine ecosystems

and habitats when evaluating the sustainability of fisheries. There are the general commitments to an ecosystem and a precautionary approach, with extra risk aversion in habitats and systems with particularly long recovery times. Quota setting is directed to take into account catches of non-target species, the needs of dependent predators, and other relevant ecological, biological, and environmental factors, including trophic relationships. There are a number of gear requirements intended to address both bycatches and habitat impacts of fisheries, with particular concern for vulnerable sharks and rays. SPRFMO too has applied the FAO's VME criteria within parts of its intended area of jurisdiction, and asked Parties to close areas known to have stands of corals and sponges to fisheries.

**Conclusion 10:** In their policies, Conventions, and adopted regulations, RFMO/As show broad consideration of biodiversity requirements and risks. These high-level policy documents espouse commitments to an ecosystem approach, precautionary approach, and sustainable use as foundations for all other policies and management measures.

**Conclusion 11:** Beyond those high-level commitments addressed in Conclusion 10, there appears to be a tendency for RFMOs to adopt over time more and more explicit and complete provisions for implementation of the high level commitments, with regard to trophic relationships and dependencies among species, bycatches, particularly of depleted or vulnerable species, and vulnerable habitats.

## DISCUSSION

This review presents a step in the evaluation of how well current fisheries management ensures biodiversity impacts are sustainable. The initial request by COP 10 in decision X/29 to look specifically at assessments produced results that suggest biodiversity concerns are rarely considered in fisheries management. Although it is well documented in the research literature that recruitment, natural mortality and growth can all be affected by predation, food supply and environmental conditions, these factors very rarely appeared in assessments of the dynamics of individual stock.

In contrast to the apparent low attention to biodiversity concerns in assessments of the dynamics of individual stocks, our review found that nearly all RFMOs were giving some attention annually to bycatches, and many were to habitat considerations as well. This information could be found both in the assessments of individual stocks, and in separate studies and reports by the expert advisory groups of the RFMO/As. In the case of bycatches the coverage was typically restricted to reporting on the composition of bycatches and sometimes its level in the fisheries. Less frequently these reports included evaluations of bycatch amounts against some reference level, but in no cases were reports found which tried to directly evaluate if the bycatches were sustainable. In the case of habitat impacts, the annual considerations tended to be incremental information on the occurrence of areas likely to be considered vulnerable marine ecosystems, and of measures taken to protect them.

Consequently the first stage of our review found at least modest attention to bycatch and habitat concerns in the annual assessment activities of RFMO/As. On the other hand there appears to be a significant oversight in taking biodiversity into account in assessments of dynamics of individual fish stocks. However, our findings actually are consistent with expert advice on considering the impacts of external factors on the dynamics of exploited stocks, when assessing their status and trends.

In the early 2000's, ICES sponsored two expert working groups to look into how environmental conditions should be taken into account in recruitment estimates (SGPRISM [ICES 2000, 2001, 2002]) and growth and maturation estimates (SGGROMAT [ICES 2003, 2004]). Both expert groups reviewed practices for inclusion of these factors in the assessment estimates. However, both focused on taking these considerations into account in medium term projections (i.e. projecting stock dynamics ahead over 5-10 years under various assumptions about harvest levels). Both noted that including the environmental factors dynamically in stock assessments is both data demanding and knowledge demanding. For few

stocks globally and even fewer in ABNJ would there be sufficient data and knowledge of the specific ecological processes for such analytical approaches to meet standards for even good practice, let alone best practice. Indeed SGGROMAT concluded that although it was “asked to implement suitable process-based models in medium-term projection methodologies and conduct sensitivity analyses to examine the likely effects of these new approaches on management advice, this continues to be an important development aim, but may take some time to achieve.” That is, the methods to include these factors directly in assessments are not yet available for routine application even in areas as data and knowledge rich as north-west Europe. In addition, these conclusions were drawn for only the projections part of the assessment process. No suitable practices were identified for including them in annual assessment computations.

The same situation was found for analytical estimates of predation mortality in multispecies assessment models. In one of the few cases where there were sufficient data on predator and prey populations and predator diets, to actually test the performance of models estimating annual natural mortality compared to using a value averaged over recent years - for the North between 1981 and 1991 - the results strongly supported the use of multi-year average conditions (ICES 1994).

Now all of these ICES reports are old studies, and assessment practices have become much more sophisticated in the past decade. However the basic findings have not changed. Even for the countries with significant resources to invest in fisheries and ecosystem research and monitoring, it is very rare that annual stock assessments are improved by including factors like predator abundance, food supply, and environmental conditions directly in the computations. It can be done (ICES 2010, Ianelli et al. 2011) but such cases are the exception not the rule. Likewise, in similarly few cases (e.g. NEAFC herring and shrimp), our review did find these biodiversity considerations included directly in the stock assessment computations, and advice on management was adjusted corresponding to annual conditions.

If assessment practice is currently not up to detailed inclusion of biodiversity considerations in annual stock assessments, what, if anything, do the experts recommend as appropriate treatment for such issues? Here the results of our review are consistent with contemporary thinking on fisheries practice. Even if the process based knowledge and data from ecosystem monitoring are insufficient to track the biodiversity issues annually, harvest strategies can and should be developed that take them into account (e.g. Howell and Bogstad 2010, Hinrichsen, et al. 2011, Hollowed et al. 2011).

