PROGRESS OF TUNA REGIONAL FISHERIES MANAGEMENT ORGANIZATIONS IN APPLYING ECOSYSTEM-BASED FISHERIES MANAGEMENT

Maria José Juan-Jordá [1,2], Hilario Murua[1], Haritz Arrizabalaga[1], Nicholas K Dulvy[2] and Victor Restrepo[3]

[1]AZTI Tecnalia, Marine Research Division, Herrera Kaia, Portualdea z/g E-20110, Pasaia, Gipuzkoa, SPAIN
[2]Earth to Ocean Research Group, Department of Biological Sciences, Simon Fraser University, Burnaby, BC, V5A 1S6, CANADA
[3]International Seafood Sustainability Foundation, 805 15th Street NW, Ste 708, Washington DC 20005, UNITED STATES
Contact author: Maria José Juan-Jordá, AZTI Tecnalia, Marine Research Division, Herrera Kaia, Portualdea z/g E-20110, Pasaia, Gipuzkoa, SPAIN, tel: +34 671072900, email: mjuan@azti.es

Abstract

Highly migratory fish species such as tunas, billfishes and sharks and associated ecosystems sustain important function and services for human wellbeing. Over the last decades international instruments of fisheries governance have set the core principles and minimum standards for the management of highly migratory fishes. Concomitantly the expectations and roles of Regional Fisheries Management Organizations (RFMOs) have changed. In response, RFMOs have been slowly incorporating ecosystem principles when managing the tuna and those tuna-like species under their juristiction. Here, our main objective is to evaluate the progress of tuna RFMOs (tRFMO) in implementing Ecosystem-Based Fisheries Management (EBFM), and specifically we focus on reviewing the ecological component, rather than the socio-economic and governance components of an EBFM approach. We first develop a benchmark Conceptual Ecological Model for what could be considered a "role model" of EBFM implementation in a tRFMO. Second, we develop a criteria to evaluate progress in applying EBFM against this benchmark role model. In our evaluation, we assess progress of the following four ecological components: targeted species, bycatch species, ecosystem properties and trophic relationships, and habitats, and review 20 elements that ideally would make EBFM more operational. We find that many of the elements necessary for an operational EBFM are already present, yet they have been implemented in a patchy way, without a long term vision of what is to be achieved and a formalized plan implementation. In global terms, tuna RFMOs have made considerable progress within the ecological component of target species, moderate progress in the ecological component of bycatch, and little progress in the components of ecosystem properties and trophic relationships and habitats, although their overall performance varies across the ecological components. All the tuna RFMOs share the same challenges of coordinating effectively all ecosystem research activities and developing a formal mechanism to better integrate ecosystem considerations into management decisions and communicating them to the Commission. While we consider tuna RFMOs are at the early stages of implementing EBFM, we believe its implementation should be seen as a step-wise adaptive process which should be supported with the best ecosystem science and an operational plan as a tool to set the path to advance towards its full implementation. With this comparative review of progress we hope to create discussion across the tuna RFMOs to inform the much needed development of operational EBFM plans.

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1. Introduction

Our main objective is to evaluate the progress of tuna Regional Fisheries Management Organizations (tRFMOs) in implementing an Ecosystem-Based Fisheries Management (EBFM) approach to manage tuna and tuna-like species and associated ecosystems. We specifically focus on reviewing the progress on developing and implementing the ecological component (rather than the socio-economic and governance components) of an EBFM approach. To do so, we first develop and describe a benchmark Conceptual Ecological Model for what could be considered a "role model" of EBFM implementation. Second, we develop criteria to evaluate the progress in tRFMOs in applying the ecological component of EBFM against this benchmark "role model" RFMO. In our evaluation, we assess progress of the following four ecological components: target species, bycatch species, ecosystem properties and trophic relationships, and habitats, and review 20 elements that would make EBFM more operational. Ultimately, we aim to establish a baseline of progress in implementing the ecological component of EBFM. We seek to identify research activities and on-going examples of good practices that are currently facilitating the implementation of EBFM that ideally could be transferred and shared across RFMOs. At the same time, we also seek to identify what are the main gaps and elements that are hindering progress.

2. Methods

First, we describe the development of a benchmark Conceptual Ecological Model for what could be considered a "role model" tRFMO based on two frameworks that facilitate the implementation of EBFM. Second, we develop criteria to assess the progress of tRFMOs in implementing EBFM by comparison against this idealized "role model" tRFMO.

2.1 Development of a benchmark Conceptual Ecological Model of a "role model" tRFMO

We use the following two frameworks, the Driver-Pressure-State-Ecosystem services-Response (DPSER) framework, derived from the more familiar Driver-Pressure-State-Impact-Response (DPSIR) framework (Fig. 1a) and the Integrated Ecosystem Assessment (IEA) framework (Fig. 1b), to develop a benchmark "role model" tRFMO. These frameworks follow a series of well-designed steps and guidelines that are now being used in a variety of contexts and regions around the world, with varying data quality and governance structure, and proving that the implementation of EBFM can be feasible from a range of starting points and governance contexts (Tallis et al. 2010). We first describe briefly these two frameworks, and how we used them to build a benchmark "role model" tRFMO. Finally, we define what it would be considered a "role model" implementation of EBFM based on a review of the best practices in which different RFMOs are addressing EBFM and implementing the precautionary approach (Lodge et al. 2007) as well as the standards and the recommendations adopted in the three joint-tRFMO meetings, also known as the Kobe process (Anonymous 2007, 2009, 2011).

The DPSER conceptual framework (Fig. 1a) consists in a planning tool that allows identifying the full range of interaction between humans and the ecosystems including the main *drivers* and *pressures* influencing the *state* of the ecosystem, their ecological effects, and identify indicators best suited to monitor these effects and the linkages among them (Kelble et al. 2013). Then, based on the state of the ecosystem, it allows identifying *responses* or management strategies to ensure sustainable levels of the *ecosystem services* desired by society. This planning tool facilitates the identification of society preferences and uses of ecosystem services. It naturally places the ecosystem services, what we aim to protect as a society, as the main driver in the framework, and naturally links the other modules to the management response (Kelble et al. 2013).

The IEA conceptual framework (Fig. 1b) is also a planning tool that outlines an iterative process of seven steps for planning and implementing EBFM, including: scoping, defining indicators, setting thresholds, conducting risk analysis, management strategy evaluation, monitoring and evaluation (Levin et al. 2009, Tallis et al. 2010). *Scoping* and identifying the ecological goals and objectives is the first step in the IEA and in most cases it is also the most challenging. Reaching agreement on a common set of operational objectives may be a time consuming but necessary, political step. It can be difficult to reach consensus among the various stakeholders where multiple interests collide (Rogers and Greenaway 2005). The second step involves defining and choosing *indicators* associated with the operational objectives to characterize and track the status and trends in the state of the ecosystem towards achieving the pre-agreed objectives. The third step in the IEA framework consists in setting indicator

thresholds to evaluate progress towards the ecosystem management goals. The forth step consists of *risk analyses* to analyze and quantify the links among the *pressures* affecting the ecological state of the ecosystem, the indicators measuring the change in the ecosystem *state*, and the value of the *ecosystem services*. *Management strategy evaluation* is step number five, and it uses the main linkages to evaluate the impacts of several fishing strategies and regulation responses on the state of the ecosystem and derived range of ecosystem services. The last steps consist in close *monitoring* of the indicators and *evaluation* of strategies to ensure the loop of the IEA is closed (Fig. 1b). Most important, the IEA framework can be applied in a variety of contexts, which can vary widely in data availability and quality, governance structure and time frame for implementation. For detail guidelines of how to apply ecosystem-based management using the IEA framework see Tallis et al 2010.

To our knowledge the DPSER and IEA frameworks have not been used yet as a planning tool to develop an EBFM plan in any of the tRFMOs. Yet many of the current practices, research products and programs conducted by the tRFMOs in support of an EBFM approach could take the place of some of the steps formulated in the DPSER and IEA frameworks. Based on the DPSER and IEA frameworks, we built a Conceptual Ecological Model for what it could be considered a benchmark "role model" tRFMO (Fig. 1c, Table 1). Our benchmark "role model" tRFMO illustrates the main elements and linkages to take into account when designing an EBFM framework or plan to ensure the management and conservation of tuna and tuna-like species is done without compromising the inherent structure and functioning of marine ecosystems and their delivery of ecosystem services for humans. Ideally, the construction of a benchmark Conceptual Ecological Model to facilitate the implementation of EBFM should be done with the involvement of all the major stakeholders, since it facilitates the initial phases of the scoping process to pre-establish operational objectives. The involvement of stakeholders would also facilitate the identification of main drivers and pressures on the state of the ecosystem aimed to be managed and conserved, the selection of most appropriate indicators to track the ecosystem state towards achieving the pre-agreed objectives and thresholds to facilitate reporting and provoke management actions. Here instead, we provide an example of a potential benchmark Conceptual Ecological Model which could be used as a starting point towards the development of an operational EBFM plan.

Our benchmark "role model" tRFMO (Fig. 1c; Table 1) first illustrates the main *drivers* and associated *pressures*. Human population growth and a rising demand for fish protein places fishing as one of the most important pressures on marine ecosystems. Since the commencement of industrial fisheries in the 1950s, commercial fishing has been identified as the primary pressure affecting tuna and billfish populations and associated ecosystems (Collette et al. 2011). Fishing impacts the *state* of tuna and tuna-like species and associated ecosystems, which in turn affects the *ecosystem services* that benefit human society. Moreover, environmental variability as well as climate change is now arising as another potential major pressure on the state of tuna and tuna-like species and associated ecosystems (Bell et al. 2013). When implementing the ecological component of EBFM, there are multiple ecological elements and attributes of the ecosystem that could be measured and monitored to characterize the state of tunas and tuna-like species and ecosystems. For practical reasons, RFMOs have traditionally addressed and made operational the EBFM approach by managing and assessing the state of the following four ecological components: (1) target species (2) bycatch species, (3) ecosystem properties and trophic interactions and (4) habitats (Lodge et al. 2007). Therefore, in our benchmark Conceptual Ecological Model we divided the *state* of tuna and tuna-like species and associated ecosystems into these four ecological components. The last element of the Conceptual Ecological Model is the *response* which consists of a set of fisheries management responses to minimize the impacts of fishing and account for environmental variation and climate change to ensure the state of tuna and tuna-like species and associated ecosystems provide healthy ecosystem services (Fig. 1c). At the end, our benchmark Conceptual Ecological Model for a "role model" tRFMO (Fig. 1c, Table 1) illustrates the main elements and interactions to take into account to implement the ecological component of EBFM and provides a framework to evaluate the progress of tRFMOs. Moreover, by dividing the state into four practical ecological components, it allows an RFMO to identify and pre-establish operational objectives, associated indicators and thresholds for each component, and develop management responses and strategies for each of them.

Our "role model" tRFMO is based on the recommendations derived from joint meetings of the tRFMOs (the so-called Kobe I, II and III meetings) and the Chatham House review of best practices across almost 20 RFMOs, in addressing EBFM and implementing the precautionary approach (Anonymous 2007, Lodge et al. 2007, Anonymous 2009, 2011). The Kobe process and Chatman House review identified best practices and key elements that are stated in the UN Fish Stocks Agreement and the FAO Code of Conduct for Responsible Fishing regarding the implementation of EBFM. In Table 1, we define and describe what would be the main elements that ideally

constitute the basic texts and main structure of a tRFMO and the best practices within each of the ecological components (target species, bycatch species, ecosystem properties and trophic relationships, and habitats) of EBFM. For each ecological component, we show potential examples of pre-established operational objectives, potential associated indicators to track the state and trend of each ecological component, potential thresholds for those indicators, and potential management and conservation measures to ensure that those thresholds are not exceeded (Table S1). With this general idealized benchmark Conceptual Ecological Model for a "role model" tRFMO, we highlight how this planning tool could potentially be used as a framework to facilitate the implementation of EBFM in tRFMOs.

2.2 Development of criteria to evaluate progress of tRFMOs in applying EBFM against the idealized "role model" RFMO.

To identify and assess progress towards applying EBFM in each tRFMO, we developed criteria to organize all the information from the current actions and practices, to supporting ecosystem science being produced by each tRFMO (Table 2). In our criteria to evaluate progress, we first review the basic texts and main structure of the tRFMOs in support of EBFM. Within this section, we assess four elements:
(1) whether and where RFMOs refer to the principles of the precautionary approach and EBFM in accordance to relevant rules of fisheries governance,
(2) whether the RFMO has designated a lead entity or group to advance the progress and implementation of EBFM, advance progress on ecosystem science and provide advice on impacts of fishing on marine ecosystems,
(3) whether the RFMO has developed and adopted an operational EBFM plan,
(4) whether it exists a long-term data collection and monitoring program to support the implementation of EBFM.

Second, for each of the ecological components of target species, bycatch species, ecosystem properties and trophic relationships and habitats, we assess four elements:
(1) whether conceptual and/or operational *objectives* have been formally stated,
(2) whether there are measurable *indicators* associated to objectives to track the state and trend of each ecological component,
(3) whether *reference points* for those indicators have been defined to activate management action
(4) whether there are *management responses and measures* to ensure that those reference points are not exceeded.
In total in our evaluation of progress we review 20 elements that would facilitate the progress of implementing and making EBFM more operational. Online supporting information provides the full criteria with all the components and elements used to assess progress against the idealized "role model" RFMO (Table 2).

When assessing progress within the four ecological components of EBFM, there might not always be clear boundaries between them. For example, a species might sometimes be considered a target species in one fishery but a bycatch species in others. Therefore, for practical reasons, under the ecological component of "Target Species" we only considered in the assessment of progress the seven principal market tunas (Skipjack tuna *Katsuwonus pelamis,* Yellowfin tuna *Thunnus albacares,* Bigeye tuna *T. obesus,* Albacore tuna *T. alalunga,* Southern bluefin tuna *T. maccoyii,* Atlantic bluefin tuna *T. thynnus and* Pacific bluefin tuna *T. orientalis*) and Swordfish (*Xiphias gladius*). On the other hand, although several species of sharks, billfishes and finfishes can also be target species at least in some fisheries, for practical reasons, under the ecological component of "Bycatch Species" we included all billfish species (except Swordfish), sharks, seabirds, sea turtles, marine mammals, and finfishes other than principal market tunas and billfishes (hereafter called "other finfishes"). Though we highlight the rising concern that some shark species are now clearly target species (Davidson et al. 2015). The bycatch of billfishes, sharks, seabirds, sea turtles, marine mammals and finfishes by tRFMO fisheries is a significant factor in the long-term conservation and management of these species. Under the ecological component of "Ecosystem Properties and Trophic Relationships", we valued the existence of ecosystem metrics (empirically and model based) and food web models depicting trophic interactions and interdependencies involving relevant species or components of ecosystems that are affected by fishing, and are relevant to maintain ecosystem structure and function, and how this information is being used to advance progress in implementing EBFM. Under the ecological component of "Habitats", we valued whether habitats of special concern (e.g. reproduction, migration, feeding, hotspots) and/or habitat utilization and preferences for relevant species have been formally investigated and delineated, and how this information is being used to advance progress in implementing EBFM.

We evaluated the progress of each element within each ecological component up to the end of 2015. The evaluation of progress for each element was based on the assessment of specific actions by establishing six progress categories

(Table 2). Within the six progress categories, we differentiated between progress done by the Commission and the Scientific Committees in each tRFMO. The six categories are:

Full Progress by the Commission (which we set as our "role model" RFMO defined in Table 1),
Moderate Progress by the Commission,
Slight Progress by the Commission,
Full Progress only by the Scientific Committee,
Moderate Progress only by the Scientific Committee, and
Slight or no Progress only by the Scientific Committee.

Thus, the six categories rank progress from the highest progress done by the Commission (Category -*Full Progress by the Commission*) to the lowest progress done by the Scientific Committee (Category -*Slight or no Progress only by the Scientific Committee*). Although, we assume that progress can be ranked linearly from the highest to the lowest category, we recognize that progress might not be always linear.

To evaluate progress done by the Commission, we mainly reviewed and evaluated five sources: (1) the Convention Agreement Text, (2) adopted management measures, (3) adopted strategic research and management plans, (4) adopted annual summary Commission reports, as well as (5) Scientific Committee reports when relevant. We only evaluated actions, practices and supporting ecosystem science that were formally requested, considered and adopted by the Commission and were performed by the Scientific Committee. For example, a country might present a proposal with a new management measure to be discussed by the Commission, and if this proposal does not get adopted, then we did not consider it as progress. To evaluate progress done by the Scientific Committee, we mainly reviewed and evaluated the annual Scientific Committee reports and subsidiary working group reports when relevant. We only evaluated actions, practices, supporting ecosystem science and derived recommendations that were formally put forward by the Scientific Committee without a formal request from Commission. When evaluating progress by the Scientific Committee, we distinguished between science products, good practices and recommendations that were formally considered by the Scientific Committee (e.g. firm recommendations, strong strategic research plans with specific actions, deadlines, and assigned budgets, finished scientific products) from actions and recommendations that were more vaguely considered (vague statements of recommendations with no specific deadlines or assigned budgets, unfinished or still under developing scientific products). For example, a scientist from a member country might present a preliminary study where new mitigation measures have been tested to reduce bycatch of sensitive species in a particular place. Given its preliminary results, the Scientific Committee might not yet formally take into account this work to provide management advice to the Commission, then we did not consider it as progress or only as slight progress by the Scientific Committee. Consequently, in our criteria of progress we differentiate between progress done at the Commission level and progress done only by the Scientific Committee (without the request from and subsequent support at the Commission level). If progress was only done within the Scientific Committee, but not later supported in statements or adopted by the Commission, this was deemed weaker than if formally recognized and adopted at the Commission level. In other words, the Commission progress generally accounts for, and depends upon, the progress done by the Scientific Committee. On the other hand, the Scientific Committee can make progress independently without following a formal request or mandate from the Commission.

In our analyses the list of elements reviewed within each of the four ecological components of EBFM and the list of actions, good practices and supporting ecosystem science products is not exhaustive and could be easily expanded in future work. Yet we think these elements are common practices already being or partially being used and implemented by some RFMOs (Lodge et al. 2007). To reiterate, in this study we do not review the socio-economic or governance components of an EBFM approach, as we focus only on reviewing progress within the ecological component of EBFM. Furthermore, we do not review the current state of the ecological component (the state of target, bycatch species, ecosystem properties and trophic relationships and habitats) and we do not evaluate or summarize the outcome of the current management measures and whether they are being effective and successful.

3. Results

Here we present the progress across the 20 elements reviewed of each tRFMOs against a "role model" RFMO in implementing the ecological component of EBFM (Fig. 2).

3.1 International Commission for the Conservation of Atlantic tunas

3.1.1. Review of basic texts and main structures in support of EBFM

(i) **Reference to the PA and EBFM principles in accordance to relevant rules of international fisheries governance**

Progress category assigned: MODERATE PROGRESS BY THE COMMISSION

ICCAT was established in 1966 and its Convention Agreement entered into force in 1969, before the UN Convention on the Law of the Sea (UNCLOS) and the UN Fish Stocks Agreement (UNFSA) entered into force. The Convention Agreement primary objective is "to maintain populations of tuna and tuna-like fishes at levels which will permit the maximum sustainable catch for food and other purposes" and it does not formally refer to the precautionary approach or EBFM principles (ICCAT 2007). The Convention defines the term of tuna and tuna-like fishes as the Scombriformes with the exception of the families Trichiuridae and Gempylidae and the genus Scomber within the family Scombridae. Thus, the Convention mandate covers species of the family Scombridae (18 species including principal market tunas, small tunas, bonitos, and Spanish mackerels), family Istiophoridae (8 species including marlins, spearfishes and sailfish) and Xiphidae (1 species, Swordfish) distributed in the ICCAT Convention Area. Although the ICCAT Convention Agreement does not make reference to the precautionary approach and EBFM principles, since its creation ICCAT has had the ability to assimilate some elements of global instruments of fishery governance (UNCLOS and UNFSA) in the form of adoption of formal management measures (binding Recommendations and non-binding Resolutions), for example by adopting measures to minimize the effects of fishing on bycatch species. In 2015, the Commission also adopted the Resolution 15-11 concerning the application of an ecosystem approach to fisheries management and Resolution 15-12 concerning the use of a precautionary approach in implementing ICCAT conservation and management measures. Resolution 15-11 calls the Commission to consider the interdependence of stocks and species belonging to the same ecosystem or associated with or dependent species, consider the impacts of fishing and environmental factors on target stocks, not-target species and associated ecosystem, and minimize impacts of fishing on the ecosystem. Resolution 15-12 calls the Commission to use the best available scientific advice, exercise caution when scientific information is uncertain, determine stock specific reference points, and the action to be taken if exceeded, and not use the absence of adequate scientific information as a reason to postpone management action. Additionally, ICCAT has recently established a Working Group to Develop Amendments to the ICCAT Convention. The Working Group has been tasked to propose amendments to the Convention that accounts in part for the inclusion of principles regarding the precautionary approach and the ecosystem approach to fisheries management relevant in international fisheries governance. This Working Group is also revising the definitions of tuna-and-tuna like species and species covered by the term oceanic, pelagic and highly migratory elasmobranchs, since the new scope of the convention might also include certain elasmobranch species (ICCAT 2014). It remains to be seen whether ICCAT will amend its Convention Agreement and if it will update its Convention objectives in accordance to the main global instruments of fisheries governance. Furthermore, the ICCAT Standing Committee on Research and Statistics (SCRS) has also developed a Science Strategic Plan for 2015-2020 to provide guidance regarding research and scientific advice to the Commission. This plan has been adopted by the Commission and includes as a strategic goal to advance towards EBFM advice by establishing a dialogue with the Commission to determine clear EBFM goals and objectives, developing workshops to develop an EBFM plan with short-term, medium and long-term objectives relevant to tuna fisheries, and developing Ecosystem Status Reports with relevant ecosystem indicators to support management advice that incorporates ecosystem considerations (ICCAT 2015b).

In conclusion, the ICCAT Convention Agreement does not refer to the principles of the precautionary approach or EBFM. Yet, ICCAT has had the ability to assimilate some elements of global instruments of fishery governance (UNCLOS and UNFSA) in the form of adoption of formal management measures. The Commission in 2015 adopted the Resolution 15-11 concerning the application of an ecosystem approach to fisheries management and Resolution 15-12 concerning the use of the precautionary approach, and it is also currently discussing to amend the Convention Agreement to include some elements of the precautionary approach and EBFM. The Scientific Committee has also expressed in the Science Strategic Plan for 2015-2020 to advance towards EBFM advice, which has been recently adopted by the Commission. We therefore assigned the progress category – Moderate progress by the Commission.

(ii) **Existence a lead entity or group to advance progress in EBFM and ecosystem science**

Progress category assigned: MODERATE PROGRESS BY THE COMMISSION

The current structure of ICCAT includes a Standing Committee on Research and Statistics (SCRS, hereinafter called Scientific Committee), which is responsible for developing and recommending to the Commission policy advice concerning fishing activities and the stocks are fished in the Convention Area. The Scientific Committee relies on the research conducted by several Species Working Groups, the Sub-Committee on Statistics, and the Sub-Committee on Ecosystems. In 2005, the Sub-committee on Ecosystems was created for the purpose of coordinating and integrating ecosystem-related monitoring, research, modeling and advice activities to facilitate the incorporation of ecosystem considerations into management decisions. Previous to 2005, there existed two separate Working Groups, one dealing with bycatch assessments and mitigation measures, and the second dealing with broader ecosystem issues and oceanographic factors affecting tuna biology and fisheries. These two working groups were merged to create the 2005 formed Sub-Committee on Ecosystems.

The Sub-Committee on Ecosystems meets every year to tackle ecosystem and bycatch research and associated activities as required by the Scientific Committee to fulfill its advisory role to the Commission. The Sub-Committee on Ecosystems has traditionally focused most of its work on those species for which Species Working Groups have not been established (e.g. sea turtles and seabird). The work conducted depends on the priorities set by the Commission, which until now has focused more on estimating fisheries interactions with bycatch species and providing guidance on mitigation measures to reduce bycatch. Every year, the Sub-Committee on Ecosystems prepares a report summarizing the main research activities conducted and reviewed during the year and prepares a series of recommendations for the Scientific Committee regarding ecosystem and bycatch issues. In addition, there also exist a series of separate Species Working Groups which review available fishery and research information for species of interest to the Commission, including tropical tunas, Albacore tuna, Bluefin tuna, billfishes, Swordfish, sharks and small tunas. These working groups provide management advice for their focus species for the most part in a single-species management context. Although the principal market tunas, billfishes, sharks and small tunas are assessed by their own working groups, these species may also be treated as bycatch species at least in some fisheries and their total removals may also have an impact on the ecosystem. Therefore the research activities and tasks derived by these working groups are also relevant to the activities conducted and recommendations provided by the Sub-Committee on Ecosystems. The current research and management advice derived from the Species Working Groups may be also relevant to provide management advice on ecosystem issues to the Commission.

In conclusion, the Sub-Committee on Ecosystems was created to better integrate ecosystem considerations into the scientific advice provided by the Scientific Committee to the Commission. However, it has limited capacity to integrate and coordinate all the ecosystem research activities (pertaining to target and bycatch species, trophic relationships and habitats) needed to fully implement the ecological components of EBFM, since some of these research activities are also conducted independently by other working groups (e.g. Billfish and Shark Working Groups).. The Scientific Committee reviews and coordinates the research and recommendations put forward by the Sub-committee on Ecosystems and the other Working Groups, and it is responsible for developing advice on data collection, on the status of the stocks and on management issues to the Commission. However, there is not clear effective mechanism to integrate and coordinate all relevant ecosystem research and activities and ensure effective communication among all the Working Groups and to the Commission. This lack of effective communication among the working groups limits a full assessment of the extent of impacts of ICCAT fisheries on target and bycatch species and the effects of their removals from the ecosystem, limiting a comprehensive implementation of EBFM. We therefore assigned the progress category – Moderate progress by the Commission.

(iii) **Existence of an EBFM plan**

Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

ICCAT has not formally developed and adopted an operational EBFM plan to ensure that ecosystem considerations derived from the main ecological elements (target, bycatch, trophic interactions and habitats) of EBFM are taken into account in management advice when managing tuna and tuna-like species and associated ecosystems. However, the recent development and adoption of the SCRS Science Strategic Plan for 2015-2020 which includes as a

strategic goal to advance towards EBFM advice is seen as a major step forward (ICCAT 2015b). The SCRS Science Strategic Plan for 2015-2020 provides guidance regarding research and scientific advice to the Commission. The plan includes as a strategic goal to advance towards EBFM advice by establishing a dialogue with the Commission to determine clear EBFM goals and objectives, developing workshops to develop an EBFM plan with short-term, medium and long-term objectives relevant to tuna fisheries, and developing Ecosystem Status Reports with relevant ecosystem indicators to support management advice that incorporates ecosystem considerations (ICCAT 2015b). We therefore assigned the progress category – Slight progress by the Commission.

(iv) **Existence of a data collection program to support the implementation of EBFM**

Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

ICCAT has not established data collection and monitoring programs to address comprehensively the impacts of fisheries on the ecosystem and support the implementation of EBFM. Instead, the existing data collection and monitoring programs were mainly designed to collect data for target species but some bycatch data is also collected at least in some relevant fisheries as requested by the Commission. A regional observer program database may exist for some relevant fisheries and fleets. The data sets are comprised of data submitted by individual member countries from their national observer programs to the RFMOs. ICCAT requires member states to have their own national scientific observer programs. The data derived from these national programs must be submitted to the ICCAT Secretariat in the formats specified by the Scientific Committee and under the confidentially rules agreed by ICCAT (Recommendation 11-10). Moreover, ICCAT has a bycatch coordinator to manage the database and monitor the data received from the national programs. Yet, countries might not provide necessarily standardized data according to the requirements of the ICCAT Secretariat or is submitted as summaries in aggregated form, which does not allow pooling to conduct joint regional EBFM analysis. Often the data are submitted is incomplete. In addition, the data sets are not open access to allow for EBFM analyses. Therefore the Scientific Committee is often unable to use data derived from the national data collection programs to conduct joint regional assessments relevant to bycatch and ecosystem issues. In the national observer programs ICCAT requires at least 5% of observer coverage for longline fleets (Recommendation 10-10), and requires 100% observer coverage for just a small region of the tropical tuna fishery (in the Gulf of Guinea) for only two months of the year for purse seiners (Recommendation 15-01). For fleets targeting bluefin tuna, the observing coverage is raised to at least 20% on longliners, baitboats and pelagic trawlers, and 100% in the harvesting operations in traps and purse seiners and farming related operations (Recommendation 12-04). This level of observer coverage is as well often too low to generate quality data to support joint regional assessments relevant to bycatch and ecosystem issues. Furthermore, the 2015-2020 SCRS Scientific Research Plan also highlights the importance to define the data collection needed for the implementation of EBFM to develop integrated ecosystem models in order to identify key ecosystem components, as well as to include the collection of socio-economic information in the national sampling programs (ICCAT 2015b). Although this is seen as a major step forward, the SCRS Scientific Research Plan did not define broad measurable targets and specific deadlines to evaluate progress in the implementation of these ecosystem-related strategies.

In conclusion, data collection and monitoring programs exist, but not necessarily to address comprehensively the impacts of fisheries on the ecosystem and support the implementation of EBFM. Existing data collection and monitoring programs were mainly designed to collect data for target species but some bycatch data is also collected at least in some relevant fisheries as requested by the Commission. A regional observer program database exist for some relevant fisheries and fleets, yet the data are not standardized or in a form that allows pooling to conduct joint regional EBFM analysis. In addition, the data sets are not open access to allow for EBFM analyses. We therefore assigned the progress category – Slight progress by the Commission.

3.1.2. Review of main ecological components in support of EBFM

For each of the ecological components of target species, bycatch species, ecosystem properties and trophic relationships and habitats, we assess the following four elements: (1) whether conceptual and/or operational *objectives* have been formally stated, (2) whether there are measurable *indicators* associated to objectives to track the state and trend of each ecological component, (3) whether *reference points* for those indicators have been

defined to activate management action, and (4) whether there are *management responses and measures* to ensure that those reference points are not exceeded.

Target species - Ecological component 1.

For practical reasons, we only considered in the assessment of progress under the ecological component of "Target Species" all principal market tunas and Swordfish. ICCAT is responsible for the conservation and management of the following principal market tunas, Skipjack tuna *Katsuwonus pelamis*, Yellowfin tuna *Thunnus albacares*, Bigeye tuna *T. obesus*, Albacore tuna *T. alalunga* and Atlantic bluefin tuna *T. thynnus*, and the conservation and management of Swordfish (*Xiphias gladius*) within its area of jurisfiction.

(i) **Objectives**

Progress category assigned: FULL PROGRESS BY THE COMMISSION

The Convention primary objective is "to maintain population of tunas and tuna-like fishes at levels that permit the maximum sustainable catch for food and other purposes". The term maximum sustainable catch is usually referred to as maximum sustainable yield. Therefore, ICCAT has explicitly defined a general long-term operational objective that applies to all tuna and tuna-like species and this objective is generally applied to the main target ICCAT species. Furthermore, the ICCAT recommendation 13-18 for Enhancing the Dialogue between Fisheries Scientists and Managers sets a framework to improve dialogue towards the establishing proper management frameworks. This is seen as an important initiative to assist in the progress of developing species-specific conservation and management objectives with associated probabilities and timelines (ICCAT 2015d). We therefore assigned the progress category – Full progress by the Commission.

(ii) **Indicators**

Progress category assigned: FULL PROGRESS BY THE COMMISSION

Fishery stock assessments have been conducted for all principal market tunas stocks (9 stocks, 5 species) and for Swordfish (3 stocks, 1 species). Thus, all target stocks (all principal market tuna stocks and Swordfish stocks) exploited by ICCAT fisheries have been evaluated with fisheries stocks assessments to determine the effects of fishing on the individual stocks and determine their exploitation status. Indicators of population status including indicators of population size over time, fishing mortality over time and associated reference points are available and monitored regularly for these assessed stocks. These stock status indicators and associated reference points are also explicitly associated to the aforementioned objective of maintaining populations at maximum sustainable yields. We therefore assigned the progress category – Full progress by the Commission.

(iii) **Reference points**

Progress category assigned: MODERATE PROGRESS BY THE COMMISSION

Stock-specific limit reference points associated with the biomass and fishing mortality rate indicators have not been defined or adopted for any of the target stocks with one exception. North Atlantic Swordfish is the only stock which the Commission has adopted an interim stock-specific limit reference point, a B_{lim} of $0.4B_{MSY}$ (Recommendation 13-02). Stock-specific limit reference points have also been proposed, and are under development for North Atlantic Albacore tuna by the Scientific Committee as requested by the Commission (Recommendation 13-05 and 15-04).

B_{MSY} and F_{MSY} (or proxies) have generally been used as the implied target reference points for all the target stocks, and since Recommendation 11-13 the green (bottom right) quadrant of the Kobe plot is implied as a target. There are two exceptions, the Eastern and Mediterranean bluefin tuna has an interim target of achieving B_{MSY} by 2022 with at least 60% probability (Recommendation 12-03) and the Western bluefin tuna has an interim target of achieving B_{MSY} by 2018 with at least 50% probability (Recommendation 13-09).

Additionally, the 2015-2020 SCRS Science Research Plan also contemplates the evaluation of species-specific precautionary reference points and harvest control rules (with target and limits) using management strategy evaluation, and in absence of species specific information the establishment of standardized precautionary approach limit (ICCAT 2015b). The ICCAT recommendation 13-18 for Enhancing the Dialogue between Fisheries Scientists and Managers also sets a framework to improve dialogue towards the establishing proper management frameworks that includes the development and testing of stock-specific reference points.

In conclusion, stock-specific limit and/or target reference points associated to pre-defined objectives and indicators have been defined and developed for some species, and adopted by the Commission. Stock-specific reference points are also under development for other species. Therefore, we assigned the progress category – Moderate progress by the Commission.

(iv) **Management responses and measures**

Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

Harvest control rules have not been developed and adopted for any of the target species. Although the Commission has requested the Scientific Committee to develop harvest control rules, and carry management strategy evaluation to test their performance on a stock-by-stock basis, for, *inter alia*, North Atlantic Albacore, bluefin tuna, North Atlantic Swordfish and tropical tunas (Resolution 15-07). Moreover, the ICCAT recommendation 13-18 for enhancing the dialogue between fisheries scientists and managers sets a framework to improve dialogue towards the establishing proper management frameworks that includes species-specific harvest control rules.

Several management measures (binding-recommendations) have been adopted by ICCAT to ensure that the management objective of maintaining target species at levels that permit maximum sustainable catches is achieved. We briefly summarize the most relevant binding conservation and management measures adopted by ICCAT to manage target stocks:

For Bigeye, Yellowfin and eastern stock of Skipjack tunas, Recommendation 15-01 (which amended previous recommendations) establishes a multi-annual management and conservation program that includes the following elements: establishes a TAC (for Bigeye and Yellowfin), a capacity limitation for the number of longline and purse seine vessels over 20 meters (only for Bigeye tuna), a record of vessels actively fishing, a two-month prohibition of fishing on floating objects in an area off of West Africa with 100% observer coverage during the closure, and an annual submission of FAD management plans. ICCAT has not adopted any Recommendation for Western Atlantic Skipjack.

For North Atlantic Albacore, Recommendation 98-08 limits the number of vessels targeting the stock, Recommendation 13-05 sets a TAC, and Recommendation 15-04 establishes the management objective of maintaining the stock in the green zone of the Kobe plot with at least 60% probability, sets a rebuilding target, and calls the Scientific Committee to identify and test candidate target and limit reference points and associated harvest control rules to support the management objective. For South Atlantic Albacore, Recommendations 11-05 and 13-06 sets a TAC. ICCAT has not adopted any Recommendation for Mediterranean Albacore.

For Eastern and Mediterranean Atlantic bluefin tuna, Recommendations 06-05, which has been amended every year, establishes a rebuilding plan aiming to recover the stock. The rebuilding program aims to recover the stock to B_{MSY} by 2022 with at least 60% probability. The rebuilding program (Recommendation 12-04) includes the following main elements: establishes TACs, capacity adjustments, closed fishing seasons for longliners, purse seiners, pole and line, pelagic trawls and sport fisheries, sets minimum sizes, establishes records for authorizes vessels and farming facilities, requires weekly catch reports to national agencies and monthly reports to ICCAT, establishes an observer program with 100% coverage for purse seiners, requires VMS on every veseel over 15 m, among others. For Western Atlantic bluefin tuna Recommendations 98-06, which has been amended every year, establishes a rebuilding program. The rebuilding program (Recommednation 14-05) aims to recover the stock to B_{MSY} by 2018 with at least 50% probability. The plan includes the following main elements: establishes TACs, minimum size limits and prohibits directed fisheries in the Gulf of Mexico.

For North Atlantic Swordfish, Recommendations 06-02, which has been amended several times, established a rebuilding plan aiming to recover the stock. Recommendation 13-02 calls for measures to ensure the conservation of North Atlantic Swordfish with the goal of maintaining B_{MSY} with greater than 50% probability, including TACs and weight and size limits. For South Atlantic Swordfish, Recommendation 15-03 establishes TACs and catch limits for the years 2014,2015 and 2016 and sets minimum size limits. For Mediterranean Swordfish, Recommendation 13-04 calls for measures including the provision to the ICCAT Secretariat with a list of all fishing vessels authorized to catch Swordfish, the creation of a fishing permit for each authorized fishery, a time-area closure, minimum size requirements, specifications for technical characteristics for fishing gears.