When we looked at the harvest strategies used by the RFMO/As, a few explicitly took some biodiversity features into account, and many did so implicitly. More importantly, perhaps, the harvest strategies used by RFMO/As are developed to achieve the overarching policy objectives and provisions of the Conventions of those commissions. When we examined such higher level guidance, explicit acknowledgement of biodiversity considerations was nearly universal. The specificity with which biodiversity considerations were addressed in policies and regulations increased with the “maturity” of the RFMO/A. Ones which had been functioning for many years had much more complete sets of policies and regulations than ones still in development. That should not be viewed as a short-coming of the new RFMOs, however, but as an opportunity. Given their consistent commitment to the ecosystem approach and precautionary approach in their developing policies and Convention provisions, these RFMOs can learn from the experience of the earlier ones, and develop appropriate conservation and management measures for biodiversity at their early stages of operation, when the measures, particularly measures for habitat protection, are likely to do the most good.

The conclusion that RFMO/As have many appropriate provisions for conservation and sustainable use of biodiversity in their Conventions and overarching policies, and the more matures ones have translated these provisions into management measures is encouraging, but is not the end of the matter. Our review found very little in the way of analytical evaluation of how effective these measures are at delivering their intended outcomes. In the case of spatial measures to protect sessile VMEs, such as coral or sponge reefs or seamounts, the measures probably can be considered effective as long as the process for VME

identification is effective and stays ahead of the expansion of fishing effort, and the measures are respected by fishing fleets. Bycatch provisions, and provisions for VME properties that are not inherently spatial (populations with life histories that make them particularly vulnerable to increased mortality), on the other hand, may or may not be effective in protecting the intended populations. They are effective only if the limits on bycatch (or other impacts) are set at appropriate levels, and if bycatch management procedures of fishing fleets actually keep bycatch mortality within the specified limits. This is documented to be possible (e.g. Grahan et al. 2007, Løkkeborg 2010), but cannot be assumed to be occurring just because a measure has been adopted, or even adopted and implemented. The effectiveness of the management measures, and the policies on which they are based, must be evaluated with information from the fisheries. Hence we return to the near absence of actual assessments of biodiversity issues in the documents we were able to find on the RFMO/A websites.

Several possible areas of constructive activities for CBD emerge from these final considerations. CBD has expertise and networks that can help RFMO/As in evaluating the sustainability of outcomes of the sets of policies and management measures that they have in place. It also can contribute expertise and support to developing RFMO/As, to accelerate inclusion of appropriate policies and management measures in their operating procedures, as these are finalized in the establishment of the RFMO/As. However, it does not appear from our review to be necessary for the biodiversity community to set up separate policy frameworks for the consideration of biodiversity in fisheries management. There seems already to be adequate receptivity to biodiversity considerations in the Conventions, policies and management measures of RFMOs today. What is needed is to ensure the existing policies and management measures are working as intended, and the outcomes are sustainable. This is an important and collaborative role for CBD with many potential partners in fisheries.

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*Table 1.* Template filled for individual stock assessments. A separate template was completed for each stock assessment of each RFMO, except when a number of stocks of the same species were assessed with very similar approaches. Each row entry was either a Y/N or a reference and extracted quotation from the assessment.

### **BIODIVERSITY EFFECTS ON STOCK DYNAMICS**

Is there a **RECRUITMENT** estimate? (yes/no)

Does it take **PREDATION** into account? (yes/no)

If yes, is it done through multispecies model, specific recruitment model, other?

Does it take **FOOD SUPPLY** into account? (yes/no)

If yes, is it done through multispecies model, specific recruitment model, other?

Does it take **PHYSICAL ENVIRONMENT** into account? (yes/no)

If yes, is it done through physical-biological model, specific recruitment model, other?

Is there an estimate of **NATURAL MORTALITY** of post-recruits? (yes/no)

Does it take **PREDATION** into account (yes/no)

If yes, is it done through multispecies model, specific survivorship model, other?

Does it take **FOOD SUPPLY** into account? (yes/no)

If yes, is it done through multispecies model, specific survivorship model, other?

Does it take **PHYSICAL ENVIRONMENT** into account? (yes/no)

If yes, is it done through physical-biological model, species survivorship model, other?

Is there an estimate of **GROWTH RATE** of post-recruits? (yes/no)

Does it take **FOOD SUPPLY** into account? (yes/no)

If yes, is it done through multispecies model, specific growth model, other?

Does it take **PHYSICAL ENVIRONMENT** into account? (yes/no)

If yes, is it done through physical-biological model, species growth model, other?

Is there an explicit **EXPLOITATION RATE OR STRATEGY** for the stock (yes/no/not available)

If yes, is it a harvest control rule based on reference points, a target exploitation rate, or other (specify if possible)

Does the control rule, reference point, or exploitation rate take explicit account of needs of dependent predators? (yes/no)

If yes, how?

### **EFFECTS OF THE FISHERY ON BIODIVERSITY**

Is **BYCATCH** of other species in the fishery mentioned in the advice? (yes/no)



If yes, include extract of text

Is bycatch of other species in the fishery mentioned in the technical document? (yes/no)

If yes, include extract of text

Is bycatch of other species in the fishery mentioned in a separate document or overview of the set of assessments for this area and jurisdiction? (yes/no)

If yes, include title and weblink to document overview and fill out **ANNEX 2** for overview

Is **DISCARDING** of target species in the fishery mentioned in the advice? (yes/no)

If yes, include extract of text

Is discarding of target species in the fishery mentioned in the technical document? (yes/no)

If yes, include extract of text

Is discarding of target species in the fishery mentioned in a separate document or overview of the set of assessments for this area and jurisdiction? (yes/no)

If yes, include title and weblink to document overview and fill out **ANNEX 2** for overview

Are **HABITAT IMPACTS** of the fishery mentioned in the advice? (yes/no)

If yes, include extract of text

Are habitat impacts of the fishery mentioned in the technical document? (yes/no)

If yes, include extract of text

Are habitat impacts of the fishery mentioned in a separate document or overview of the set of assessments for this area and jurisdiction? (yes/no)

If yes, include title and weblink to document overview and fill out **ANNEX 2** for overview

Other considerations? Give brief summary and extracted text

*Table 2.* Template filled out for thematic documents on RFMO websites. Each row entry includes a Yes/No, the weblink or citation to the assessment, year and author(s) of the document and extracted quotations.