In conclusion, harvest control rules have not been adopted for any target species but are under development by the Scientific Committee and being discussed by the Commission for some species. Furthermore, several management measures have been adopted to ensure management objectives are achieved for majority of target stocks and species. We therefore assigned the progress category – Slight progress by the Commission.

Bycatch species - Ecological component 2.

For practical reasons, we reviewed under the ecological component of "Bycatch Species" all billfish species (except Swordfish), as well as sharks, seabirds, sea turtles, marine mammals, and other finfishes impacted by fisheries. Yet we stress several species of billfishes, sharks and other finfishes can also be target species at least in some fisheries.

(i) **Objectives**

Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

The ICCAT Convention mandate does not make explicit provisions addressing the impact of ICCAT fisheries on by-catch or dependent species and ecosystems (ICCAT 2009b). The Convention mandate in Article IV includes only a small reference calling to study all the species exploited by tuna fisheries in the Convention Area. Nevertheless, since its creation ICCAT has adopted several measures (binding Recommendations and non-binding Resolutions) where vague conceptual objectives have been stated in relation to the minimization and mitigation of the effects of ICCAT fisheries on bycatch species including sharks, seabirds and turtles (see below the section on Responses and Management Measures). Therefore, the adopted measures do not establish clear operational objectives to reduce the effects of fisheries on bycatch species.

Moreover, the 2015-2020 SCRS Science Research Plan, which has been adopted by the Commission, contains as a strategic conceptual objective to advance EBFM advice by focusing on the fishery and its role on the ecosystem, including commercial and non-commercial species as well as the habitat (ICCAT 2015b). The Terms of Reference for the Sub-Committee on Ecosystems also calls for monitoring and improving information on the interactions of ICCAT fisheries with bycatch species which is critical to the development of indicators of stock status and associated operational objectives, and critical to provide advice on the impacts of ICCAT fisheries on by-catch species (ICCAT 2005). These types of initiatives by the Scientific Committee are seen as a positive step towards defining conceptual and operational objectives to reduce the impact of fisheries on bycatch species and associated ecosystems.

In conclusion, ICCAT has not formally adopted in its Convention Agreement conceptual or operational objectives to account for the impacts of ICCAT fisheries on bycatch species. However, at least conceptual objectives have been recently stated in the adopted SCRS Science Research Plan and have also been vaguely stated in several adopted management measures. We therefore assigned the progress category – Slight progress by the Commission.

(ii) **Indicators**

Billfishes - Progress category assigned: MODERATE PROGRESS BY THE COMMISSION

Some billfish stocks and species, including Atlantic blue and white marlins and sailfish, are regularly assessed with traditional fishery stock assessments. Thus, indicators of stock status, including indicators of population size and

fishing mortality over time, are regularly developed and are being monitored for these assessed species to provide management advice. In conclusion, a series of region-wide indicators of stock status (associated to pre-established objectives) are routinely developed and monitored only for some billfish species which are used to provide robust management advice to the Commission. We therefore assigned the progress category – Moderate progress by the Commission.

Sharks - Progress category assigned: MODERATE PROGRESS BY THE COMMISSION

A level 2 ecological risk assessment (ecological risk assessment) was conducted by the Scientific Committee for 16 sharks species (20 stocks) in 2012. This ecological risk assessment consisted in a productivity-susceptibility risk assessment of 20 stocks of sharks to ICCAT longline fisheries. The ecological risk assessment provided a stock-level index of vulnerability to longline fisheries, which allowed the identification of those species most vulnerable (ICCAT 2013). The ecological risk assessment was used to prioritize research and management measures. In addition to the ecological risk assessment, a group of shark species (two stocks of blue shark, two stocks of shortfin mako, and three stocks of porbeagle) have been assessed with traditional fishery stock assessments (ICCAT 2015c). Thus, indicators of stock status, including indicators of population size and fishing mortality over time, have been developed to monitor the status of these assessed species in order to provide management advice. However, these shark assessments and their resultant stock status indicators and current exploitation status are currently considered preliminary and highly uncertain due to the limitation of the quantity and quality of data (ICCAT 2013). The limited quantity and quality of information available on the biology of sharks and fisheries statistics affects the provision of scientific advice to the Commission. In 2013 a Shark Research and Data Collection Program was created with the aim of reducing the main sources of uncertainties when providing scientific advice, including the improvement of data collection and reporting procedures (ICCAT 2013). In conclusion, a series of regional indicators of stock status (associated to pre-established objectives) have been developed and are routinely monitored only for some shark species, which are used to provide robust management advice. We therefore assigned the progress category – Moderate progress by the Commission.

Seabirds - Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

The Commission requested to the Scientific Committee to conduct an assessment of the impacts of ICCAT fisheries on seabirds (Resolution 02-14). As a result the Scientific Committee conducted a seabird assessment, which included (1) the identification of seabird species most at risk from fishing with an ecological risk assessment (ecological risk assessment) productivity-susceptibility risk analysis (level 2), (2) collation of data on at-sea distribution, (3) analysis of spatial and temporal overlap between seabird species distribution and longline fishing effort, (4) revision of existing bycatch rates of ICCAT longline fisheries, (5) estimation of total annual seabird bycatch in the ICCAT Convention Area, and finally (6) a quantitative ecological risk assessment (level 3) for a small group of relatively data-rich seabird species (ICCAT 2009a, Tuck et al. 2011). As a result of this six-stage seabird assessment, the ecological risk assessment level 2 productivity-susceptibility risk analysis provided a vulnerability index for 68 populations (41 species) of seabirds raking the relative risk of these species from fishing. The spatial distribution analysis also provided an indicator of degree of overlap of 22 populations (ten species) of seabirds with longline fishing effort. Furthermore, the estimation of total seabird bycatch, population specific when possible, provided a preliminary picture of annual bycatch rates and trends, yet, these estimates were highly uncertain due to the inadequate observer coverage of most fleets. Finally, the quantitative ecological risk assessment (level 3) provided indicators of population trends between 1950s to 2010 of the number of breeding pairs for four seabird populations. Only four populations had sufficient data available on their distribution and demography to conduct the modeling for the ecological risk assessment level 3 assessments. It was the first time a region wide assessment including the North and South Atlantic Ocean and Mediterranean Sea was conducted, yet this region wide seabird assessment and derived indicators of population status and fishery impacts are not regularly monitored and updated by the Scientific Committee to provide scientific advice to the Commission.

In conclusion, the seabird assessment conducted by the Scientific Committee as requested by the Commission has provided a series of indicators which quantified for the first time the impacts of ICCAT longline fisheries on seabird populations. Yet, the indicators resulting from the level 2 and 3 ERAs, the total bycatch estimates, and the spatial overlap analyses are not regularly updated or monitored over time by the Scientific Committee. The developed indicators cannot be used to provide robust management advice (e.g. establish level of exploitation status, set impact

or catch limits or evaluate the efficacy of current adopted mitigation measures). Therefore, we assigned the progress category – Slight progress by the Commission.

Sea turtles - Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Although the Commission has requested to assess the incidental catch of sea turtle resulting from ICCAT fisheries (Recommendation 10-09), the Scientific Committee has made very small progress towards the request. Region-wide assessments and indicators of stock status or fishery impacts for sea turtles impacted by ICCAT fisheries have not been developed by the Scientific Committee. Despite its efforts, the Scientific Committee has not been able to conduct a region wide ecological risk assessment to assess the impact of longline and purse seine fisheries on sea turtle populations. Efforts are being hindered by insufficient data quality and quantity (ICCAT 2015a). Not all members are submitting the required data and those submitted the data do not report on mortalities associated with the reported interactions. At a courser scale, the Scientific Committee conducted a taxonomic-wide ecological risk assessment in 2010, comprising target tuna species as well as bycatch species, which included four species of sea turtles (Arrizabalaga et al. 2011). This ecological risk assessment consisted of a level 2 semi-quantitative productivity-susceptibility risk analyses for the EU purse-seine fishery and US pelagic longline fishery and ranked the relative vulnerability of four sea turtle species to fishing impacts. Given the limitations to conduct a region-wide risk assessment for sea turtles, the Scientific Committee has instead focused on routinely evaluating studies on the incidental catch rates of sea turtles by individual country fleets, review bycatch mitigation strategies and safe-release protocols for turtles in the ICCAT area. Several recommendations on safe-release protocols have been put forward to reduce mortality of sea turtles in ICCAT fisheries.

In conclusion, the Commission has requested to assess the incidental catch of sea turtle resulting from ICCAT fisheries. Yet region-wide assessmetns and indicators of stock status or fishery impacts for sea turtles impacted by ICCAT fisheries have not been developed by the Scientific Committee. The attempt to conduct a region-wide assessment for sea turtles is being slow but under development, which is hindered by insufficient data quality and quantity. Therefore, we assigned the progress category – Slight or no progress only by the Scientific Committee.

Marine mammals - Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Region-wide assessments and indicators of stock status or fishery impacts for marine mammals impacted by ICCAT fisheries have not been developed by the Scientific Committee or have been requested by the Commission. ICCAT members have reported bycatch of marine mammals in their fisheries, but data are insufficient and virtually non-existent to calculate species-specific gear interactions, mortality rates, or indicators of fishery impacts. Thus, there is need to guther information to determine if fisheries interactions are significant and to propose effective mitigation techniques to reduce incidental mortalities. Even the most basic information on marine mammal distributions and how it overlaps with fishing effort is lacking. At a coarse scale, the Scientific Committee has conducted a taxonomic-wide level 1 and 2 ecological risk assessment, comprising target tuna species as well as bycatch species including some marine mammals, to assess the relative risk of both target and bycatch species being impacted by ICCAT fisheries (Arrizabalaga et al. 2011). Marine mammals were only included in the level-1 qualitative analysis ranking their intrinsic vulnerability to different fishing gears in comparison to the rest of taxonomic groups. Without more comprehensive data, the Scientific Committee is unable to assess the risk of marine mammal bycatch and develop indicators of status or fishery impacts in the ICCAT Convention Area, constraining its ability to provide robust management advice. Therefore, we assigned the progress category – Slight or no progress only by the Scientific Committee.

Other finfishes - Progress category assigned: *SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE*

Region-wide assessmetns and indicators of stock status or fishery impacts for finfish speices other than tunas and billfishes impacted by ICCAT fisheries have not been developed by the Scientific Committee. The availability of fisheries and biological data and its quality for finfishes in the ICCAT Convention area is very fragmented and varies across species. The current information does not allow the Scientific Committee to conduct region wide assessments and indicators of stock status or fishery impacts for any of the finfishes in the Convention area, which affects the provision of scientific advice to the Commission. In response to this, in 2013, a Small Tunas Research

Program was created by the Commission with the main objective of recovering historical fisheries and biological data in the main fishing areas and the long-term goal of carrying assessment of stock status and providing management advice for these species. This is seen as a positive step towards developing regional assessmetns and indicators of status for finfishes. To date, the ICCAT Scientific Committee has focused its efforts on recovering historical fisheries data sets and assessing the relative risk of finfishes to longline and purse seine fisheries using ecological risk assessments. Several ecological risk assessments of the impacts of several ICCAT fisheries on finfishes have been conducted and reviewed by the Scientific Committee. The first ecological risk assessment was taxonomic-wide level 1 and 2 assessment of both target and bycatch species being impacted by ICCAT fisheries (Arrizabalaga et al. 2011). Sixteen species of finfishes were included in the level 2 semi-quantitative productivity-susceptibility risk analyses for the EU purse-seine fishery and US pelagic longline fishery. In 2015, a semi-quantitative level 2 ecological risk assessment (productivity-susceptibility analysis) was conducted, which estimated the vulnerability of tunas, billfishes and other teleost caught by longliners in the Atlantic and Indian Oceans (Lucena Frédou et al. 2015). This assessment identified and rank finfishes according to their vulnerability to tuna longline fisheries in the South Atlantic. (Arrizabalaga et al. 2011)This last ecological risk assessment is still considered preliminary and is still under development, and therefore it has not been used yet to provide robust management advice for finfishes (e.g. establish level of exploitation status, set impact or catch limits or evaluate the efficacy of current adopted mitigation measures).
In conclusion, since region-wide assessmetns and indicators of stock status or fishery impacts for finfish other than tunas and billfishes impacted by ICCAT fisheries have not been developed by the Scientific Committee, we assigned the progress category – Slight or no progress only by the Scientific Committee.

(iii) **Reference points**

Billfishes - Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

Limit reference points associated to the biomass and fishing mortality rate indicators have not been defined, developed or adopted for any of the assessed billfish stocks. B_{MSY} and F_{MSY} (or proxies) have been the unofficial implied target reference points used in ICCAT for assessed billfishes. Since Recommendation 11-13 for managed ICCAT stocks the green (bottom right) quadrant of the Kobe plot is also implied as a target. We therefore assigned the progress category – Slight progress by the Commission.

Sharks - Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

Limit reference points associated to the biomass and fishing mortality rate indicators have not been defined, developed or adopted for any of the assessed shark stocks. B_{MSY} and F_{MSY} (or proxies) have been the unofficial implied reference points used in ICCAT for assessed sharks. Since Recommendation 11-13 for managed ICCAT stocks the green (bottom right) quadrant of the Kobe plot is also implied as a target. We therefore assigned the progress category – Slight progress by the Commission.

Seabirds - Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Target and/or limit reference points associated to indicators of stock status or bycatch rate estimates have not been defined, developed or adopted for any of the species, and are not under development or being discussed. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

Sea turtles - Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Target and/or limit reference points associated to indicators of stock status or bycatch rate estimates have not been defined, developed or adopted for any of the species, and are not under development or being discussed. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

Marine mammals - Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Target and/or limit reference points associated to indicators of stock status or bycatch rate estimates have not been defined, developed or adopted for any of the species, and are not under development or being discussed. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

Other finfishes - Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Target and/or limit reference points associated to indicators of stock status or bycatch rate estimates have not been defined, developed or adopted for any of the species, and are not under development or being discussed. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

(iv) **Management responses and measures**

ICCAT has adopted an extensive list of conservation and management measures (binding Recommendations and non-binding Resolutions) for billfishes, sharks, seabirds, and sea turtles, and none for marine mammals or other finfishes. We briefly list them below and group them by taxonomic group. Overall the adopted measures have the main purpose to minimize the effects of fishing on by-catch species as for example with the modification of gears to avoid them or in the form of prohibition. The adopted measures also focus on establishing requirements for data reporting and conduct specific type of research. We find no management measure has been adopted to set a management response linked to pre-established operational objectives, indicators and reference points for any of the bycatch species impacted by ICCAT fisheries, precluding them to be activated when predefined reference points are exceeded. The adopmed measures (mostly to mitigate impacts) are not known whether they are being effective to affect the current status of populations since they have not been linked to status indicators or reference points to judge whether the current state of species is acceptable. We therefore assigned the progress category – Slight progress by the Commission to the taxonomic group of sharks, seabirds and sea turtles. We made an exception with billfishes, and assigned the category – Moderate progress by the Commission, since recommendation 12-04 recognizes that longliners and other fisheries take Atlantic blue and white marlin as bycatch, and both of which are thought to be overfished, and calls for a rebuilding plan to rebuild the populations to the target of B_{MSY} levels and sets catch limits for blue marlin and white marlin for 2013, 2014, and 2015 by country. No management measures have been adopted or are under discussion by the Scientific Committee to minimize the impacts of fisheries on marine mammals and other finfishes, therefore, we assigned the progress category – Slight or no progress only by the Scientific Committee.

Measures related to the conservation and management of bycatch species	**Type of Measure**
Billfishes – Progress category assigned: Moderate progress by the Commission	
Recommendation 15-05 – Recalls a rebuilding plan is in place to rebuild the populations to the target of B_{MSY} levels and sets catch limits for blue marlin and white marlin/spearfish for 2016, 2017, and 2018 by country.	-Binding -Sets a rebuilding target and catch limits
Sharks - Progress category assigned: Slight progress by the Commission	
Resolution 95-02 - Recognizes that some sharks are incidentally caught in tuna fisheries and resolves that FAO should be the focal point to initiate a program to collect necessary data and serve as a coordinator among RFMOs.	-Non-binding -Data collection
Resolution 03-10 -Recognizes that an extensive shark fishery is reported and resolves that CPCs should provide the WG of the Sub-Committee on Bycatch information on their shark catches, effort by gear type, landings and trade of shark products, and fully implement FAO IPOA for sharks.	-Non-binding -Data collection
Recommendation 04-10 -Recommends CPCs to report Task I and Task II data for catches of sharks, fully utilize the entire catches of catch, establishes a limit on the ratio of fin weight to total shark weight that can be retained onboard a fishing vessel, encourages the release of live sharks in fisheries that do not target sharks, identify ways to make fishing gears more selective, identify shark nursery areas, review assessments of shortfin mako sharks and reassess blue shark.	-Binding -Minimize bycatch -Sets limit on ratio of weight of retained shark fins
Recommendation 05-05 - Recommends CPCs to reduce North Atlantic shortfin mako shark mortality, implement the recommendation and report to the Commission.	-Binding -Minimize bycatch
Recommendation 06-10 -Recommends that CPCs should submit all relevant data in advance of the 2008 meeting to conduct stock assessments for shortfin mako and blue	-Binding -Data submission to

sharks.	conduct assessment
Recommendation 07-06 -Recommends sustainable levels of harvest and limits mortality on porbeagle and North Atlantic shortfin mako, and where possible to implement research to identify nursery areas.	-Binding -Encourage sustainable harvest
Recommendation 09-07 -Recommends CPCs prohibit the retention on board of Bigeye thresher and require vessels to release them unharmed. Do not undertake directed fisheries for species of thresher sharks of the genus Alopias spp, implement research to identify nursery areas for thresher sharks.	-Binding -Minimize bycatch
Recommendation 10-06 - Prohibit the retention of shortfin mako onboard vessels flagged to countries that do not report catches for this species. SCRS should conduct a stock assessment in 2012.	-Binding -Minimize bycatch -Conduct assessment
Recommendation 10-07 -Recognizes that Oceanic whitetip shark is caught as bycatch, and prohibit the retention on board oceanic whitetip shark, and CPCs shall record in their observer programs the number of discards and releases with indication of status (dead or alive) and report to ICCAT.	-Binding -Minimize bycatch -Data collection
Recommendation 10-08 - Prohibits the retention on board of several species of hammerhead sharks, requires the release unharmed, conduct research to identify nursery areas.	-Binding -Minimize bycatch
Recommendation 11-08 -Prohibit the retention on board of silky sharks and require the release unharmed. Purse-seine vessels should take additional measures to increase the survival rate of silky sharks. CPCs should record through their observer programs the number of discards and releases with indication of status (dead or alive).	-Binding -Minimize bycatch -Data collection
Recommendation 12-05 -Requires all parties in 2013 to report on their implementation of and compliance with Recs. 04-10, 07-06, 09-07, 10-08, 10-07, 11- 08, and 11-15.	-Binding -Minimize bycatch
Recommendation 13-10 -Permits scientific observers of CPCs to collect biological samples of sharks species, which collection was prohibited in other recommendations, under a series of conditions.	-Binding -Data collection
Recommendation 14-06- Recommends CPCs to improve their catch reporting systems, and include in their annual reports actions taken to monitor catches and conserve shortfin mako sharks. Encourages CPCs to undertake research on key biological/ecological parameters. SCRS should conduct stock assessment by 2016. Replaces Rec 05-05 and 06-10.	-Binding -Data collection -Conduct research -Conduct assessment
Recommendation 14-01 - Recommends CPCs shall replace by 2016 existing FADs with non-entangling FADs in order to minimize the ecological impact of FADs, in particular the entanglement of sharks, turtles and other non-targeted species. CPCs shall report to ICCAT Secretariat on an annual basis on the steps undertaken to comply with this provision.	-Binding -Minimize bycatch -Data collection
Recommendation 15-06 – Requires CPCs to release unharmed, to the extent practicable, porbeagle sharks in ICCAT fisheries, ensure the collection of Task I and II data and encourage research and monitoring programs to improve biological data and identify areas of high abundance of important life history stages (e.g. nursery grounds).	-Binding -Minimize bycatch -Data collection
Seabirds – Progress category assigned: Slight progress by the Commission	
Recommendation 07-07- Requires longliners operating south of 20°S to use at least two of several mitigation measures such as weighted branch lines or tori (bird-scaring) lines. The measure also requires CPCs to collect and report data on interactions between fisheries and sea birds.	-Binding -Minimize bycatch -Data collection
Recommendation 11-09- Strengthens the mitigation measures in 07-07, especially for longliners fishing south of 25°S, and in the Mediterranean. Requires SCRS to conduct in 2015 an ecological risk assessment to evaluate the efficacy of the mitigation measures.	-Binding -Minimize bycatch -Evaluate efficacy of measure
Sea turtles – Progress category assigned: Slightl progress by the Commission	
Recommendation 10-09 - Set up reporting requirements for sea turtle interactions and mandates its scientific committee to assess, by 2014, the impact of tuna fisheries on sea turtle populations. The measure has specific requirements for longline operators to be trained on appropriate handling and release of live turtles so as to maximize their	-Binding -Minimize bycatch -Data collection -Assess impact

survival.	
Recommendation 13-11 - Set up reporting requirements for sea turtle interactions and mandates its scientific committee to assess, by 2014, the impact of tuna fisheries on sea turtle populations. The measure has specific requirements for longline operators to be trained on appropriate handling and release of live turtles so as to maximize their survival.	-Binding -Minimize bycatch -Data collection -Assess impact
Recommendation 14-01 - Recommends CPCs shall replace by 2016 existing FADs with non-entangling FADs in order to minimize the ecological impact of FADs, in particular the entanglement of sharks, turtles and other non-targeted species. CPCs shall report to ICCAT Secretariat on an annual basis on the steps undertaken to comply with this provision.	-Binding -Minimize bycatch -Data collection
Marine mammals – Progress category assigned: Slight or no progress only by the Scientific Committee	
No measures	
Other finfishes – Progress category assigned: Slight or no progress only by the Scientific Committee	
No measures	

Ecosystem properties and trophic relationships - Ecological component 3.

Under the ecological component of "Ecosystem Properties and Trophic Relationships", we valued the existence of ecosystem metrics (empirically and model based) and food web models depicting trophic interactions and interdependencies involving relevant species or components of ecosystems that are affected by fishing, and are relevant to maintain ecosystem structure and function, and how this information is being used to advance progress in implementing EBFM.

(i) **Objectives**

Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

The ICCAT Convention Agreement does not contain any specific provisions addressing the impact of ICCAT fisheries on trophic interactions and interdependencies involving relevant species or components of ecosystems in order to maintain the structure and functioning of marine food webs and ecosystem health (ICCAT 2007). However, in 2015 the Commission adopted the Resolution 15-11 concerning the application of an ecosystem approach to fisheries management. This resolution calls the Commission to consider the interdependence of stocks and species belonging to the same ecosystem or associated with or dependent species, also consider the impacts of fishing and environmental factors on target stocks, not-target species and associated ecosystem, and minimize impacts of fishing on the ecosystem. Thus, the new ICCAT adopted management and conservation measure captures conceptually the objective of minimizing impacts of fishing on trophic interactions and interdependencies involving relevant species or components of ecosystems. Moreover, the recently adopted 2015-2020 SCRS Science Research Plan contains as a strategic objective to advance EBFM advice by developing ecosystem status reports with relevant ecosystem indicators, and developing management advice that incorporates and considers these critical indicators (ICCAT 2015b). The Terms of Reference of the Sub-committee on Ecosystems also call for investigating trophic interactions of ICCAT target species, which is critical to the development of ecosystem and multi-species indicators and associated operational objectives. It also calls for modeling mixed fisheries, multispecies, bycatch and ecosystem issues, in order to develop mechanisms to better integrate ecosystem considerations into management advice.

In conclusion, while the Convention Agreement do not contain any specific provisions addressing the impacts of ICCAT fisheries on trophic interactions and interdependencies involving relevant species or components of ecosystems, in 2015 the Commission adopted the Resolution 15-11 calling to consider the interdependence of stocks and species belonging to the same ecosystem or associated with or dependent species when evaluating the impacts of ICCAT fisheries on marine ecosystems. Thus, the new ICCAT adopted management and conservation measure captures conceptually the objective of addressing the impacts of fishing on trophic interactions and

interdependencies involving relevant species or components of ecosystems. We therefore assigned the progress category – Slight progress by the Commission.

(ii) **Indicators**

Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Research activities conducted by the Scientific Committee on food web interactions, ecosystem modelling, diet analysis, and development of indicators to track ecosystem change or impacts of fishing on ecosystems have been scarce in ICCAT (ICCAT 2011, 2012). Ecosystem metrics and food web models with interactions of relevant species and components of ecosystems have not been developed to understand broader community-based and ecosystem level consequences of fishing in the ICCAT Convention Area. However, the Scientific Committee has discussed the potential uses of ecosystem models, such as Ecopath with Ecosim and SEAPODYM, and has recommended the identification and evaluation of ecosystem indicators to advance towards the implementation of EBFM, especially focusing on interpretation of ecosystem indicators, their robustness, responsiveness and associated reference points (ICCAT 2010). The Scientific Committee has also expressed value and interest in conducting research on multi-species and multi area stock assessments to evaluate management objectives for multiple stocks and evaluate species interactions. Recent efforts to apply ecosystem modeling to Atlantic pelagic ecosystems include a preliminary food web to assess the ecological value of Sargassum ecosystems for tuna and tuna-like species, and a preliminary Ecopath ecosystem model to test the effects of the development of the FAD fishery in the Gulf of Guinea, although these models are at the very early stages of development (ICCAT 2015a). Moreover, the SEAPODYM model has also started to be developed in the Atlantic Ocean for both target (Dragon et al. 2015) and bycatch species (Schirripa et al. 2011), but are not yet been considered for management advice. Other ecosystem models like APECOSM (Maury 2010) are also being developed and might be helpful in the future for RFMO decisions.

In conclusion, ecosystem metrics and food web models with interactions of relevant species and components of ecosystems have not been developed to understand broader community-based and ecosystem level consequences of fishing in the ICCAT Convention Area. Empirically- based and/or model-based ecosystem indicators are not available or monitored to track the impacts of fisheries on ecosystems and to assist the Commission in making its management decisions and ensure ecosystem considerations are part of its agenda. Overall, the ecosystem-related research activities have been relatively scarce in ICCAT, and despite there are some recent examples of ecosystem modelling efforts, they are considered too preliminary and they are not yet taken into account in setting management advice or discussed at the Commission level. Therefore, we assigned the progress category – Slight or no progress only by the Scientific Committee.

(iii) **Reference points**

Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Ecosystem and/or multispecies management plans (including harvest strategies) with pre-defined reference points for relevant species and components of ecosystems have not been developed and are not under discussion. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

(iv) **Management responses and measures**

Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Management measures have not been adopted to explicitly account for the impacts of fishing on trophic interactions and the food web in order to maintain the structure and functioning of marine ecosystems, or have been linked to any pre-established ecosystem model, ecosystem indicators and operational objectives. Conceptual ecosystem models or multispecies management plans have not been developed and their use evaluated in decision-making or addressed in management measures. No formal mechanisms exist to accommodate multispecies and food web

interactions and ecosystem modelling into the current management and conservation of target or bycatch species and associated ecosystems. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

Habitats - Ecological component 4.

Under the ecological component of "Habitats", we valued whether habitats of special concern (e.g. reproduction, migration, feeding, hotspots) and/or habitat utilization and preferences for relevant species have been formally investigated and delineated, and how this information is being used to advance progress in implementing EBFM.

(i) **Objectives**

Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

The ICCAT Convention Agreement does not contain any specific provisions relevant to habitats of special concern for ICCAT species. Habitats of special concern have not been formally defined or delineated in the Convention Agreement. Yet a series of conservation and management measures have been adopted recognizing the importance of conducting habitat research to identify habitats of special concern for some species of interest to the Commission. Five recommendations concerning the conservation of sharks recommends member states, where possible, conduct research to identify shark nursery areas, since this research could be used to consider time and area closures and other measures to protect vulnerable shark habitat (Recommendations 04-10, 07-06, 09-07, 10-08, 15-06). Two resolutions have been adopted on the Sargasso Sea to request the Scientific Committee to assess the ecological importance of Sargassum to tuna and tuna-like species (Resolutions 05-11, 12-12). One recommendation has been adopted to encourage research to identify spawning grounds of Eastern and Mediterranean Atlantic bluefin tuna to provide advice to the Commission on the creation of sanctuaries (Recommendation 14-04). Last, one recommendation calls for the prohibition of targeting western Atlantic bluefin tuna in the Gulf of Mexico spawning grounds (Recommendation 08-04).

Moreover, the 2015-2020 SCRS Science Research Plan contains as a strategic objective to advance EBFM advice by focusing on the fishery and its effect on the ecosystem, including commercial and non-commercial species as well as the habitat. The Terms of Reference for the Sub-committee on Ecosystems does not make reference to the importance of conducting research to identify habitats of special concern, yet, it has the specific task of conducting research and characterize the main feeding and reproductive habitat for ICCAT target species.

In conclusion, conceptual objectives have at least been formally stated in adopted management measures to recognize the importance of conducting research to identify and potentially protect habitats of special concern for some species of interest to the Commission. We therefore assigned the progress category – Slight progress by the Commission.

(ii) **Indicators**

Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

Habitats of special concern (e.g. reproduction, migration, feeding, hotspots) and habitat utilization and preferences for some relevant ICCAT species have been formally investigated by the Scientific Committee as requested by the Commission, and indicators (associated to pre-established objectives) describing habitat needs and preferences are under development. Research activities and practices to identify habitats of special concern and habitat preferences and utilization for relevant species in support of the implementation of EBFM have historically been relatively scarce in the ICCAT area, yet there are few exceptions of recent initiatives that recognize the importance of habitat research and set the basis towards advancing the habitat component of EBFM in ICCAT.

As requested by the Commission, the ICCAT Sub-Committee on Ecosystems started a collaborative research program to map the relative significance of the Sargasso Sea as essential habitat for ICCAT tunas and tuna-like species (Luckhurst 2014a, Luckhurst and Arocha 2015). The Sargasso Sea may play a fundamental role in the

trophic web of highly migratory species in the west Atlantic (Luckhurst 2014b), and potentially it could be a case study in implementing an ecosystem based management approach within ICCAT in collaboration with other research institutions (ICCAT 2015a). Moreover, ICCAT has developed an international cooperative tagging program in the Atlantic Ocean and its adjacent seas, and it is involved in several tagging programs (e.g. the Atlantic-wide research program for bluefin tuna -BBYP). These tagging programs have been mostly designed to increase the understanding on the population dynamics of tunas and their basic life histories including estimates of longevity, growth, and natural mortality, and tuna movements and their interactions with fishing gears (Fonteneau and Hallier 2015), and their use to support habitat research has been limited by the Scientific Committee. Yet these tagging programs are slowly revealing critical information of seasonal migrations, habitat utilization, breeding migration, migration corridors, hot spots, and physical oceanographic patterns that are important to understand how tunas use the open ocean environment e.g. (Block et al. 2001, Galuardi and Lutcavage 2012). Some studies have also been conducted to document habitat preferences and identify most important variables driving the spatio-temporal distributions of some ICCAT target species (Arrizabalaga et al. 2015, Druon et al. 2016). There is also an increasing use of ecosystem and habitat models such as SEAPODYM and APESCOM to investigate the dynamics and spatial distributions of target species and their responses natural climate and climate change in the ICCAT area (Schirripa et al. 2011, Lefort et al. 2014, Lehodey et al. 2014a). Habitat research focused on the habitat utilization and preferences of bycatch species has been scarce. Despite these efforts and initiatives that recognize the importance of habitat research which potentially set the basis towards advancing the habitat component of EBFM in the ICCAT area, the outcomes of these research studies have had a limited impact on formally identifying, delineating and protecting habitat of special concerns for relevant species in the ICCAT area and on developing indicators describing habitat needs and preferences for relevant species.

In conclusion, habitats of special concern and habitat utilization and preferences for some relevant ICCAT species have been formally investigated by the Scientific Committee as requested by the Commission, and indicators (associated to pre-established objectives) describing habitat needs and preferences are under development and under discussion by the Scientific Committee to provide management advice to the Commission. We therefore assigned the progress category – Slight progress by the Commission.

(iii) **Reference points**

Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Minimum habitat needs and requirements (linked to pre-established indicators and objectives) have not been identified and are not under discussion for any relevant species with habitats of special concern. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

(iv) **Management responses and measures**

Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

The Commission has requested through several Recommendations and Resolutions to conduct research to identify habitats of special concern for some species of sharks (Recommendations 04-10, 07-06, 09-07, 10-08, 15-06), tunas (Recommendation 08-04, 14-04) and identify the ecological importance of Sargassum for tuna and tuna-like species (Resolutions 05-11, 12-12), but these management measures do not call for the protection of habitats of special concern for any of the species. The habitat research conducted in the ICCAT area is at the early stages of providing management advice to protect habitats of special concern for relevant species. Currently, the research outcomes and recommendations on habitats of special concern produced by the Scientific Committee are discussed to produce management advice but not used in decision-making at the Commission level. We therefore assigned the progress category – Slight progress by the Commission.

3.2 Indian Ocean Tuna Commission

3.2.1. Review of basic texts and main structures in support of EBFM

(i) **Reference to the PA and EBFM principles in accordance to relevant rules of international fisheries governance**

Progress category assigned: MODERATE PROGRESS BY THE COMMISSION

IOTC was established in 1993 and its Convention Agreement entered into force in 1996. Its Convention Agreement makes explicit reference to "promote cooperation among its members with a view to ensuring, through appropriate management, the conservation and optimum utilization of stocks covered by this Agreement and encouraging sustainable development of fisheries based on such stocks". The Agreement covers the conservation and optimum utilization of 16 species of tuna and tuna-like species which include the principal market tunas, neritic tunas, mackerels and billfishes. The Convention Agreement does not make reference to the principles of the precautionary approach or EBFM (IOTC 2009). However, since its creation IOTC has had the ability to assimilate some elements of global instruments of fishery governance (UNCLOS and UNFSA) in the form of adoption of some formal management measures (binding Resolutions and non-binding Recommendation), for example by adopting measures to mitigate the effects of fishing on bycatch species and a measure calling for the application of the precautionary approach in accordance to relevant guidelines set in the UNFSA. IOTC Resolution 12/01 agrees to apply the precautionary approach in accordance with relevant international agreed standards, in particular with the guidelines set forth in the UNFSA, and to ensure the sustainable utilization of fisheries resources as set forth in Article V of the IOTC Agreement. Moreover, the Scientific Committee has also conveyed its intention of developing indicators and reference points that explicitly incorporate ecosystem considerations, and develop mechanisms to integrate ecosystem considerations into the scientific advice provided to the Commission in its Terms of Reference for the IOTC Working Party on Ecosystems and Bycatch (IOTC 2007). Yet there has been small progress towards advancing these aforementioned intentions.

In conclusion, the IOTC Convention Agreement does not make reference to the principles of the precautionary approach or EBFM. However, since IOTC has had the ability to assimilate some principles of EBFM stated in international instruments of fisheries governance in the form of adoption of formal management measures. Therefore we assigned the progress category – Moderate progress by the Commission.

(ii) **Existence a lead entity or group to advance progress in EBFM and ecosystem science**

Progress category assigned: MODERATE PROGRESS BY THE COMMISSION

IOTC has a Science Committee, which is responsible for developing advice on data collection, on the status of the stocks and on management issues to the Commission. The Scientific Committee relies on the scientific input and research conducted by several Working Parties (WP), including the WP on Data Collection and Statistics, WP on Methods, WP on Temperate Tunas, WP on Tropical Tunas, WP on Neritic Tunas, WP on Billfish and WP on Ecosystems and Bycatch. The Working Party on Bycatch was created in 2005, and in 2007 this Working Party was renamed as the WP on Ecosystem and Bycatch and expanded its terms of reference to coordinate and integrate ecosystem and bycatch monitoring, research, modeling and advice activities to facilitate the incorporation of ecosystem considerations into management decisions (IOTC 2007). The Working Party on Ecosystems and Bycatch meets every year to tackle ecosystem and bycatch related research and associated activities as required by the Scientific Committee to fulfill its advisory role to the Commission. The work conducted depends on the priorities set by the Commission, which until now has focused on estimating fisheries interactions with bycatch species and providing guidance on mitigation measures to reduce bycatch (IOTC 2014b). Every year, the Working Party on Ecosystems and Bycatch prepares a report summarizing the main research activities conducted and reviewed during the year and prepares a series of recommendations for the Scientific Committee regarding bycatch and ecosystem issues and progress in implementing EBFM.

In addition, the Working Parties on Temperate Tunas, on Tropical Tunas, on Neritic Tunas, and Billfish review available fishery and research information for their species of interest to the Commission and provide mostly advice with a single-species focus. Yet these species may also be treated as a bycatch species and their total removals may also have an impact on the ecosystem, therefore the research activities and tasks derived by these working groups are also relevant to the activities conducted and recommendations provided by the Working Party on Ecosystems and Bycatch. The current research and management advice derived from these Working Parties may be also relevant to provide management advice on ecosystem issues to the Commission. IOTC also lacks of an effective mechanism to coordinate all ecosystem-relevant research, and ensure effective communication and exchange of information pertaining to ecosystem issues among all the Working Parties, which limits a full assessment of the cumulative impact of IOTC fisheries on target and bycatch species and the effects of their removals from the ecosystem, limiting a comprehensive implementation of EBFM.