## **Bycatch (or Habitat)**

### **How is it handled in advice?**

Solely narrative treatment? (yes/no)

If yes, include extract(s)

Quantitative estimate from directed computations / monitoring? (yes/no)

If yes, include extract(s)

Results of multispecies / ecosystem modelling? (yes/no)

If yes, include extract(s)

Is it linked to particular stocks / advisory reports? (yes/no)

If yes, include reference

### **How is it handled in technical report?**

Solely narrative treatment? (yes/no)

If yes, include extract(s)

Quantitative estimate from directed computations / monitoring? (yes/no)

If yes, include extract(s)

Results of multispecies / ecosystem modelling? (yes/no)

If yes, include extract(s)

Is it linked to particular stocks / advisory reports? (yes/no)

If yes, include reference

Table 3. Summary of the information on biodiversity considerations that was found in the *individual stock assessments* conducted by the expert groups of RFMOs with competence for bottom fisheries, or by their external advisory bodies. For Recruitment, Natural Mortality and Growth, the column heading are P = Predator impacts considered explicitly, F = Food supply considered explicitly, E = physical Environmental impacts considered explicitly. Y = Value used for the biological parameter, and calculation included the consideration in the column; N = Value used for the biological parameter, but calculation did explicitly include the consideration in the column; - = no value for that biological parameter was found in the analytical assessment. For Harvest Rate, Bycatch, and Habitat Impacts, the Y/N column refers to whether or not the factors was referenced explicitly in the assessment report, and the Form column describes briefly how it was considered in cases when it was mentioned explicitly in the assessment.

RFMO Stock	Recruitment			Natural Mortality			Growth		Harvest Rate		Bycatch		Habitat Impacts	
	P	F	E	P	F	E	F	E	Y / N	Form	Y/ N	Form	Y/ N	Form
<b>CCAMLR</b>														
Icefish	-	-	-	N	N	N	N	N	Y	Target F from average productivity	Y	List of species taken	Y	Area restrictions
Toothfish	-	-	-	N	N	N	N	N	Y	Target F from average productivity	Y	List with caps for some species	Y	Area restrictions
Krill	-	-	-	-	-	-	-	-	Y	Based on multispecies models considering predator needs	Y	Reporting, caps, and spatial measures	N	
<b>GFMC</b>														
Diplodus linnularis	N	N	N	N	N	N	N	N	Y	Target F from average productivity	Y	List of species taken	N	
Mullus sp.	-	-	-	-	-	-	-	-	N		Y	List of species taken	N	
Corrallium rubrum	-	-	-	-	-	-	-	-	Y	Single species model	Y	List of species taken	Y	Brief narrative of possible effects
Solea	N	N	Y	-	-	-	-	-	Y	Single species model	Y	List of species taken	N	
Pagellus	-	-	-	-	-	-	-	-	Y	Single species model with Reference Point	Y	List of species taken	N	
Nephrops norvegicus	-	-	-	-	-	-	-	-	Y	Single species model with Reference Point	Y	List of species taken	N	
<b>NAFO</b>														
Shrimp 3LNO	N	N	N	Y	N	N	N	N	Y	Single species model with Reference Point including	Y	List of species taken with cap for bycatch as	N	

RFMO Stock	Recruitment			Natural Mortality			Growth		Harvest Rate		Bycatch		Habitat Impacts			
	P	F	E	P	F	E	F	E	Y / N	Form	Y/ N	Form	Y/ N	Form		
												allowance for average predator consumption		percent of total catch		
Shrimp 3M	N	N	N	N	N	N	N	N	Y		Y	Single species model with Reference Point including allowance for average predator consumption		List of species taken with cap for bycatch as percent of total catch	N	
Greenland Halibut	N	N	N	N	N	N	N	N	Y		Y	Single species model with Reference Point partly based on Management Strategy Evaluation		List of species taken with cap for bycatch as percent of total catch	N	
Shortfin squid	-	-	-	N	N	N	N	N	Y		N	Single species model with Reference Point partly based on Management Strategy Evaluation			N	
<b>NEAFC</b>																
Herring	N	N	N	Y	N	N	Y	Y	Y		Y	Multispecies model including predation		List of species taken	N	
Redfish	N	N	N	N	N	N	N	N	Y		Y	Target average exploitation rate		List of species taken	Y *	Noted to be fishery using pelagic gear not contacting seafloor
Mackerel	-	-	-	-	-	-	-	-	Y		Y	Single species production model		List of species taken	Y	Reference as managed to FAO Guidelines
Haddock	N	N	N	N	N	N	N	N	Y		Y	Single species population model		Reported to be “clean” fishery with little bycatch	N	
Blue Whiting	N	N	N	N	N	N	-	-	Y		Y	Single species population model		Reported to be “clean” fishery with little bycatch	Y	Reported to be exploited with gears unlikely to impact seafloor
<b>SEAFO</b>																
Red crab	-	-	-	N	N	N	-	-	Y		Y	Single species production model		List and rules about proportion of catch	Y	Narrative of potential concerns and possible

RFMO Stock	Recruitment			Natural Mortality			Growth		Harvest Rate		Bycatch		Habitat Impacts	
	P	F	E	P	F	E	F	E	Y / N	Form	Y / N	Form	Y / N	Form
														options
Alfonsino	-	-	-	-	-	-	-	-	Y	Exploratory fishery rules to stay “precautionary”	Y	List and rules about proportion of catch	N	
Orange Roughy	-	-	-	-	-	-	-	-	Y	Exploratory fishery rules to stay “precautionary”	Y	List and rules about proportion of catch	N	
Toothfish	-	-	-	N	N	N	-	-	Y	Single species population model	Y	List and rules about proportion of catch	Y	Narrative of potential concerns and possible options
<b>SIOFA</b>														
RFMO In development	No stock assessments yet posted on website. See Table 4 for policy issues and objectives													
<b>SPRFMO</b>														
Chub Mackerel	N	N	N	N	N	N	N	N	N		Y	Narrative on issues and options	Y	Narrative on issues and options
Jack Mackerel	N	N	N	N	N	N	N	N	Y	Single species population model	N		N	

*Table 4.* Reports and extracts from specific working papers or expert group reports of non-tuna RFMOs, where issues associated with bycatches or habitat impacts of fisheries are considered. Although policies and regulations guiding fishing practices are reported in Table 5, these entries show how expert advisory groups are recommending that bycatch and habitat issues be dealt with in policies and regulations.

Name of RFMO/A	Bycatch		Habitat impacts	
	Treatment	Extract	Treatment	Extract
APFIC	General Policy	Reported on status of data and methods for assessing stocks harvest in the area, with a view to improving practice in these multispecies fisheries	None found	
	Food webs	Considered “the increasing demand for trash/low value fish as feed for aquaculture (through both direct feeding and through conversion into fish meal/oil), the sustainability of harvesting in an attempt to meet this demand, the impact on the ecosystems”		
CCAMLR	Stock Specific Quantitative Estimates	Data collection methods and procedures for data analysis aimed at yielding standardised information for comparisons across species and sites		
	Analyses of impacts relative to standards from multispecies models	Trends in CEMP parameters and the occurrence of anomalous years in the monitored parameters are identified by species and site		
FCWC	Plans in development	Early stages of RFMA. Capacity for surveillance, including of bycatches as priority		

Name of RFMO/A	Bycatch		Habitat impacts	
	Treatment	Extract	Treatment	Extract
GFMC	Directed study and Review papers	Had sponsored workshop to Determine the Current Status of Studies on the Effect of the Trawl 40 mm Square Mesh and 50 mm Diamond Mesh in Reducing By-Catches and Discard and Increasing the Selectivity of the Trawl Related to the Mediterranean Fisheries. Also had review of “By-catch and interactions between fisheries and species of conservation concern”, with proposals for action where necessary adopted by GFMC for action by member States		Hosted review of “impact of all fishing gears used in the Mediterranean and proposals to minimize it”. Proposals adopted by GFMC for action by member States
NAFO	Directed study	Bycatches and discarding in Greenland Halibut fisheries being quantified to assess scale of the issue	Science Working Group	Special Working Group of Scientific Council created to evaluate areas against FAO – VME criteria, and recommend areas which meet the criteria
		Bycatches in Shrimp fishery being monitored by observers and reports reviewed	Science – Management Working Group	Special Working Group of scientists and managers created to take information from Science Working Group, consider appropriate management actions, and make recommendations to NAFO Council
		Study completed of bycatch in pelagic redfish fishery and concluded bycatches low		

Name of RFMO/A	Bycatch		Habitat impacts	
	Treatment	Extract	Treatment	Extract
NEAFC	Directed study	Directed study of salmon post-smolt bycatches. Maximum sustainable mortality from ICES salmon assessments	Directed study	Habitat features of VMEs, including deep-water corals being mapped and quantified in key areas, with areas meeting VME criteria closed to bottom fishing. Assessments by ICES WGDEC
OLDE-PESCA	Recommendation for future work	More complete information needed about bycatches of sharks and other threats to sharks in the same area	Generic narrative	Discussion of importance of protecting habitat quality and productivity, and potential threats from fishery, but no specific proposed actions
SEAFO			Pre-emptive policy action	See Table 5 for details
SIOFA	Narrative	General call for monitoring if fisheries expand area		
SPRFMO	Annual reporting	Tracking of all bycatches and reporting in specified format mandatory. Discussed as issues appear	Mandatory assessments of habitat impacts	“Guidelines for report writing on the impacts of fishery on habitat, in terms of important characterizing, structural, endemic or functional species, habitat damage and ecosystems impacts.”
SWIOFC	Management plans for major bycatch as well as target species	General structure of management plans for bycatch species modelled on management plan for target species. Working towards assessments of major bycatch species, and evaluation of bycatch mitigation devices		



Name of RFMO/A	Bycatch		Habitat impacts	
	Treatment	Extract	Treatment	Extract
WECAFC	Scientific Advisory Committee call for future action (2007)	“Future reports on status of stocks should include reporting on trends and conditions of critical ecosystem habitats and on specific issues such as fishery policy and rights-based approaches to managing small-scale fisheries.”	Scientific Advisory Committee call for future action (2007)	“Fisheries departments should attempt to ensure that fisheries objectives are taken into account, as appropriate, in the establishment of marine protected areas (MPAs) with goals other than fisheries management. Also recommended that MPAs should be established within the broader framework of the EAF and integrated coastal zone management/integrated coastal area management (ICZM/ICAM).”
	Recommendations for future work	Need to improve management of fisheries that caught sharks, including improving knowledge of the status of the stocks	Recommendations for future work	Damage to near-shore habitats such as mangroves and reefs would have had a negative impact on a number of shark species that required such habitats for early life stages. Future reports on status of stocks should include reporting on trends and conditions of critical ecosystem habitats

*Table 5.* Consideration of biodiversity issues in guiding Policies and adopted Management Strategies of RFMOs/As. Entries in this table are partially guided by responses of RFMO Secretariats to direct email inquiries. In cases when replies from Secretariats were not received, relevant policies and regulations may have been missed.