In conclusion, the Working Party on Ecosystems and Bycatch was created to better integrate ecosystem considerations into the scientific advice provided by the Scientific Committee to the Commission. However, it has limited capacity to coordinate effectively all relevant ecosystem research activities (pertaining to target and bycatch species, trophic relationships and habitats) needed to fully implement EBFM, since some of these research activities are conducted independently by other working groups (e.g. WP on Billfish, WP on Neritic Tunas). The Scientific Committee reviews and supervises the research and recommendation put forward by the Working Party on Ecosystems and Bycatch and other Working Parties. However, to our knowledge there is no effective mechanism to coordinate and integrate all ecosystem-relevant research or to exchange information pertaining to ecosystem issues and to ensure effective communication among the Working Parties and to the Commission. This lack of effective and coordinated communication among the working groups limits a full assessment of the cumulative impact of IOTC fisheries on target and bycatch species and the effects of their removals from the ecosystem, limiting a comprehensive implementation of EBFM. We therefore assigned the progress category – Moderate progress by the Commission.

(iii) **Existence of an EBFM plan**

Progress category assigned: MODERATE PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

IOTC has not formally developed and adopted an operational EBFM plan to account for ecosystem considerations derived from the main ecological elements (target, bycatch, trophic interactions and habitats) of EBFM, so these ecological elements are taken into account in management advice when managing tuna and tuna-like species and associated ecosystems in the Indian Ocean. The Scientific Committee has not developed either an EBFM plan or a Strategic Research Plan stating strategic goals and guidance regarding research and scientific advice to the Commission. However, the work plan of the Working Party on Ecosystem and Bycatch in 2015 included the task of developing a plan for EBFM approaches in the IOTC area as a high priority to guide the development of ecosystem research or ecosystem considerations and ecosystem management advice to ensure it remains responsive to the Commission needs (IOTC–WPEB11 2015). Therefore, since an operational EBFM plan has not been developed or adopted by IOTC but its development is under discussion by the Scientific Committee, we assigned the progress category – Moderate progress only by the Scientific Committee.

(iv) **Existence of a data collection program to support the implementation of EBFM**

Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

IOTC has not established data collection and monitoring programs to address comprehensively the impacts of fisheries on the ecosystem and support the implementation of EBFM. Instead, the existing data collection and monitoring programs were mainly designed to collect data for target species but some bycatch data is also collected at least in some relevant fisheries as requested by the Commission. In 2010 IOTC established a regional observer program required in vessels >24 meters operating in the IOTC area of competence, and in January of 2013 it was extended to vessels less than 24 m operating outside national waters (Resolution 09/04 superseded by Resolution 10/04 and Resolution 11/04). The regional observer program is partially coordinated by the IOTC Secretariat since it gives support to those members without their own national observer programs. The observer programs supply the

observers, and the data collected must be submitted to the IOTC Secretariat. A regional observer program database exists for some relevant fisheries and fleets. However, the data sets are not open access to allow for EBFM analyses. The data sets are comprised of data submitted by individual member countries from their observer programs. The data are often not standardized or is submitted as summaries in aggregated form, which does not allow pooling to conduct joint regional EBFM analysis. The data submission and level of observer coverage are also often too low or incomplete to generate quality data to support joint regional assessments relevant to bycatch and ecosystem issues. Prior to the regional observer program, some members had already their own national regional observer programs at least for some fishing gears and fleets. There is a requirement of 5% coverage for the number of operations/sets for each gear type by fleet for each member country.

In conclusion, data collection and monitoring programs exist, but not necessarily to address comprehensively the impacts of fisheries on the ecosystem and support the implementation of EBFM. Existing data collection and monitoring programs were mainly designed to collect data for target species but some bycatch data is also collected at least in some relevant fisheries as requested by the Commission. A regional observer program database exist for some relevant fisheries and fleets, yet the data are not standardized or in a form that allows pooling to conduct joint regional EBFM analysis. In addition, the data sets are not open access to allow for EBFM analyses. Therefore, we assigned the progress category – Slight progress by the Commission.

3.2.2. Review of main ecological components in support of EBFM

For each of the ecological components of target species, bycatch species, ecosystem properties and trophic relationships and habitats, we assess the following four elements: (1) whether conceptual and/or operational *objectives* have been formally stated, (2) whether there are measurable *indicators* associated to objectives to track the state and trend of each ecological component, (3) whether *reference points* for those indicators have been defined to activate management action, and (4) whether there are *management responses and measures* to ensure that those reference points are not exceeded.

Target species - Ecological component 1

For practical reasons, we only considered in the assessment of progress under the ecological component of "Target Species" all principal market tunas and Swordfish. IOTC is responsible for the conservation and management of the following principal market tunas, Skipjack tuna *Katsuwonus pelamis,* Yellowfin tuna *Thunnus albacares,* Bigeye tuna *T. obesus* and Albacore tuna *T. alalunga,* and the conservation and management of Swordfish (*Xiphias gladius*) within its area of jurisdiction.

(i) **Objectives**

Progress category assigned: MODERATE PROGRESS BY THE COMMISSION

The Convention primary objective is "to promote cooperation among its members with a view to ensuring, through appropriate management, the conservation and optimal utilization of stocks of tuna and tuna-like species covered by the Convention Agreement and encouraging sustainable development of fisheries based on such stocks". The term "optimum utilization" is not defined in the Convention Agreement, plus it is considered a vague, narrow and outdated concept (IOTC 2009). Therefore, the IOTC Convention has not explicitly defined a general operational objective that applies to fish stocks covered by the Convention. Instead IOTC has adopted a management measure (Resolution 15/10) stating the management objective of maintaining fish stocks in perpetuity and with high probability, at levels not less than those capable of producing their maximum sustainable yield as qualified by relevant environmental and economic factors including the special requirements of developing States in the IOTC area of competence. Therefore, although an operational objective has not been formally stated in the Convention agreement of IOTC, IOTC has adopted a management measure (Resolution 15/10) with the operational objective of maintaining fish stocks at levels not less than those capable of producing their maximum sustainable yield. We therefore assigned the progress category – Moderate progress by the Commission.

(ii) **Indicators**

Progress category assigned: FULL PROGRESS BY THE COMMISSION

Fishery stock assessments have been conducted for all principal market tunas stocks (4 species/stocks) and Swordfish (1 stock). Thus, all target stocks exploited by IOTC fisheries have been evaluated with fisheries stocks assessments to determine the effects of fishing on the individual stocks and determine their exploitation status. Indicators of population status including indicators of population size and fishing mortality over time and associated reference points are available and monitored regularly for these assessed stocks. These stock status indicators and associated reference points are also explicitly associated to the implicit aforementioned objective of maintaining populations at maximum sustainable yields. We therefore assigned the progress category – Full progress by the Commission.

(iii) **Reference points**

Progress category assigned: FULL PROGRESS BY THE COMMISSION

Stock-specific interim limit and target reference points associated with the biomass and fishing mortality rate indicators have been adopted for all target species including Bigeye tuna ($B_{TARGET}=B_{MSY}$; $B_{LIM}=0.50B_{MSY}$; $F_{TARGET}=F_{MSY}$; $F_{LIM}=1.30B_{MSY}$), Skipjack tuna ($B_{TARGET}=B_{MSY}$; $B_{LIM}=0.40B_{MSY}$; $F_{TARGET}=F_{MSY}$; $F_{LIM}=1.50B_{MSY}$) and Yellowfin tuna, Albacore tuna, and Swordfish ($B_{TARGET}=B_{MSY}$; $B_{LIM}=0.40B_{MSY}$; $F_{TARGET}=F_{MSY}$; $F_{LIM}=1.40B_{MSY}$) (Resolution 15/10). Furthermore, Resolution 14/03 requires a series of Science and Management Dialogue Workshops to advance work on the adoption of reference points and harvest control rules. We therefore assigned the progress category – Full progress by the Commission.

(iv) **Management responses and measures**

Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

Harvest control rules have not been developed or adopted for any of the target species. Yet Resolution 15/10 establishes a decision framework and requests to the IOTC Scientific Committee to develop harvest strategy rules for IOTC species in relation to the agreed target and limit reference points which are evaluated through a management strategy evaluation. The Managers-Science Dialogue Meeting Process that has been established under Resolution 14/03 to enhance dialogue between scientist and managers are used to discuss the establishment and development of harvest strategy rules and determining risk levels and time frames for different actions (IOTC 2014c). The last Commission in 2015 agreed to continue supporting the development of the HCR/MSE Scientific Committee Workplan as set in Resolution 14/03 and 15/10.

Furthermore, IOTC has adopted relatively few management measures (binding-resolutions) in comparison to other tRFMOs to ensure the aforementioned management objective is achieved. We briefly summarize the most relevant binding conservation and management measures adopted by IOTC to manage target species. IOTC has not adopted any binding conservation and management measures for any of the main target tuna species or Swordfish. Resolution 14/02 calls for members to establish a quota allocation systems or any relevant measure based on the Scientific Committee recommendations for the main targeted species under IOTC competence, however, it was not specified how this will be done. Resolution 15/06 requires all purse seiner to retain on board and then land all Bigeye, Skipjack and Yellowfin tunas, thus establishing a ban on discard of this species by purse seiners.

In conclusion, harvest control rules have not been adopted for any target species but are under development by the Scientific Committee and being discussed by the Commission for some species. Furthermore, relative few binding management measures have been adopted (mostly focused to regulate fishing effort) to ensure management objectives are achieved. We therefore assigned the progress category – Slight progress by the Commission.

Bycatch species - Ecological component 2.

For practical reasons, we reviewed under the ecological component of "Bycatch species" all billfish species (except Swordfish), as well as sharks, seabirds, sea turtles, marine mammals, and other finfishes impacted by fisheries. Yet we stress several species of billfishes, sharks and other finfishes can also be target species at least in some fisheries.

(i) **Objectives**

Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

The IOTC Convention mandate does not make explicit provisions addressing the impacts of IOTC fisheries on by-catch or dependent species and ecosystems (IOTC 2009). Nevertheless, since its creation IOTC has adopted several measures (binding-resolutions and non-binding recommendations) where vague conceptual objectives have been stated in relation to the minimization and mitigation of the effects of fishing on bycatch species including sharks, seabirds, marine mammals and turtles (see below the section on Responses and Management Measures). However, these adopted measures do not state clear operational objectives to reduce the impacts of fishing on these groups of bycatch species. Furthermore, the Working Party on Ecosystems and Bycatch has the task to review and analyze matters relevant to bycatch, and non-target species impacted by IOTC fisheries including sharks, marine turtles, seabirds, mammals and other fishes. Their program of work (2015-2019) includes as a high research priority to conduct biological studies and stock assessments and review mitigation measures for sharks, and review mitigation measures for marine turtles and seabirds (IOTC 2014b).

In conclusion, IOTC has not formally adopted in the Convention Agreement conceptual or operational objectives to account for the impacts of fisheries on bycatch species. However, at least conceptual objectives have been stated in the work program of the Working Party on Ecosystem and Bycatch and have also been vaguely stated in several adopted management measures. We therefore assigned the progress category – Slight progress by the Commission.

(ii) **Indicators**

Billfishes - Progress category assigned: MODERATE PROGRESS BY THE COMMISSION

Some billfish stocks and species, including black marlin, striped marlin, blue marlin and sailfish, are regularly assessed with traditional fishery stock assessments. Thus, indicators of stock status, including indicators of population size and fishing mortality over time are regularly developed and monitored for these assessed species to provide management advice. In conclusion, a series of region-wide indicators of stock status (associated to pre-established objectives) are routinely developed and monitored only for some billfish species which are used to provide robust management advice to the Commission. We therefore assigned the progress category – Moderate progress by the Commission.

Sharks - Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

The Indian Ocean Blue shark was assessed with traditional fishery stock assessments for the first time in 2015. However, the assessment could not determine the current exploitation status of the stock, and the resultant status indicators were considered preliminary and highly uncertain due to the limitation of the quantity and quality of data (IOTC–WPEB11 2015). Currently, the Scientific Committee is prioritizing the development of indicators of stock status for three relatively data-rich species of sharks (Blue shark, Oceanic white tip shark and Shortfin mako). The indicators of stocks status available consist in evaluating the temporal patterns of several standardized CPUEs from several longline fleets for these three species of sharks, which is seen as the first step towards developing a traditional fishery stock assessment. The development of the 2014 Multiyear Shark Research Program, initiated by the IOTC Scientific Committee and shark experts in the Working Party on Ecosystems and Bycatch, is facilitating the development of stock assessments and status indicators for shark species caught by IOTC fisheries and improving the collaboration and cooperation among IOTC researchers (IOTC 2014a).

In 2012 the Scientific Committee also conducted a preliminary ecological risk assessment for shark species, as determined by a susceptibility and productivity analysis (Murua et al. 2012), in order to rank their relative vulnerability to logline and purse fisheries in the IOTC area. An ecological risk assessment for sharks in gillnet fisheries is still missing driven by a lack of data availability. The preliminary ecological risk assessment allowed

identifying the 10 most vulnerable sharks species to longline and purse seine fisheries, which has been used to set research and provide advice on shark management to the Commission.

In conclusion, preliminary indicators of stock status based on nominal catches and fishing effort have been developed for some shark species which are used to provide weak management advice since they cannot be used directly for determining the status of stock, and more robust indicators derived from fisheries stock assessments are under development for Blue shark by the Scientific Committee. We therefore assigned the progress category – Slight progress by the Commission.

Seabirds - Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Regional wide assessments and indicators of stock status or fishery impacts for seabirds impacted by IOTC fisheries have not been developed by the Scientific Committee or have been requested by the Commission (IOTC 2014d, IOTC–WPEB11 2015). Members do not follow the guidance on data reporting formats, and data are insufficient to calculate species-specific gear interactions, mortality rates, or indicators of stock status (IOTC–WPEB11 2015). To date, the IOTC Scientific Committee has focused its efforts on identifying areas of overlap of high vulnerability to industrial longline fisheries for seabirds, assessing their relative risk to longline fisheries with ecological risk assessments, and proposing effective bycatch mitigation measures (IOTC 2014d). Yet its progress on these tasks has been mixed. Although longline interaction with seabirds is known to be the most relevant source of incidental mortalities, seabirds are also known to be taken by gillnet fisheries but the interactions of gillnet fisheries with seabirds populations are unknown. In 2010, a preliminary level 1 ecological risk assessment was conducted for seabirds to evaluate the risk of seabirds from bycatch in longline fisheries in the IOTC area (IOTC–WPEB06 2010). This assessment was considered preliminary and it has not been used to provide managemet advice to the Commission. In this risk assessment, forty seabird populations were identified as high priority. The ecological risk assessment was conducted by the Agreement on the Conservation of Albatrosses and Petrels (ACAP) and BirldLife International (BirdLife). The Scientific Committee recommended to undertake a level 2 ecological risk assessment for those species identified as high priority, and to conduct a level 3 assessment for a smaller number of species where data availability permits it. These assessments have not been undertaken or reviewed by the Scientific Committee yet.

In conclusion, regional wide risk assessments and indicators of stock status or fishery impacts for seabirds impacted by IOTC fisheries have not been developed by the Scientific Committee. The 2010 level 1 ecological risk assessment to evaluate seabirds-longline fishery interactions was considered preliminary and it has not been used to provide managemet advice to the Commission. Therefore, we assigned the progress category – Slight or no progress only by the Scientific Committee.

Sea turtles - Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Region wide assessmetns and indicators of stock status or fishery impacts for sea turtles impacted by IOTC fisheries have not been developed by the Scientific Committee (IOTC 2014d, IOTC–WPEB11 2015). Although Resolution 12/04 On the conservation of marine turtles includes an annual evaluation requirement by the Scientific Committee, yet the Scientific Committee has made very small progress towards the request (IOTC–WPEB11 2015). Members do not follow the guidance on data reporting formats, and data are insufficient to understake impact assessments, calculate species-specific gear interactions, total bycatch mortality rates, or indicators of stock status. Instead the IOTC Scientific Committee has focused its efforts on assessing the relative risk to longline, purse seine and gillnet fisheries on sea turtles, and proposing mitigation measure s (IOTC-SC17 2014). A qualitative level 1 ecological risk assessment was conducted in 2013 for all six species of marine turtles found in the IOTC area to evaluate their interactions with longline, purse seine and gillnet fisheries (Nel et al. 2013). This preliminary ecological risk assessment indicated gillnets posed a greater threat to sea turtles, followed by longliners and to lesser extent by purse seiner.

In conclusion, the Scientific Committee is unable to assess the risk of sea turtle bycatch and develop indicators of stock status or fishery impacts given the lack of data reporting by members, constraining its ability to develop any needed conservation measure. Therefore, we assigned the progress category – Slight or no progress only by the Scientific Committee.

Marine mammals - Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Region-wide assessments and indicators of stock status or fishery impacts for marine mammals impacted by IOTC fisheries have not been developed by the Scientific Committee, or have been requested by the Commission. It has been extremely limited the reporting of the interactions of IOTC fisheries with marine mammals (IOTC–WPEB11 2015). IOTC members have reported bycatch of marine mammals in their fisheries, but data are insufficient to calculate species-specific gear interactions, mortality rates, or indicators of fishery impacts. Thus, there is need to gather information to determine if fisheries interactions are significant and to propose effective mitigation techniques to reduce incidental mortalities. Even the most basic information on marine mammal distributions and how it overlaps with fishing effort is lacking except for some purse seine fisheries. The Scientific Committee has noted that gillnets are a major impact on marine mammals in certain areas of the Convention, which still needs to be addressed in order to determine if this bycatch is sustainable. Currently marine mammals are a lower priority than sharks, seabirds and turtles for the Scientific Committee. In the work assessment schedule for the IOTC Working Party on Ecosystems and Bycatch for 2016-2020, there are no planned assessments for marine mammals. Yet the Scientific Committee encourages research on the interaction IOTC fisheries with marine mammals, and it periodically reviews data and information presented to the group on the interactions of fisheries with marine mammals and on depredation events to quantify the economic impacts of depredation on several fisheries (IOTC–WPEB11 2015). The Scientific Committee work has focused on studying depredation rates from marine mammals, and less regarding interactions, hooking or entanglement of marine mammals with longline gears or other fishing gears driven by the lack of data (IOTC–WPEB09 2013). IOTC endorsed a five year research program one marine mammal depredation on tuna caught with longline gear in 1999. Yet the frequency of depredation events, loss of catch to depredation, and overall impact of these interactios is poorly known at large scales, and no management measures have been adopted to minimize these interactions. Currently, the Scientific Committee is unable to assess the risk of marine mammal bycatch and develop indicators of stock status or fishery impacts, constraining its ability to develop robust management advice. Therefore, we assigned the progress category – Slight or no progress only by the Scientific Committee.

Other finfishes - Progress category assigned: MODERATE PROGRESS BY THE COMMISSION

The Scientific Committee has focused its efforts on assessing the exploitation status for six species of neritic tunas and mackerels as requested from the Commission (IOTC 2011). Neritic tunas and mackerels have become as important or more important than the three tropical principal market tuna species in some IOTC coastal states. The six species of neritic tunas and mackerel include Bullet tuna *Auxis rochei*, Frigate tuna *Auxis thazard*, Kawakawa *Euthynnus affinis*, Longtail tuna *Thunnus tonggol*, Indo-Pacific king mackerel *Scomberomorus guttatus* and Narrow-barred Spanish mackerel *Scomberomorus commerson*. The Scientific Committee has conducted quantitative assessments for Kawakawa, Longtail tuna, Indo-Pacific king mackerel, Narrow-barred Spanish mackerel in the Indian Ocean, using data-poor assessment approaches or formal approaches depending on the species (IOTC 2015). These assessments have provided indicators of stock status, however, considerable uncertainty remains about their exploitation status, and these assessments and derived indicators of stock status remain preliminary. The Scientific Committee is giving high priority to the development of indicators such as the development of standardized CPUE time series for Longtail, Kawakawa, Spanish mackerel and Indo-Pacific mackerel in order to develop more formal assessment to determine their stock status. No quantitative assessments have been conducted for bullet tuna, frigate tuna in the Indian Ocean, and reconstruction of catch history statistics needs to occur before any assessment can be conducted (IOTC 2015). Their current stock status remains unknown and uncertain, hindering any management advice.

The Scientific Committee has also focused its efforts on assessing the relative risk of teleost fish species including finfishes other than the principal market tunas and billfishes to longline and purse seine fisheries in comparison to other taxonomic groups. A level 2 ecological risk assessment (productivity-susceptibility analysis) conducted in 2015 evaluated the vulnerability of tunas, billfishes and other teleost caught by longliners in the South Atlantic and Indian Oceans (Lucena Frédou et al. 2015). Another ecological risk assessment, which included several taxonomic groups, was conducted in 2009 to assess the relative risk of both target and bycatch species being impacted by various tuna fleets managed by IOTC, purse seine and longline fisheries (Murua et al. 2009). This assessment created an index of vulnerability to overfishing in longline and purse seine fisheries for species in several taxonomic groups including the target tuna species, as well as bycatch species such as billfishes, other teleost, sharks, skates,

rays, turtles, seabirds, and marine mammals. This risk assessment has been used to establish research and management priorities in IOTC.

In conclusion, the Scientific Committee has recently assessed and developed for the first time a series of indicators of stock status for some (four species) neritic tunas and mackerels, and although preliminary and uncertain at this stage, they are used to provie management advice. The Scientific Committee is also working to improve the current assessments and expand these assessments to more neritic tunas and mackerels species. Therefore, we assigned the progress category – Moderate progress by the Commission.

(iii) **Reference points**

Billfishes - Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

Limit reference points associated to the biomass and fishing mortality rate indicators have not been defined, developed or adopted for any of the assessed billfish stocks. B_{MSY} and F_{MSY} (or proxies) have been the unofficial implied target reference points used in IOTC for assessed billfishes. We therefore assigned the progress category – Slight progress by the Commission.

Sharks - Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

Limit reference points associated to the biomass and fishing mortality rate indicators have not been defined, developed or adopted for any of the assessed shark stocks. B_{MSY} and F_{MSY} (or proxies) have been the unofficial implied reference points used in IOTC for assessed sharks. We therefore assigned the progress category – Slight progress by the Commission.

Seabirds - Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Target and/or limit reference points associated to indicators of stock status or bycatch rate estimates have not been defined, developed or adopted for any of the species, and are not under development or being discussed. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

Sea turtles - Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Target and/or limit reference points associated to indicators of stock status or bycatch rate estimates have not been defined, developed or adopted for any of the species, and are not under development or being discussed. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

Marine mammals - Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Target and/or limit reference points associated to indicators of stock status or bycatch rate estimates have not been defined, developed or adopted for any of the species, and are not under development or being discussed. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

Other finfishes - Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

Limit reference points associated to the biomass and fishing mortality rate indicators have not been defined, developed or adopted for any of the finfish stocks. B_{MSY} and F_{MSY} (or proxies) have been the unofficial target reference points used in IOTC for the assessed neritic tunas (for kawakawa, longtail tuna, Indo-Pacific king mackerel, narrow-barred Spanish mackerel). We therefore assigned the progress category – Slight progress by the Commission.

(iv) **Management responses and measures**

IOTC has adopted an extensive list of conservation and management measures (non-binding Recommendations and binding Resolutions) for billfishes, sharks, seabirds, sea turtles, marine mammals, and none for other finfishes. We briefly list them below and group them by taxonomic group. Overall the adopted measures have the main purpose to minimize the effects of fishing on by-catch species as for example with the modification of gears to avoid them or in

the form of prohibition. The adopted measures also focus on establishing requirements for data reporting and conduct specific type of research. We find no management measure has been adopted to set a management response linked to pre-established operational objectives, indicators and reference points for any of the bycatch species impacted by IOTC fisheries, precluding them to be activated when predefined reference points are exceeded. The adopted measures (mostly to mitigate impacts) are not known whether they are being effective to affect the current status of populations since they have not been linked to status indicators or reference points to judge whether the current state of species is acceptable. We therefore assigned the progress category – Slight progress by the Commission to the taxonomic group of billfishes, sharks, seabirds, sea turtles and marine mammals. No management measures have been adopted or are under discussion by the Commission or Scientific Committee to minimize the impacts of fisheries on other finfishes, therefore, we assigned the progress category – Slight or no progress only by the Scientific Committee".

Measures	**Type of Measure**
Billfishes – Progress category assigned: Slight progress by the Commission	
Resolution 15/05 encourages CPCs to reduce in 2016 the level of catches of their vessels for striped marlin, black marlin and blue marlin, requests to release any billfish of these three species brought alive onboard. The baseline of the reduction of catches shall be the average catches for the period between 2009-2014.	-Binding -Minimize bycatch
Sharks - Progress category assigned: Slight progress by the Commission	
Resolution 05/05 established a limit on the ratio of fin weight to total shark weight that can be retained onboard a fishing vessel, and encouraged the release of live sharks in fisheries that do not target sharks. Includes minimum reporting requirements for sharks, calls for full utilization of sharks.	-Binding -Minimize bycatch -Sets limit on ratio of weight of retained shark fins
Resolution 12/09 prohibits the retention on board of all species of thresher sharks.	-Binding -Minimize bycatch
Resolution 13/05 prohibits intentional purse seine setting on tunas associated with whale sharks and requests that the IOTC Scientific Committee develop best practice mitigation and handling guidelines.	-Binding -Minimize bycatch
Resolution 13/06 prohibits the retention of oceanic whitetip sharks.	-Binding -Minimize bycatch
Resolution 13/08 calls for a transition to non-entangling FADs in purse seine fisheries starting in 2014.	-Binding -Minimize bycatch
Seabirds - Progress category assigned: Slight progress by the Commission	
Resolution 12/06 requires longliners operating south of 25°S to use at least two of several mitigation measures, requires to provide data on interactions between fisheries and sea birds to the Scientific Committee.	-Binding -Minimize bycatch
Sea turtles - Progress category assigned: Slight progress by the Commission	
Resolution 12/04 requires to mitigate sea turtle mortality and to provide data on turtle bycatch to the Scientific Committee. Provides requirements to facilitate the appropriate handling and release of live turtles.	-Binding -Minimize bycatch
Resolution 13/08 calls for a transition to non-entangling FADs in purse seine fisheries starting in 2014.	-Binding -Minimize bycatch
Marine mammals - Progress category assigned: Slight progress by the Commission	
Resolution 13/02 prohibits deliberate purse seining around cetaceans and requires reporting of interactions.	-Binding -Minimize bycatch
Resolution 13/04 request information from CPCs on the interaction rates with other fishing gears, in particular gillnets and longlines; requests that the IOTC Scientific Committee develop best practice mitigation and handling guidelines.	-Binding -Minimize bycatch
Other finfish - Progress category assigned: Slight or no progress only by the Scientific	

Committee	
No measures	
General measures for all taxa	
Resolution 12/12 measure to ban the use of large-scale driftnets on the high seas within the IOTC area of competence.	-Binding -Minimize bycatch

Ecosystem properties and trophic relationships - Ecological component 3.

Under the ecological component of "Ecosystem Properties and Trophic Relationships", we valued the existence of ecosystem metrics (empirically and model based) and food web models depicting trophic interactions and interdependencies involving relevant species or components of ecosystems that are affected by fishing, and are relevant to maintain ecosystem structure and function, and how this information is being used to advance progress in implementing EBFM.

(i) **Objectives**

Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

The IOTC Convention Agreement or adopted management and conservation measures do not contain any specific provisions addressing the impact of IOTC fisheries on trophic interactions and interdependencies involving relevant species or components of ecosystems in order to maintain the structure and functioning of marine food webs and ecosystem health (IOTC 2009). The Working Party on Ecosystems and Bycatch has the task to review and analyze matters relevant to ecosystems in which IOTC fisheries operate, and develop mechanisms to better integrate ecosystem considerations into the scientific advice provided by the Scientific Committee to the Commission, yet the Working Party has not defined or stated clear conceptual or operational objectives on these matters and it has not described the main research activities to ensure their stated tasks are accomplished. Furthermore, the program of work (2015-2019) for the Working Party on Ecosystems and Bycatch does not include any research tasks to progress on the understanding of the impact of IOTC fisheries on trophic interactions involving relevant components of ecosystems or on ecosystem properties and structure (IOTC 2014b).

In conclusion, the IOTC Convention Agreement and the adopted conservation and management measures do not contain any specific provisions addressing the impacts of IOTC fisheries on trophic interactions and interdependencies involving relevant species or components of ecosystems. The Scientific Committee has not yet established a research agenda to ensure ecosystem considerations including the maintenance of trophic interactions and interdependencies involving relevant component of ecosystems and the impacts of fisheries on marine food webs are incorporated in decision making. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

(ii) **Indicators**

Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Research activities and practices to address the importance of trophic interactions, food web models, diet analysis, ecosystem modelling, and development of ecosystem indicators to track ecosystem change or impacts of fishing on ecosystems have been relatively rare in IOTC (IOTC–WPEB08 2012, IOTC–WPEB09 2013). Nevertheless, the Scientific Committee encourages research on ecosystem approaches, modeling of potential benefits at the ecosystem level of alternative management strategies, on diet studies to investigate the trophic interactions among predators and prey species interacting with IOTC fisheries, on multi-species interactions to understand ecosystem variability since populations explosions of mantis shrimps, swimming crabs and lancetfish have been documented in the western Indian Ocean (IOTC–WPEB07 2011). Furthermore, the Scientific Committee also encourages the development of mechanisms to better integrate ecosystem considerations into the scientific advice provided by the Scientific Committee to the Commission.

In conclusion, ecosystem metrics and food web models with interactions of relevant species and components of ecosystems have not been developed to understand broader community-based and ecosystem level consequences of fishing in the IOTC Convention Area. Empirically- based and/or model-based ecosystem indicators are not available or monitored to track the impacts of fisheries on ecosystems and to assist the Commission in making its management decisions and ensure ecosystem considerations are part of its agenda. Overall, the ecosystem-related research activities have been relatively scarce in IOTC. Therefore, we assigned the progress category – Slight or no progress only by the Scientific Committee.

(iii) **Reference points**

Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Ecosystem and/or multispecies management plans (including harvest strategies) with pre-defined reference points have not been developed or are being discussed. We therefore assigned the progress category – Slight or no progress only by the scientific committee.

(iv) **Management responses and measures**

Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Management measures have not been adopted to explicitly account for the impacts of fishing on trophic interactions and the food web in order to maintain the structure and functioning of marine ecosystems, or have been linked to any pre-established ecosystem model, ecosystem indicators and operational objectives. Conceptual ecosystem models or multispecies management plans have not been developed and their used evaluated in decision-making and addressed in management measures. No formal mechanisms exist to accommodate multispecies and food web interactions and ecosystem modelling into the current management and conservation of target or bycatch species and associated ecosystems. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

Habitats – Ecological component 4.

Under the ecological component of "Habitats", we valued whether habitats of special concern (e.g. reproduction, migration, feeding, hotspots) and/or habitat utilization and preferences for relevant species have been formally investigated and delineated, and how this information is being used to advance progress in implementing EBFM.

(i) **Objectives**

Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

The IOTC Convention Agreement and adopted conservation and management measures do not contain any specific provisions relevant to habitats of special concern for IOTC species. Habitats of special concern have not been formally defined or delineated by the Commission. The Working Party on Ecosystems and Bycatch recognizes the importance of habitat in the development of an ecosystem approach to fisheries, and encourages the following research activities including the evaluation of the effect of oceanographic and climatic factors on the abundance, distribution and migration of IOTC target and non target species, and the characterization of main feeding and reproductive habitats for IOTC species. Yet the Working Party has not defined or stated clear conceptual or operational objectives relevant to habitats of special concern. Their program of work for 2015-2019 does not include either any research tasks relevant to habitats of special concern or habitat research (IOTC 2014b). We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

(ii) **Indicators**

Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Habitats of special concern (e.g. reproduction, migration, feeding, hotspots) and habitat utilization and preferences for relevant IOTC species have not been formally investigated and delineated by the Commission or Scientific Committee. Indicators (associated to pre-established objectives) describing habitat needs and preferences have not been developed, monitored or being used in management advice. Although the importance of conducting habitat research is acknowledged in the research agenda of the Scientific Committee, research activities and practices to identify habitats of special concern and habitat preferences and utilization for relevant species in support of the implementation of EBFM have been relatively scarce in the IOTC area. The current adopted Working Plan of the Working Party on Ecosystems and Bycatch does not include in its current or future research planned activities any activities regarding habitat research in support of implementing EBFM. However, some recent initiatives recognize the importance of habitat research setting the basis towards advancing the habitat component of EBFM, such as the Shark Research Program for which satellite tagging is identified as priority for shark habitat preferences studies. Furthermore, recent efforts to apply ecosystem and habitat modeling include a preliminary application of the SEAPODYM model to Swordfish in the Pacific and Indian Oceans, although this model is at the very early stages of development and is not used to provide management advice (Dragon et al. 2014). Other few research activities consist in accounting for environmental factors in several CPUE standardization techniques, particularly for target species in the Japanese longline fisheries (IOTC–WPEB09 2013).

In conclusion, habitats of special concern and habitat preferences and utilization have not been formally mapped or delineated for any IOTC species of interest, or are under discussion by the Scientific Committee. Indicators describing habitat needs and preferences for IOTC species have not been either developed, or are under discussion by the Scientific Committee. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

(iii) **Reference points**

Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Minimum habitat needs and requirements (linked to pre-established indicators and objectives) have not been identified and are not under discussion for any relevant species with habitats of special concern. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

(iv) **Management responses and measures**

Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Management measures have not been adopted to explicitly protect habitats of special concern for relevant species. Knowledge of habitats of special concern and habitat preferences and utilization is not under discussion to be used potentially in decision-making. There are no formal mechanism to accommodate minimum habitat needs and habitat protection into the current management or management decisions, nor are under discussion by the Scientific Committee. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

3.3 Western and Central Fisheries Commission

3.3.1. Review of basic texts and main structures in support of EBFM

(i) **Reference to the PA and EBFM principles in accordance to relevant rules of international fisheries governance**

Progress category assigned: FULL PROGRESS BY THE COMMISSION

The WCPFC was established by the Convention for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean which entered into force in 2014. The Convention Agreement

primary objective is "to ensure, through effective management, the long-term conservation and sustainable use of highly migratory fish stocks in the western and central Pacific Ocean in accordance with the 1982 Convention and Agreement". The Convention conforms to the 1982 United Nations Convention on the Law of the Sea, the 1995 United Nations Fish Stocks Agreement, and the 1995 FAO Code of Conduct for Responsible Fisheries. Therefore, the Convention makes explicit reference to the application of the precautionary approach, the use of the best scientific information available and ecosystems considerations to make management decisions, and emphasizes the need to avoid adverse impacts on marine environment, protect biodiversity and maintain integrity of marine ecosystems (Review Team 2012). It is the only tRFMO which Convention uses the term "highly migratory fish stocks" instead of the term "tuna and tuna-like" species. The highly migratory fish stocks term refers to the species listed in Appendix I in Article 64 of the 1982 United Nations Convention of the Law of the Sea. The WCPFC is mandated to manage and conserve all these species listed in the Appendix I, except sauries. Thus, the term comprises some of the scombrid species including the principal market tunas, small tunas including bullet tuna, frigate tuna, little tunny and kawakawa, but also billfishes, dolphinfishes and oceanic sharks.

In conclusion, the WCPFC Convention Agreement makes explicit reference to the principle of the precautionary approach and elements of EBFM in accordance with global instruments of fisheries governance. Therefore, we assigned the progress category – Full progress by the Commission.

(ii) **Existence a lead entity or group to advance progress in EBFM and ecosystem science**

Progress category assigned: MODERATE PROGRESS BY THE COMMISSION

The WCPFC has three subsidiary bodies including the Science Committee, the Technical and Compliance Committee, and the Northern Committee. The Scientific Committee provides the Commission with the best scientific information and advices on the status of the stocks and management and conservation issues. Originally the Scientific Committee comprised the following Specialist Working Groups (SWG): Assessment SWG, Fishing technologies SWG, Methods SWG, Biology SWG, Ecosystem and By-catch SWG, and Statistics SWG. Now these SWGs are refered as Themes. All the Themes are now discussed during the annual Scientific Committee meeting, while before the individual SWGs used to meet previuos to the annual Scientific Committee meetings to generate science recommendations that were afterwards disussed at the annual Scientific Committee meetings. Now it all ocurrs during the annual Scientific Committee meeting. The Ecosystem and Bycatch SWG (now referred as the Ecosystem and Bycatch Mitigation Theme) was created in 2005 to review relevant issues related to bycatch and ecosystem modeling (WCPFC 2009c). In the Ecosystem and Bycatch Theme during the annual Scientific Committee meetings a series of recommendations regarding bycatch, ecosystem impacts and ecosystems modeling are generated. Moreover, the WCPFC has formally identified potential overlaps of functions and responsibilities between all the Themes to ensure the Commission overall objectives are met. For example, the environmental variability discussed in the Ecosystem and Bycatch Mitigation Theme might be of interest to the Stock Assessment Theme, since it may need to be accounted for in the assessments themselves. The Stock Assessment Theme has the responsibility of evaluating the status of stocks of interests and critically reviews the assessments for not only target stocks, but also non-target stocks.

Most of the science requested by the WCPFC is produced by the capabilities of the Secretariat of the Pacific Community –Ocean Fisheries Program (SPC-OFP). The SPC-OFP is contracted to provide scientific advice for the southern Pacific stocks (serves as the Commission's Science Services Provider and Data Manager). The International Scientific Committee (ISC) for tuna and tuna-like species in the North Pacific Ocean also provides scientific support for the northern Pacific stocks, and follows a Working Group model similar to ICCAT and IOTC to conduct assessments for stocks of tunas, billfishes and sharks in the North Pacific Ocean.