RFMO/A	Biodiversity issue	Guidance on consideration in harvesting
APFIC	General	Overall policy commitment to “promote the full and proper utilization of living aquatic resources by the development and management of fishing and culture operations [...] in conformity with the objectives of its members.”
	Trophic relationships and impacts of fisheries on lower trophic levels	As far back as 2005, an APFIC report reviewed “recent information on the status and trends of low value/trash fish production and uses in the Asian region. It also highlights many emerging issues to identify actions to reverse the unfavourable trends and promote sustainable development of both fisheries and aquaculture and to provide input for a more thorough policy analysis. These issues include the increasing demand for trash/low value fish as feed for aquaculture (through both direct feeding and through conversion into fish meal/oil), the sustainability of harvesting in an attempt to meet this demand, the impact on the ecosystems, the incentives for lower post-harvest handling, growth overfishing of small juveniles of commercially important species, discarding at sea, and social concerns of using trash/low value fish to feed livestock rather than as a source of animal protein for poor people.
CCAMLR	Trophic relationships	The assessment model has an explicit escapement of 75% $B_0$ to account for the needs of krill predators and a spatial allocation of the precautionary catch limit to avoid local concentration of catches that might cause localised negative ecosystem effects. These are required under explicit Conservation Measures included 51-01 to 51-04.
	Bycatch	All vessels required to use a marine mammal excluder on nets. There is also a requirement for scientific observers to cover at least 50% of the time a vessel fishes in the Convention Area. These Observers collect data on fish bycatch (including larval fish) as well as conducting regular observation/recording of any seabird incidental mortality including warp strikes. Conservation measure 25(2) includes several provisions for requiring longline vessels to use variety of gear measures to deter seabird bycatches, and have usually full observed coverage to document level of mortality.
	Habitat	Conservation measure 22-06 requires that “All bottom fishing activities shall be subject to assessment by the Scientific Committee, based on the best available scientific information, to determine if such activities, taking account of the history of bottom fishing in the areas proposed, would contribute to having significant adverse impacts on VMEs, and to ensure that if it is determined that these activities

RFMO/A	Biodiversity issue	Guidance on consideration in harvesting
		<p>would make such contributions, that they are managed to prevent such impacts or are not authorised to proceed.” This is followed by guidance on the assessments to ensure they cover all the issues specified in the FAO Deep Sea Fishery Guidelines. It also includes a requirement for Encounter Protocols and specifies what they must include.</p> <p>In addition a Scientific Working Group has been active in evaluating areas against the FAO Criteria for VMES, with the intent that these areas would be closed to fishing with all bottom-contacting gears unless it could be shown that such fishing could occur without serious adverse impacts.</p>
NAFO	Species relationships	<p>All current precautionary reference points for target stocks are from single-species models, but Science Working Groups currently exploring multispecies models and Management Strategy Evaluations, with the intent to revise reference points and control rules to take account of environmental variability, including predator-prey relations.</p> <p>Management Council has asked science advisors to look at specific multi-species relationships, including shrimp-cod-redfish.</p> <p>The official cod recovery strategy includes the provision that “Considering the importance of capelin as a food source, consistent with the ecosystem approach, the moratorium on 3NO capelin will continue until at least Dec 31, 2012”.</p>
	Bycatches	<p>The NAFO Management Measures Article 12 require that:</p> <p>a) Vessels of a Contracting Party shall limit their by-catch to a maximum of 2500 kg or 10%, whichever is the greater, for each species listed in <u>Annex I</u> for which no quota has been allocated in that Division to that Contracting Party. However, for cod in Division 3M and redfish in Divisions 3LN vessels of a Contracting Party shall limit their by-catch to a maximum of 1250 kg or 5%, whichever is greater.</p> <p>b) In cases where a ban on fishing is in force or an “Others” quota has been fully utilized, the by-catch of the species concerned may not exceed 1250 kg or 5%, whichever is the greater.</p> <p>Article 13 has a number of gear requirements to reduce bycatch, including a requirement to use a sorting grid on all vessels fishing for shrimp.</p> <p>Article 18 includes provisions to deter shark finning in any directed shark fisheries, and to promote immediate life release of sharks taken in any fisheries not directing at sharks.</p>

RFMO/A	Biodiversity issue	Guidance on consideration in harvesting
	Habitats	<p>In Article 15 of the NAFO CEM, seamounts are close to bottom fishing for at least five years.</p> <p>In article 16, 12 areas are delineated, and each closed to all bottom fishing due to presence of corals and sponges.</p>
NEAFC	Generic	<p>Article 4.2 of the Convention requires that decision making should</p> <ul style="list-style-type: none"> <li>b) apply the precautionary approach;</li> <li>c) take due account of the impact of fisheries on other species and marine ecosystems, and in doing so adopt, where necessary, conservation and management measures that address the need to minimise harmful impacts on living marine resources and marine ecosystems; and</li> <li>d) take due account of the need to conserve marine biological diversity.</li> </ul>
	Bycatch	<p>General requirement to monitor and report bycatches. In 2011 additional management measures were implemented to reduce the bycatches of deep-water sharks. As new measures, their effectiveness will have to be evaluated in the future.</p>
	Habitats	<p>NEAFC has closed three large areas and two seamounts to all fishing, based on their meeting FAO criteria for VME. In, 2011 NEAFC and OSPAR met jointly to apply both the FAO-VME and CBD-EBSA criteria within their regulatory areas, and agreed to pursue appropriate conservation actions in the jointly identified areas using tools within their respective competences.</p> <p>A new Annex 3 to Article 5 of the Convention was adopted in 2011, requiring assessments of new areas where bottom fishing will occur, consistent with the full guidance in the FAO Deep Sea Fishery Guidelines, and encounter protocols to be developed and implemented.</p>
SEAFO	Seafloor habitat	<p>Scientific Sub-Committee (2007) agreed that exploratory fishing surveys in unexplored areas should not be permitted since they may cause irreversible damage to the seamounts. In alternative, the Sub-Committee agreed that in these areas a preliminary evaluation of the habitat vulnerability to exploitation, as well as mapping, must be carried out using tools with minor impact effect over the bottom (e.g. multibeam sonars). At already exploited areas the Sub-Committee agreed that plans for exploratory fisheries should be reported to the SEAFO Secretariat and analysed by the Scientific Committee that would evaluate the adequacy of the proposal.</p>
SPRFMO	SPRFMO is a developing RFMO and its programs are also in development	<p>Article 2: “[...] to safeguard the marine ecosystems in which these resources occur”;</p> <p>Article 3.2.a.ii: “fishing shall be commensurate with the sustainable use of fishery resources taking into account the impacts on non-target and associated or dependent species</p>