In conclusion, the Ecosystem and Bycatch Mitigation Theme was created to provide information to the Commission to fulfill Articles 5 (d and e) of the Convention Agreement, which include to assess the impacts of fishing and environmental factors on target stocks, non target species, and species belonging to the same ecosystem or dependent on the target stocks, also adopt measures to minimize bycatch, and protect biodiversity in the marine environment. However, it has limited capacity or has partial authority to coordinate all relevant ecosystem research activities (pertaining to target and bycatch species, trophic relationships and habitats) needed to fully implement EBFM, as well as to effectively communicate them to the Commission. To our knowledge there is no effective mechanism to coordinate and integrate all ecosystem-relevant research or to ensure effective communication across

all the Themes exists and ensure effective communication to the Commission. This lack of coordination and capacity to fully integrate ecosystem considerations into science recommendations and management advice limits a full assessment of the cumulative impact of WCPFC fisheries on target and bycatch species and the effects of their removals from the ecosystem, limiting a comprehensive implementation of EBFM. We therefore assigned the progress category – Moderate progress by the Commission.

(iii) **Existence of an EBFM plan**

Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

The WCPFC has not formally developed and adopted an operational EBFM plan to account for ecosystem considerations derived from the main ecological elements (target, bycatch, trophic interactions and habitats) of EBFM, so they are taken into account in management advice when managing highly migratory fish species and associated ecosystems in the WCPO. However, the Convention Agreement requires that the Scientific Committee recommends a Research Plan to the Commission. Thus, the Scientific Committee prepares periodically a Strategic Research Plan which main objective is to guide the development of annual work plans for the Scientific Committee to ensure it remains responsive to the Commission needs. The last Strategic Research Plan for the period 2012-2016 was adopted in 2011 by the Commission (WCPFC 2011). The plan includes as research priorities (1) to monitor fishing activities through the collection of data, (2) monitor and assess target stocks, (3) monitor and assess non target species, associated species or dependent on the target stocks and monitor the pelagic ecosystem of the WCPO, and (4) evaluate the existing conservation and management measures and potential management actions. The Research Plan also acknowledges the importance of assessing the impact of environment and fishing on other species than target stocks including prey, competitors, and habitats to support an ecosystem approach to fisheries. The periodic development of a Strategic Research Plan is seen as a major step forward towards preparing an operational EBFM plan. We therefore assigned the progress category – Slight progress by the Commission.

(iv) **Existence of a data collection program to support the implementation of EBFM**

Progress category assigned: MODERATE PROGRESS BY THE COMMISSION

The WCPFC has not established data collection and monitoring programs to address comprehensively the impacts of fisheries on the ecosystem and support the implementation of EBFM. Instead, the existing data collection and monitoring programs were mainly designed to collect data for target species but some bycatch data is also collected at least in some relevant fisheries as requested by the Commission. In place since 2009, the WCPFC has an extensive standardized regional observer program coordinated by the SPC/OFP and the WCPFC Secretariat. Prior to 2009, a broad scale observer program was in operation since 1995 in the Pacific Island countries, thus, the SPC/OFP has been processing observer data on behalf of their member countries for more than 15 years (Clarke et al. 2014). Currently the WCPFC regional observer program only processes data from the purse seine and longline fleets. The purse seine fleet operating in the high seas or between two or more exclusive economic zones has a requirement of 100% observer coverage since 2010, while longliners have a 5% requirement for observer coverage (CMM 2012-01). Thus, a regional observer program data base exist for some relevant fisheries. The data sets are comprised of records pooled directly from observer national fisheries programs in a standardized form that allows pooling. Yet the data submission and level of observer coverage are often too low to generate quality data to support robust joint regional assessments relevant to bycatch and ecosystem issues.

The raw observer data is not available in a standardized form, only aggregated or data summaries may be available. The data set is not open access to allow for EBFM analyses. Therefore, we assigned the progress category – Moderate progress by the Commission.

3.3.2. Review of main ecological components in support of EBFM

For each of the ecological components of target species, bycatch species, ecosystem properties and trophic relationships and habitats, we assess the following four elements: (1) whether conceptual and/or operational

objectives have been formally stated, (2) whether there are measurable *indicators* associated to objectives to track the state and trend of each ecological component, (3) whether *reference points* for those indicators have been defined to activate management action, and (4) whether there are *management responses and measures* to ensure that those reference points are not exceeded.

Target species - Ecological component 1.

For practical reasons, we only considered in the assessment of progress under the ecological component of "Target Species" all principal market tunas and Swordfish. The WCPFC is responsible for the conservation and management of the following principal market tunas, Skipjack tuna *Katsuwonus pelamis*, Yellowfin tuna *Thunnus albacares*, Bigeye tuna *T. obesus*, Albacore tuna *T. alalunga and* Pacific bluefin tuna *T. orientalis*, and the conservation and management of Swordfish (*Xiphias gladius*) within its area of jurisfiction. The management and conservation of Pacific Albacore tuna, Pacific bluefin tuna and Swordfish is shared between the WCPFC and IATTC.

(i) **Objectives**

Progress category assigned: FULL PROGRESS BY THE COMMISSION

The Convention primary objective is "to ensure, through effective management, the long-term conservation and sustainable use of highly migratory fish stocks in the Western and Central Pacific Ocean". Specifically, Article 5a of the Convention requires members to "adopt measures to ensure long-term sustainability of highly migratory fish stocks in the Convention Area and promote the objective of their optimum utilization", Article 5b requires "ensure that such measures are based on the best scientific evidence available and are designed to maintain or restore stocks at levels capable of producing maximum sustainable yield", Article 6.1a requires members to determine "stock-specific reference points", and Article 6.3 requires to develop harvest control rules by taking "measures to ensure that, when reference points are approached, they will not be exceeded" and "without delay, take the action determined under paragraph 1.a to restore the stocks" (WCPFC 2000). Therefore, the Convention has explicitly defined a general long-term operational objective that applies to their managed highly migratory fish species. Furthermore, the recent establishment of the management objective workshops in the WCPFC to enhance dialogue between fisheries managers and scientists is also seen as an important initiative which is being used to assist in the progress of developing species-specific conservation and management objectives towards establishing proper management frameworks (Cartwright et al. 2013). We therefore assigned the progress category – Full progress by the Commission.

(ii) **Indicators**

Progress category assigned: FULL PROGRESS BY THE COMMISSION

Fishery stock assessments have been conducted for all principal market tunas stocks (6 stocks, 5 species) and Swordfish (3 stocks). Thus, all target stocks (all principal market tuna and Swordfish stocks) exploited by WCPFC fisheries have been evaluated with fisheries stocks assessments to determine the effects of fishing on the individual stocks and determine their exploitation status. Indicators of population status including indicators of population size and fishing mortality over time and associated reference points are available and monitored regularly for these assessed stocks. These stock status indicators and associated reference points are also explicitly associated to the aforementioned objective of maintaining populations at maximum sustainable yields. The WCPFC also calculates for consideration some surrogate empirical indicators of stock status for those years where stock assessments are not being conducted. These indicators include: total catch by gear, nominal CPUE trends, spatial distribution of catch and associated trends, size composition of the catch and trends in average size. These indicators do not provide stock status, but serve as surrogate indicators to monitor status and establish comparisons with previous year values (Harley and Williams 2013). We therefore assigned the progress category – Full progress by the Commission.

(iii) **Reference points**

Progress category assigned: MODERATE PROGRESS BY THE COMMISSION

A stock-specific limit reference points (LRP *20%$SB_{F=0}$*) was adopted in 2012 for West and Central Pacific Bigeye, Yellowfin, Skipjack tuna stocks and South Pacific Albacore tuna stock (WCPFC 2012a). This limit reference point has been defined as the 20% of the equilibrium spawning biomass that would be expected in the absence of fishing under current environmental conditions (using the most recent 10 years of the current assessment, excluding the final year). Target reference points have not been yet defined for the long term for West and Central Pacific Bigeye, Yellowfin and South Pacific Albacore tunas. Yet in the CMM-2014-01 achieving for Bigeye tuna $F \leq F_{MSY}$ by 2017 is implied as an interim target. In 2015 an interim target reference point has also been adopted for the West and Central Pacific Ocean Skipjack stock (WCPFC 2015b). The Skipjack tuna stock shall initially be 50% of the estimated recent average spawning biomass in the absence of fishing ($BS_{F=0, t1-t2}$) (CMM-2015-06). Limit and target reference points have not been defined for North Pacific Albacore tuna, Pacific bluefin tuna or Swordfish. The management and conservation of North Pacific Albacore, South Pacific Albacore and Pacific bluefin tunas, and Swordfish is shared between the WCPFC and IATTC.

The Scientific Committee is currently assessing and testing a series of candidate target reference points and harvest control rules for key tuna species in the WCPO (Australia 2014, SPC et al. 2014). Since 2012, a series of Management Objective Workshops (MOWs) have been carried out prior to the Commission meetings with the objective of assisting the Commission to understand the purpose and implications of management objectives, the role of reference points and the process of evaluating potential management measures in achieving management objectives. Prior to the MOWs, the Commission has made little progress on defining and agreeing on operational management objectives and associated targets and limits (Cartwright et al. 2013). These workshops are now making progress towards exchanging ideas to the point of producing a candidate list of management objectives, potential performance indicators, and target reference points for each major fishery (for tropical tunas and South Pacific Albacore).

In conclusion, stock-specific limit and/or target reference points associated to pre-defined objectives and indicators have been defined and developed for some species, and adopted by the Commission. Stock-specific reference points are also under development for other species. Therefore, we assigned the progress category – Moderate progress by the Commission.

(iv) **Management responses and measures**

Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

Harvest control rules have not been developed and adopted for any of the target species. Yet the CMM-2014-06 calls for the WCPFC to develop and implement a harvest strategy approach that includes target reference points, harvest control rules among other elements. The Commission has agreed a work plan including a schedule of actions and indicative timeframes to adopt and refine harvest strategies (under the CMM-2014-06) for skipjack, bieye, yellowfin, south and north Pacific albacore and Pacific bluefin tunas (WCPFC 2015b). The development of the harvest strategies including the following elements: definition of operational objectives, development of target and limit reference points, acceptable levels of risks of not breaching limit reference points, setting a monitoring strategy to assess performance against reference points, setting harvest control rules to achieve the reference points, management strategy evaluation to assess the performance. The adopted workplan includes the development of harvest control rules for skipjack and south albacore tuna for the year 2016 (WCPFC 2015b).
(Cartwright et al. 2013)
Several management responses or measures (binding - Conservation and Management Measures [CMM]) have also been adopted by WCPFC to ensure that aforementioned management objective of ensuring, through effective management, the long-term conservation and sustainable use of highly migratory fish stocks in the Western and Central Pacific Ocean is achieved. Next we briefly summarize the most relevant binding conservation and management measures adopted by WCPFC to manage target stocks. CMM-2014-01 establishes for Bigeye, yellow and Skipjack tuna a time-area closure for FAD fishing, limits on the number of FAD sets, limits on the number of vessels days, a requirement to submit FAD management plans, a requirement for a full retention in purse seiners,

100% regional observer coverage for all purse seiners in several settings, a limit on the number of purse seiners and longliners with freezing capacity.

For the North Pacific Albacore tuna stock, CMM-2005-03 calls for members not to increase fishing effort beyond current levels. IATTC, which also shares the management of North Pacific Albacore with the WCPFC, has a similar measure (Resolution C-05-02). For the South Pacific Albacore tuna stock, the CMM-2010-05 aims to limit fishing mortality by establishing a capacity limitation scheme and set a cap on the number of fishing vessels for some members. IATTC, which also shares the management of South Pacific Albacore with the WCPFC, has not adopted any measure.

For Pacific bluefin tuna, the CMM-2014-04 establishes a multi-annual rebuilding plan (starting in 2015) to rebuild the spawning biomass to its median levels by 2025 with at least 60% probability, and includes limits in total fishing effort, and reduction in catches of juveniles. IATTC, which also shares the management with the WCPFC, adopted Resolution C-14-06 to limit commercial catches in 2015 and 2016. For Swordfish in the South Western Pacific region, CMM-2009-03 call for limiting the number of fishing vessels for Swordfish in the Convention Area south of 20^{o} S and limiting the amount of Swordfish caught to an amount caught in any one year during 200-2006.

In conclusion, harvest control rules have not been adopted for any target species but are under development by the Scientific Committee and being discussed by the Commission for some species (WCPFC 2015bWCPFC, 2015 #6469). Furthermore, several management measures have been adopted to ensure management objectives are achieved for majority of target stocks and species. We therefore assigned the progress category – Slight progress by the Commission.

Bycatch species - Ecological component 2.

(i) **Objectives**

Progress category assigned: FULL PROGRESS BY THE COMMISSION

The WCPFC Convention has several Articles requiring the minimization of the impacts of fisheries on bycatch species. These include Article 6.1c which tasks the members of the Commission to "develop data collection and research programs to assess the impact of fishing on non-target and associated or dependent species and their environment, and adopt plans where necessary to ensure the conservation of such species and to protect habitats of special concern", and Article 10.1c tasks the members of Commission "to adopt, where necessary, conservation and management measures and recommendations for non- target species and species dependent on or associated with the target stocks, with a view to maintaining or restoring populations of such species above levels at which their reproduction may become seriously threatened" (WCPFC 2000). Therefore, the WCPFC Convention formally recognizes and addresses the impact of fisheries on bycatch species, and it formally states the operational objective of adopting conservation and management measures with a view to maintaining or restoring populations above levels at which their reproduction may become seriously threatened. We therefore assigned the progress category – Full progress by the Commission.

(ii) **Indicators**

For practical reasons, we reviewed under the ecological component of "Bycatch species" all billfish species (except Swordfish), as well as sharks, seabirds, sea turtles, marine mammals, and other finfishes impacted by fisheries. Yet we stress several species of billfishes, sharks and other finfishes can also be target species at least in some fisheries.

Billfishes - Progress category assigned: MODERATE PROGRESS BY THE COMMISSION

Some billfish stocks and species, including the Southwest Pacific striped marlin, West and Central North Pacific striped marlin and North Pacific blue marlin, are regularly assessed with traditional fishery stock assessments. Thus, indicators of stock status, including indicators of population size and fishing mortality over time, are regularly developed and are being monitored for these assessed species to provide management advice. In conclusion, a series of region-wide indicators of stock status (associated to pre-established objectives) are routinely developed and

monitored only for some billfish species which are used to provide robust management advice to the Commission. We therefore assigned the progress category – Moderate progress by the Commission.

Sharks - Progress category assigned: MODERATE PROGRESS BY THE COMMISSION

The WCPFC is the first tRFMO to establish a formal 2010-2014 Shark Research Plan (adopted in 2010). By 2014, the Shark Research Plan has delivered the evaluation of the exploitation status using age structure stock assessments for three key shark stocks (North Pacific blue shark, West and Central Pacific silky shark and oceanic whitetip). Thus, indicators of stock status, including indicators of population size and fishing mortality over time, have been developed to monitor the status of these assessed species in order to provide robust management advice to the Commission. The Shark Research Plan has also delivered a series of simple indicators of stock status that integrated catch rate, size, sex, maturity, distribution and species composition for a set of designated key shark species using the WCPFC's Regional Observer Program data (Clarke et al. 2011, Rice et al. 2015). These simple indicators of stock status are used to provide weak management advice to the Commission, since they cannot be used directly to establish the exploitation status of species or set impact or catch limits. Moreover, the International Scientific Committee (ISC) for Tuna and Tuna-like species in the North Pacific Ocean (which provides scientific advice on northern Pacific stocks to IATTC and WCPFC) has also developed a set of possible stock status indicators to indirectly assess status for Shortfin mako *Isurus oxyrinchus* in the North Pacific. Yet this fishery stock assessment could not determine the current exploitation status of the stock, and the resultant status indicators were considered preliminary and highly uncertain (ISC 2015). The ISC for Tuna and Tuna-like species in the North Pacific Ocean has also assessed Blue shark in the North Pacific in 2013 and in 2014 with traditional fishery stock assessments and has developed indicators of stock status, including indicators of population size and fishing mortality over time for these assessed stock (IATTC 2015b, ISC 2015). The Blue shark stock assessment results, although uncertain, has been used to provide management advice to IATTC and WCPFC.

In conclusion, a series of regional indicators of stock status (associated to pre-established objectives) have been developed and are routinely monitored only for some shark species, which are used to provide robust management advice to the Commission. We therefore assigned the progress category – Moderate progress by the Commission.

Seabirds - Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

Overall, the WCPFC Scientific Committee has focused its efforts on identifying species and areas of vulnerability to industrial longline fisheries for seabirds, assessing their relative risk to longline fisheries, and proposing seabird mitigation measures and attempting their the effectiveness. The first taxonomic-wide ecological risk assessments (level 2 - productivity-susceptibility analyses) were conducted in the 2006 and 2007 for the WCPFC-managed longline fisheries which included seabird species in addition to bony fish, sharks, rays, mammals, and turtles (Kirby 2006, Kirby and Hobday 2007). These analyses were key to identify what species are at relatively high risk from longline fisheries for which management measures or further research is required. Then, in 2009 and 2010 a region wide spatially explicit ecologically risk assessment (a level 2 - productivity-susceptibility analyses) for seabirds was conducted in the WCPFC Convention Area in 2009 and 2010 to determine the probability of seabird-fisheries interactions and to determine the risk of adverse effects of fishing-induced mortality on populations of seabirds. Key data outputs indicated area of greatest risk of species interactions, species of greatest concern for population impacts and the flags or fisheries most likely to contribute to the risk (Filippi et al. 2010, Waugh et al. 2012). Although all the output results are tailored to the needs of fisheries management, the ecological risk assessment was not linked to pre-determined management decisions, which limits its utility. Yet, the Scientific Committee recommended updating the assessment as new information becomes available in order to guide differentional management and monitoring of seabird bycatch for different zones (WCPFC 2009a), recommendation that has been endorsed by Commission (WCPFC 2009b). Despite the recommendation to continue updating the assessment, the region wide ecological risk assessment and derived indicators of species vulnerability to longline fisheries has not been regularly monitored and updated by the Scientific Committee to provide scientific advice to the Commission.

In conclusion, a region wide spatially explicit ecologically risk assessment (a level 2 - productivity-susceptibility analyses) for seabirds was conducted in the WCPFC Convention Area in 2009 and 2010. This seabird assessment has provided a series of products including fishery impacts indicators of spatially explicity seabird-fisheries interactions in the WCPFC area. Yet, this level 2 assessment and derived indicators are not regularly updated or monitored over time by the Scientific Committee. The developed indicators cannot be used to provide robust

management advice (e.g. establish level of exploitation status, set impact or catch limits or evaluate the efficacy of current adopted mitigation measures). Therefore, we assigned the progress category – Slight progress by the Commission.