RFMO/A	Biodiversity issue	Guidance on consideration in harvesting
	<p>There are a number of provisions in the Convention which address ecosystem considerations</p>	<p>and the general obligation to protect and preserve the marine environment”;</p> <p>3.2.a.iv: “full and accurate data on fishing, including information relating to impacts on the marine ecosystems in which fishery resources occur, shall be collected, verified, reported and shared in a timely and appropriate manner”;</p> <p>3.2.a.vii: “marine ecosystems shall be protected, in particular those ecosystems which have long recovery times following disturbance”;</p> <p>3.2.b: “apply the precautionary approach and an ecosystem approach in accordance with paragraph 2”;</p> <p>2.b: “An ecosystem approach shall be applied widely to the conservation and management of fishery resources through an integrated approach under which decisions in relation to the management of fishery resources are considered in the context of the functioning of the wider marine ecosystems in which they occur to ensure the long-term conservation and sustainable use of those resources and in so doing, safeguard those marine ecosystems.”</p> <p>20.1.c: “maintain or restore populations of non-target and associated or dependent species to above levels at which their reproduction may become seriously threatened;” and d.: protect the habitats and marine ecosystems in which fishery resources and non-target and associated or dependent species occur from the impacts of fishing, including measures to prevent significant adverse impacts on vulnerable marine ecosystems and precautionary measures where it cannot adequately be determined whether vulnerable marine ecosystems are present or whether fishing would cause significant adverse impacts on vulnerable marine ecosystems”;</p> <p>20.3. [in setting allowable catches and effort consider]:</p> <p>“e. catch of non-target and associated or dependent species and impacts on the marine ecosystems in which the fishery resource occurs;</p> <p>f. relevant ecological and biological factors limiting the nature of fishery resources that may be harvested;</p> <p>g. relevant environmental factors, including trophic interactions which may have an effect upon the fishery resource and non-target and associated or dependent species;”</p> <p>22.1: “A fishery that has not been subject to fishing or has not been subject to fishing with a particular gear type or technique for ten years or more shall be opened as a fishery or opened to fishing with such gear type or technique only when the Commission has adopted cautious preliminary conservation and management measures in respect of that fishery, and, as appropriate, non-target and associated or dependent species, and appropriate measures to protect the</p>

RFMO/A	Biodiversity issue	Guidance on consideration in harvesting
		marine ecosystem in which that fishery occurs from adverse impacts of fishing activities.”
WECAFC	Generic	Overall commitment to precautionary approach and ecosystem approach
	Mixed nature of catches	Tracked and included in individual stock trends
	Trophic relationships	The potential implications of predator-prey interaction involving <i>P. argus</i> were discussed in relation to likely decreases in the abundance of some predators such as groupers and sharks and rays.
	Bycatches and habitat	No specific provisions found. Commitment to Ecosystem Approach and Sustainability, and call for further research on the issues.

*Annex I*

**LIST OF ACRONYMS OF RFMOS/RFMAS REFERENCED IN THIS OVERVIEW.**

APFIC: Asia-Pacific Fishery Commission

CCAMLR: Convention on the Conservation of Antarctic Marine Living Resources

FCWC: Fisheries Committee for the West Central Gulf of Guinea

GFCM: General Fisheries Commission for the Mediterranean

NAFO: Northwest Atlantic Fisheries Organization

NEAFC: North-East Atlantic Fisheries Commission

OLDEPESCA: Organizacion latinoamericana de desarrollo pesquero

SEAFO: South-East Atlantic Fisheries Organization

SIOFA: South Indian Ocean Fisheries Agreement

SPRFMO: South Pacific Regional Fisheries Management Organization

SWIOFC: Southwest Indian Ocean Fisheries Commission

WECAFC: Western Central Atlantic Fishery Commission

*Annex II*

**URLS FOR THE PRIMARY WEBSITES AND DOCUMENTS USED AS SOURCES OF  
INFORMATION (COMPILED FOR TABLES 3-5)**

APFIC

- <http://www.apfic.org/uploads/2009-07.pdf>
- <http://www.apfic.org/modules/wfdownloads/singlefile.php?cid=39&lid=166>
- <http://www.apfic.org/modules/wfdownloads/singlefile.php?cid=39&lid=33>
- <http://www.apfic.org/modules/wfdownloads/singlefile.php?cid=39&lid=34>
- <http://www.apfic.org/modules/wfdownloads/visit.php?cid=35&lid=263>
- [www.fao.org/docrep/012/i1663e/i1663e00.pdf](http://www.fao.org/docrep/012/i1663e/i1663e00.pdf)

CCAMLR

- [http://www.ccamlr.org/pu/e/e\\_pubs/fr/10/appS.pdf](http://www.ccamlr.org/pu/e/e_pubs/fr/10/appS.pdf)
- [http://www.ccamlr.org/pu/e/e\\_pubs/fr/10/appT.pdf](http://www.ccamlr.org/pu/e/e_pubs/fr/10/appT.pdf)
- [http://www.ccamlr.org/pu/e/e\\_pubs/fr/10/appE.pdf](http://www.ccamlr.org/pu/e/e_pubs/fr/10/appE.pdf)
- [http://www.ccamlr.org/pu/e/e\\_pubs/fr/10/appG.pdf](http://www.ccamlr.org/pu/e/e_pubs/fr/10/appG.pdf)
- <http://www.ccamlr.org/Pu/e/sc/cemp/species.htm>
- [http://www.ccamlr.org/pu/e/e\\_pubs/fr/10/appJ.pdf](http://www.ccamlr.org/pu/e/e_pubs/fr/10/appJ.pdf)
- [http://www.asoc.org/storage/documents/Meetings/CCAMLR/XXIX/ASOC\\_krill\\_fishery\\_uncertainty\\_reduction.pdf](http://www.asoc.org/storage/documents/Meetings/CCAMLR/XXIX/ASOC_krill_fishery_uncertainty_reduction.pdf)
- <http://www.ccamlr.org/pu/e/sc/kri-surv-intro.htm>
- [http://www.ccamlr.org/pu/e/e\\_pubs/cm/drt.htm](http://www.ccamlr.org/pu/e/e_pubs/cm/drt.htm)
- [http://www.ccamlr.org/pu/e/e\\_pubs/sr/00/all.pdf](http://www.ccamlr.org/pu/e/e_pubs/sr/00/all.pdf)
- [http://www.ccamlr.org/pu/e/e\\_pubs/std-meth04.pdf](http://www.ccamlr.org/pu/e/e_pubs/std-meth04.pdf)
- <http://www.ccamlr.org/Pu/e/sc/cemp/intro.htm>
- [http://www.ccamlr.org/pu/e/e\\_pubs/fr/10/appE.pdf](http://www.ccamlr.org/pu/e/e_pubs/fr/10/appE.pdf)

FCWC

- [http://www.fcwc-fish.org/images/documents/project%20terminal%20report%20tcp\\_raf\\_3215\\_dedi\\_aug%202011.pdf](http://www.fcwc-fish.org/images/documents/project%20terminal%20report%20tcp_raf_3215_dedi_aug%202011.pdf)

GFCM

- [http://151.1.154.86/meetingdocs/2009/SCSA\\_WG\\_Demersal\\_Species\\_Ancona/StockAssessmentForms/GFCM\\_SCSA\\_StockAssessmentForms\\_\(Sept\\_2009\\_gsa14\)\\_not\\_reviewed\\_in\\_meeting.xls](http://151.1.154.86/meetingdocs/2009/SCSA_WG_Demersal_Species_Ancona/StockAssessmentForms/GFCM_SCSA_StockAssessmentForms_(Sept_2009_gsa14)_not_reviewed_in_meeting.xls)
- [http://151.1.154.86/GfcmWebSite/SAC/13/GFCM\\_SAC13\\_2011\\_Inf.19-e.pdf](http://151.1.154.86/GfcmWebSite/SAC/13/GFCM_SAC13_2011_Inf.19-e.pdf)
- [http://151.1.154.86/GfcmWebSite/SAC/13/GFCM\\_SAC13\\_2011\\_Inf.20-e.pdf](http://151.1.154.86/GfcmWebSite/SAC/13/GFCM_SAC13_2011_Inf.20-e.pdf)
- <http://151.1.154.86/GfcmWebSite/e-Compendium/info.html>
- [http://151.1.154.86/GfcmWebSite/CoC/5/COC\\_V\\_2011\\_Inf.5-e.pdf](http://151.1.154.86/GfcmWebSite/CoC/5/COC_V_2011_Inf.5-e.pdf)
- <http://www.fao.org/docrep/011/i0328f/i0328f00.htm>
- <ftp://ftp.fao.org/docrep/fao/meeting/014/aj297e.pdf>
- <ftp://ftp.fao.org/docrep/fao/meeting/014/aj309e.pdf>
- <http://151.1.154.86/GfcmWebSite/MeetingsReportsRepository.html>
- <http://www.gfcm.org/gfcm/topic/16100/en>



## NAFO

- <http://archive.nafo.int/open/rb/2010/SCRep-2010.pdf>
- <http://archive.nafo.int/open/sc/2010/scr10-045.pdf>
- <http://archive.nafo.int/open/sc/2011/scr11-008.pdf>
- <http://www.nafo.int/publications/meetproc/2011/sc/scs11-16.pdf>
- <http://archive.nafo.int/open/sc/2010/scr10-049.pdf>

## NEAFC

- <http://www.ices.dk/committe/acom/comwork/report/2011/2011/Her-2532-Ex-Go.pdf>
- <http://www.ices.dk/committe/acom/comwork/report/asp/advice.asp?titlesearch=redfish&Region=-1&Species=-1&Period=-1&submit1=Submit+Query&mode=2>
- <http://www.ices.dk/committe/acom/comwork/report/2011/2011/smn-arct.pdf>
- <http://www.ices.dk/committe/acom/comwork/report/asp/advice.asp?titlesearch=&Region=-1&Species=47&Period=-1&submit1=Submit+Query&mode=2>
- <http://www.neafc.org/system/files/062010mackerel-postalvote.pdf>
- <http://www.ices.dk/committe/acom/comwork/report/2008/Special%20Requests/EC%20evaluation%20of%20mackerel%20management%20plan.pdf>
- <http://www.ices.dk/committe/acom/comwork/report/2010/2010/mac-nea.pdf>
- [http://firms.fao.org/fi/common/format/popUpImage.jsp?xp\\_imageid=17166](http://firms.fao.org/fi/common/format/popUpImage.jsp?xp_imageid=17166)
- <http://firms.fao.org/firms/resource/10401/en#HabitatBio>
- <http://firms.fao.org/firms/fishery/481/en>
- <http://www.dfo-mpo.gc.ca/fgc-cgp/documents/meltzer/NEAFCfinal.pdf>
- <http://firms.fao.org/firms/fishery/484/en>
- <http://www.ices.dk/reports/SSGSUE/2009/SIMWG09.pdf>
- [http://www.neafc.org/system/files/rec2\\_bluewhiting2009.pdf](http://www.neafc.org/system/files/rec2_bluewhiting2009.pdf)
- [http://www.neafc.org/system/files/fisheries\\_status\\_report\\_1998\\_2007.pdf](http://www.neafc.org/system/files/fisheries_status_report_1998_2007.pdf)
- [http://archive.neafc.org/reports/annual-meeting/am\\_2004/docs/2004-55\\_salmon\\_by-catch\\_rev1.pdf](http://archive.neafc.org/reports/annual-meeting/am_2004/docs/2004-55_salmon_by-catch_rev1.pdf)
- <http://www.ices.dk/committe/acom/comwork/report/2011/Special%20Requests/NEAFC-EC%20Vulnerable%20Marine%20Habitats.pdf>
- <http://www.ices.dk/committe/acom/comwork/report/2008/Special%20Requests/NEAFC%20request%20regarding%20vulnerable%20habitats%20and%20deep-water%20species.pdf>
- [http://www.ices.dk/reports/ACOM/2008/WGDEC/WGDEC\\_2008.pdf](http://www.ices.dk/reports/ACOM/2008/WGDEC/WGDEC_2008.pdf)

## OLDEPESCA

- [http://www.oldepesca.com/userfiles/file/INFORME\\_REGIONAL\\_TIBURONES\\_AGOS\\_TO\\_2011.pdf](http://www.oldepesca.com/userfiles/file/INFORME_REGIONAL_TIBURONES_AGOS_TO_2011.pdf)
- [http://www.oldepesca.com/userfiles/file/INDNR\(1\).pdf](http://www.oldepesca.com/userfiles/file/INDNR(1).pdf)

## SEAFO

- <http://www.seafo.org/PerformanceReview/Performance%20Review%20English%20Report-2010.pdf>
- <http://www.seafo.org/ScientificCommittee/Reports/SC%20Report%202006%20Eng.pdf>
- <http://firms.fao.org/firms/resource/13377/en>
- <http://www.seafo.org/ScientificCommittee/Reports/SC%20Report%202006%20Eng.pdf>
- <http://firms.fao.org/firms/resource/13377/en>

- <http://www.fao.org/fishery/species/2249/en>
- <http://www.oecd.org/dataoecd/28/39/31652324.pdf>
- <http://www.seafo.org/ScientificCommittee/Reports/scientific%20report%20-%202010.pdf>
- <http://www.iucnredlist.org/apps/redlist/details/161619/0>
- <http://www.seafo.org/ScientificCommittee/Reports/SC%20Report%202007.pdf>

#### SIOFA

- [ftp://ftp.fisheries.ubc.ca/FCWP/FCWP\\_2009-12\\_CullisSuzukiPauly.pdf](ftp://ftp.fisheries.ubc.ca/FCWP/FCWP_2009-12_CullisSuzukiPauly.pdf)
- <http://ec.europa.eu/world/agreements/prepareCreateTreatiesWorkspace/treatiesGeneralData.do?step=0&redirect=true&treatyId=6661>
- <http://www.daff.gov.au/fisheries/international/siofa>
- <http://www.fao.org/newsroom/en/news/2006/1000360/index.html>
- <http://www.fao.org/docrep/009/a0653e/a0653e06.htm#bm06.3>

#### SPRFMO

- <http://www.southpacificrfmo.org/assets/10th-SWG-and-9th-DIWG-meetings-Vanuatu/SWG-10/Annex-SWG-03-Jack-Mackerel-SubGroup-Report-SWG10.pdf>
- <http://www.southpacificrfmo.org/assets/Species-Profiles-Final/chub-mackerel-species-profile-040507-Science-IV.pdf>
- <http://www.southpacificrfmo.org/assets/8th-Meeting-November-2009-New-Zealand/SWG-VIII/GUIDELINES-FOR-ANNUAL-NATIONAL-REPORTS-TO-THE-SPRFMO-SCIENTIFIC-WORKING-GROUP.pdf>
- <http://www.southpacificrfmo.org/assets/Science%20II/FINAL%20Species%20profile%20template.pdf>
- <http://www.southpacificrfmo.org/assets/10th-SWG-and-9th-DIWG-meetings-Vanuatu/DIWG-09/9th-DIWG-Report-Vanuatu-adopted-23-Sep-20113pm.pdf>
- <http://www.southpacificrfmo.org/assets/10th-SWG-and-9th-DIWG-meetings-Vanuatu/SWG-10/Annex-SWG-04-ReportDWSG-10Meeting.pdf>
- <http://www.southpacificrfmo.org/assets/Science%20II/FINAL%20Habitat%20template.pdf>
- <http://www.southpacificrfmo.org/species-profiles/>
- <http://www.southpacificrfmo.org/assets/PrepCon-2/Meeting-Report/SPRFMO-PrepCon2-Data-Standards-Adopted-28-Jan-2011-Final-Plain-Version.pdf>

#### SWIOFC

- <http://www.fao.org/docrep/meeting/021/a1957e.pdf>
- <http://www.swiofp.net/publications/annual-reports/annual-status-report-recommendations-year-2>

#### WECAFC

- <http://www.fao.org/docrep/010/a1339t/a1339t00.htm>
- <ftp://ftp.fao.org/docrep/fao/011/i0877t/i0877t00.pdf>

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