Sea turtles - Progress category assigned: SLIGHT OR NO PROGRESS ONLY THE BY THE SCIENTIFIC COMMITTEE

Region-wide assessmetns and indicators of stock status or fishery impacts for sea turtles impacted by WCPFC fisheries have not been developed by the Scientific Committee or have been requested by the Commission. To date, the WCPFC Scientific Committee has focused its efforts on assessing the interaction rates of sea turtles with longline and purse seine fisheires, and proposing mitigation measures to reduce their bycatch (Williams et al. 2001, WCPFC 2009a). Several taxonomic-wide semi-quantitative level 2 ecological risk assessments (productivity-susceptibility analyses) have been conducted for the WCPFC longline and purse seine tuna fisheries which included sea turtle species in addition to bony fish, sharks, rays, mammals, and seabirds (Kirby 2006, Kirby and Hobday 2007). Yet, these assessments are too coarsed to provide robust management advice. Moreover, since 2010 the Scientific Committee has not reviewed any turtle-related research or provided management advice on sea turtle conservation since no studies have been presented at the Scientific Committee meetings (WCPFC 2009a). Therefore, we assigned the progress category – Slight or no progress only by the Scientific Committee. However, the WCPFC is planning to held two workshops to analyze interactions and mortality rates of sea turtles in pelagic longline fisheries in the West and Central Pacific Ocean in 2016(WCPFC 2015a).

Marine mammals - Progress category assigned: SLIGHT OR NO PROGRESS ONLY THE BY THE SCIENTIFIC COMMITTEE

Region-wide assessments and indicators of stock status or fishery impacts for marine mammals impacted by WCPFC fisheries have not been developed by the Scientific Committee or have been requested by the Commission. WCPFC members have reported interactions of marine mammals in their fisheries and there has been some attemps to summarize marine mammal interactions with the tropical purse fishery in the West and Central Pacific Ocean (WCPFC 2012b). Yes comprehensive region wide assessments of marine mammal bycatch and interations fish relevant fishing gears and indicators of stock status or fisheries impacts are lacking, and those available are sporadic in tima and space and limited to few fisheries. Without more comprehensive data, the WCPFC is unable to assess the risk of marine mammal bycatch and develop indicators of status, constraining its ability to develop any needed conservation measure and provide robust management advice. Therefore, we assigned the progress category – Slight or no progress only by the Scientific Committee.

Other finfishes - Progress category assigned: SLIGHT OR NO PROGRESS ONLY THE BY THE SCIENTIFIC COMMITTEE

Region-wide assessments and indicators of stock status or fishery impacts for finfish species other than tunas and billfishes impacted by WCPFC fisheries have not been developed by the Scientific Committee or have been formally requested by the Commission. The Scientific Committee has focused its efforts on assessing the relative risk of finfishes to longline fisheries in comparison to other taxonomic groups. Several taxonomic-wide level 2 ecological risk assessment (productivity-susceptibility analyses) have been conducted for the WCPFC longline and purse seine tuna fisheries which included finfish species other than tunas and billfishes in addition to sharks, rays, sea turtles, marine mammals, and seabirds (Kirby 2006, Kirby and Hobday 2007). Yet, these assessments are too coarsed to provide robust management advice. Moreover, the Scientific Committee has also assessed the volumes of catches discarded of several species of finfishes in regional tuna fishes, especially in tropical purse seine fisheries near developing states to evaluate its impact on food security issues (Pilling et al. 2012, Pilling et al. 2013). Several finfishes (Dorado *Coryphaena hippurus*, Rainbow runner *Elagatis bipinnulata* and Wahoo *Acanthocybium solandri*) have been identified as important species for sustainable livelihoods in the WCPFC region. Comprehensive assessments to assess if these catches are sustainable have not been conducted yet. Still the Scientific Committee is planning to update these analyses to include bycathes of finfish from longlime fisheries, and to use Ecopath model to examine the potential impcats of WCPO fisheries on key bycatch species. Since comprehensive region wide assessments and indicators of stock status or fisheries impacts are lacking for finfish species, constraining the ability to develop any needed conservation measure and provide robust management advice, we assigned the progress category – Slight or no progress only by the Scientific Committee

(iii) **Reference points**

Billfishes- Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

Limit reference points associated to the biomass and fishing mortality rate indicators have not been defined, developed or adopted for any of the assessed billfish stocks. As part of the assessment process, B_{MSY} and F_{MSY} (or proxies) are commonly estimated for the assessed billfihes and they might be used as unofficially implied target reference points. We therefore assigned the progress category – Slight progress by the Commission.

Sharks - Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

Limit reference points associated to the biomass and fishing mortality rate indicators have not been defined, developed or adopted for any of the WCPFC key shark species. As part of the assessment process, B_{MSY} and F_{MSY} (or proxies) are commonly estimated for the assessed sharks species and they might be used as unofficially implied target reference points. However, the Scientific Committee is working to develop limit reference points for WCPFC key shark species to ensure consistency with article 10.1 (c) of the convention. The WCPFC funded a consultancy study, which has proposed three different approaches for developing limit reference points for sharks taking into consideration the WCPFC´s limit reference point framework for target species (Clarke and Hoyle 2014). In 2014 the Scientific Committee recommended to the Commission to support the tiered species-specific approach (based on availability of information) to develop management reference points for sharks similar to that adopted for target species to ensure consistency with article 10.1 (c) of the Convention. In 2014, the Commission also supported a proposal to hold an expert working group to compile and review life history data for use in the development of limit reference points for sharks (WCPFC 2014a). We therefore assigned the progress category – Slight progress by the Commission.

Seabirds - Progress category assigned: SLIGHT OR NO PROGRESS ONLY THE BY THE SCIENTIFIC COMMITTEE

Target and/or limit reference points associated to indicators of stock status or bycatch rate estimates have not been defined, developed or adopted for any of the species, and are not under development or being discussed. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

Sea turtles - Progress category assigned: SLIGHT OR NO PROGRESS ONLY THE BY THE SCIENTIFIC COMMITTEE

Target and/or limit reference points associated to indicators of stock status or bycatch rate estimates have not been defined, developed or adopted for any of the species, and are not under development or being discussed. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

Marine mammals- Progress category assigned: SLIGHT OR NO PROGRESS ONLY THE BY THE SCIENTIFIC COMMITTEE

Target and/or limit reference points associated to indicators of stock status or bycatch rate estimates have not been defined, developed or adopted for any of the species, and are not under development or being discussed. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

Other finfishes - Progress category assigned: SLIGHT OR NO PROGRESS ONLY THE BY THE SCIENTIFIC COMMITTEE

Target and/or limit reference points associated to indicators of stock status or bycatch rate estimates have not been defined, developed or adopted for any of the species, and are not under development or being discussed. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

(iv) **Management responses and measures**

The WCPFC has adopted an extensive list of conservation and management measures (non-binding Resolutions and binding Conservation and Management Measures [CMMs]) for billfishes, sharks, seabirds, sea turtles and marine mammals, and none for other finfishes. We briefly list them below and group them by taxonomic group. Overall the adopted measures have the main purpose to minimize the effects of fishing on by-catch species as for example with the modification of gears to avoid them or in the form of prohibition. The adopted measures also focus on establishing requirements for data reporting and conduct specific type of research. We find no management measure has been adopted to set a management response linked to pre-established operational objectives, indicators and reference points for any of the bycatch species impacted by IOTC fisheries, precluding them to be activated when predefined reference points are exceeded. The adopted measures (mostly to mitigate impacts) are not known whether they are being effective to affect the current status of populations since they have not been linked to status indicators or reference points to judge whether the current state of species is acceptable. We therefore assigned the progress category – Slight progress by the Commission to the taxonomic group of billfishes, sharks, seabirds, sea turtles and marine mammals. No management measures have been adopted or are under discussion by the Scientific Committee to minimize the impacts of fisheries on other finfishes, therefore, we assigned the progress category – Slight or no progress only by the Scientific Committee.

Measures	**Type of Measure**
Billfishes – Progress category assigned: Slight progress by the Commission	
CMM 2010-01 sets a cap on the catch of striped marlin for each member relative to historical levels, which are also caught as bycatch in longliners.	-Binding -Limits bycatch
Sharks - Progress category assigned: Slight progress by the Commission	
CMM-2010-07 requires reporting of shark catches and discards by gear type and species, an establishes a limit on the ratio of shark fins to total shark weight that can be retained onboard fishing vessels, and encourages the live release of sharks.	-Binding -Minimize bycatch -Sets a limit on ratio of weight of retained shark fins
CMM-2011-04 prohibits the retention of oceanic whitetip sharks.	-Binding -Minimize bycatch
CMM-13-08 prohibits the retention of silky sharks.	-Binding -Minimize bycatch
CMM-2012-04 prohibits on deliberately setting purse seines on whale sharks and requires reporting of interactions.	-Binding -Minimize bycatch
CMM-2014-05 requires to either not use wire trace as branch lines or not use shark lines and for fisheries targeting sharks it requires a management plan to limit shark catches.	-Binding -Minimize bycatch
Seabirds - Progress category assigned: Slight progress by the Commission	
CMM 2012-07 requires longliners operating north of 23°N and south of 23°S to use at least two of several mitigation measures such as weighted branch lines or tori (bird-scaring) lines, requires to record data on seabird bycatch by species and report annually; and encourages mitigation research to be conducted.	-Binding -Minimize bycatch
Sea turtles - Progress category assigned: Slight progress by the Commission	
CMM 2008/03 requires members to report their interactions with sea turtles; requires longliners to use line cutters and de-hookers to handly and release sea turtles; requires members to report their progress with implementation of the "FAO Guidelines to Reduce Sea Turtle Mortality in Fishing Operations" to the Commission; and requires purse seiners to avoid setting on turtles if possible and to release them when caught alive.	-Binding -Minimize bycatch
Marine mammals - Progress category assigned: Slight progress by the Commission	
CMM 2011/03 -prohibits purse seiners sets around cetaceans and requires reporting of interactions.	-Binding -Minimize bycatch
Other finfish - Progress category assigned: Slight or no progress only by the Scientific Committee	
No measures	
General measures applying to all taxa	
CMM 2008/04 - prohibits the damaging practice of driftnets fishing in the WCPFC area.	-Binding -Minimize bycatch

CMM 2013/01 - calls to provide advice to the Commission on the relative impact of FAD set measures.	-Binding -Minimize bycatch

Ecosystem properties and trophic relationships - Ecological component 3.

Under the ecological component of "Ecosystem Properties and Trophic Relationships", we valued the existence of ecosystem metrics (empirically and model based) and food web models depicting trophic interactions and interdependencies involving relevant species or components of ecosystems that are affected by fishing, and are relevant to maintain ecosystem structure and function, and how this information is being used to advance progress in implementing EBFM.

(i) **Objectives**

Progress category assigned: MODERATE PROGRESS BY THE COMMISSION

The WCPFC Convention has several Articles addressing the impacts of fishing on both target stocks and non-target species or associated or dependent species belonging to the same ecosystem (Article 5d), and addressing the protection of biodiversity in the marine environment (Article 5f) (WCPFC 2000). Therefore the Convention captures the broader impacts of fishing on species dependent on tuna species and biodiversity and promotes ecosystem-based approaches to management. Yet the Convention Agreement does not explicitly sets an operational objective to address the impacts of fishing on trophic interactions, and relevant species and components of ecosystems in order to maintain the structure and functioning of marine food webs (Review Team 2012). Likewise, the Strategic Research Plan of the Scientific Committee 2012-2016 establishes as a research priority to monitor and assess non-target or associated or dependent species, including research activities such as establishing ecosystem indicators to monitor the effects of fishing, investigating trophic (predator/prey) relationships, and use of ecosystem models to support the inclusion of ecosystem consideration into management advice (WCPFC 2011). The Terms of References of the Ecosystem and Bycatch Specialist Working Group also establishes the importance of reviewing the impact of fishing on components of the ecosystem not targeted by fisheries, and supporting ecosystem modeling including trophic studies and species interactions to assist the Commission in decision making (WCPFC 2009c). Yet, the Strategic Research Plan or the Terms of Reference of the working group do not explicitly set operational objectives to address the impacts of fishing on the structure and functioning of marine food webs.

In conclusion, although the WCPFC Convention does not state any operational objective to address the impacts of fishing on the structure and functioning of marine food webs, it states conceptually the importance of addressing the impacts of fishing on trophic interactions, and relevant species and components of ecosystems and protecting biodiversity in the marine environment. We therefore assigned the progress category – Moderate progress by the Commission.

(ii) **Indicators**

Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

The WCPFC Scientific Committee, as requested by the Commission through the Convention agreement, has focused its effort on developing and reviewing ecosystem models to investigate food web dynamics and how fisheries and climate variability impact the upper and middle trophic levels in the Western and Central Pacific Ocean, and developing ecosystem indicators to understand the broader community based and ecosystem level consequences of fisheries. Ecosystem research and modeling initiatives include discussing ecosystem boundaries as a preliminary step to ecosystem based fishery management (Sibert 2005), the development of empirical and model-derived ecosystem indicators to assist fishery management (Allain et al. 2012), assessing the trophic dynamics of tunas, and the development, application and performance of ecosystem models such as SEPODYM and Ecopath with Ecosim to investigate the dynamics of tuna species under the influence of both fishing and climate and environmental effects (Allain 2005, Lehodey et al. 2014b). The ecosystem model SEAPODYM has become an important element for the application of an ecosystem approach to fisheries management in the WCPFC. SEAPODYM, developed by the SPC with the support of the WCPFC Scientific Committee and Commission, is a spatial ecosystem and population dynamics model originally developed to investigate the spatial population dynamics of three tropical tuna species

under the influence of both fishing and climate and environmental effects. Now, SEAPODYM complements the single species fisheries stock assessments by providing additional information on how tuna distributions are structured in space and time. It can also assist in marine spatial planning and CMM evaluation (Lehodey et al. 2013, Lehodey et al. 2014b). In the last Commission meeting (2014), the Commission supported the external peer review of the SEAPODYM ecosystem model, which will be useful to develop new standards for SEAPODYM applications.

In conclusions, several ecosystem and food web models (e.g. SEAPODYM, Ecopath with Ecosim) and ecosystem indicators have been developed to track and understand the broader community-based and ecosystem lecel consequences of fishing as requested by the Commission through the Convention agreement. However, the developed ecosystem models and ecosystem indicators have not been linked to pre-established objectives and they are not requlary updated or used to assist in managemenf advice discussed at the Commission level. There is little evidence that these types of ecosystem products and considerations are taken into account to assist in management decisions. We therefore assigned the progress category – Slight progress by the Commission.

(iii) **Reference points**

Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Ecosystem and/or multispecies management plans (including harvest strategies) with pre-defined reference points for relevant species and components of ecosystems have not been developed and are not under discussion. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

(iv) **Management responses and measures**

Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Management measures have not been adopted to explicitly account for food web and multispecies interactions and maintain the structure and functioning of marine food webs, or have been linked to any pre-established ecosystem model, and associated indicators and operational objectives. Some ecosystem/food web models are being developed and tested for some relevant species and components of ecosystems which could potentially be used in decision-making or incorporated in management measures. Yet a formal mechanism does not exist to accommodate multispecies and food web interactions and ecosystem modelling into the current management or potential management measures (e.g. multispecies harvest control rules, time-area closures, etc…). We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

Habitats – Ecological component 4.

Under the ecological component of "Habitats", we valued whether habitats of special concern (e.g. reproduction, migration, feeding, hotspots) and/or habitat utilization and preferences for relevant species have been formally investigated and delineated, and how this information is being used to advance progress in implementing EBFM.

(i) **Objectives**

Progress category assigned: MODERATE PROGRESS BY THE COMMISSION

The WCPFC Convention has specific provisions relevant to habitats of special concern. Article 6.1c tasks the members of Commission to "develop data collection and research programs to assess the impact of fishing on non-target and associated or dependent species and their environment, and adopt plans where necessary to ensure the conservation of such species and to protect habitats of special concern" (WCPFC 2000). The Terms of References of the Ecosystem and Bycatch Specialist Theme of the WCPFC (previously known as a working Group) also contains the task of assessing the impacts of fishing on habitats of special concern. Yet the Commission or the Scientific Committee has not formally stated operational objectives or have formally delineated and identified habitats of special concern for relevant species. Since conceptual objectives have at least been formally stated in the

Convention Agreement to recognize the importance of protection of habitats of special concern, we therefore assigned the progress category – Moderate progress by the Commission.

(ii) **Indicators**

Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

The WCPFC Convention has specific provisions concerning the protection of habitats of special concern. The WCPFC Scientific Committee has focused its habitats research activities and practices to identify habitat preferences and utilization for species of interest to the Commission, specifically for the principal market tunas, yet habitats of special concern have not been formally investigated and delineated for relevant species. The WCPFC with the support of its science provide, the SPC, has a strong research program to assess the effect of environment and climate on the distribution, abundance and population dynamics of principal market tunas. The Scientific Committee reviews periodically and encourages research work to improve the knowledge of environmental drivers, from ENSO patterns, seasonal and decadal trends and regime shifts, on the variability of tuna fisheries (e.g recruitment and biomass trends) and food webs (WCPFC 2013, 2014b). Outcomes of this type of research have direct application for the spatial ecosystem and population dynamic model SEAPODYM. The SEAPODYM model is an useful tool for assessing fine-scale spatial effects on tuna stocks as well as large-scale and climate effects, both short to long term, and therefore, it is a very important tool to map and monitor habitat utilization and preferences for species of interest to the Commission. Moreover, the WCPFC also conducts a region-wide Tuna Tagging Program since 2006. The tagging program collects critical information for the assessment of target tuna species in the West and Central Pacific Ocean. The tagging program allows to obtain information of the growth, natural mortality and fishing mortality of tunas as well as revealing information on movements, seasonal migrations, horizontal and vertical habitat utilization, breeding migration, migration corridors, hot spots, main feeding and reproductive habitats (Caillot et al. 2012, WCPFC 2013). Habitat research focused on the habitat utilization and preferences of bycatch species has been scarce. Despite these efforts and initiatives that recognize the importance of habitat research, the outcomes of these research studies have had a limited impact on formally identifying, delineating and protecting habitat of special concern for relevant species in the WCPFC area and on developing indicators describing habitat needs and preferences for relevant species.

In conclusion, while the WCPFC Convention has specific provisions concerning the protection of habitats of special concern, habitats of special concern have not been formally mapped or delineated for any species of interest to the commission, yet for some species, particularly for the principal market tunas, habitat utilization and preferences have been investigated or are under investigation by the Scientific Committee. Indicators describing habitat needs and preferences are also at the early states of development. Habitat models and indicators have not been linked to pre-established objectives and they are not requlary updated or used to assist in managemenf advice discussed at the Commission level. There is little evidence that these types of habitat products and considerations are taken into account to assist in management decisions. We therefore assigned the progress category – Slight progress by the Commission.

(iii) **Reference points**

Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Minimum habitat needs and requirements (linked to pre-established indicators and objectives) have not been identified and are not under discussion for any relevant species with habitats of special concern. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

(iv) **Management responses and measures**

Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Management measures have not been adopted to explicitly protect habitats of special concern for relevant species. Knowledge of habitats of special concern and habitat preferences and utilization is not under discussion to be used

potentially in decision-making. There are no formal mechanism to accommodate minimum habitat needs and habitat protection into the current management or management decisions and this is not under discussion by the Scientific Committee. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

3.4 Inter-American Tropical Tuna Commission

3.4.1. Review of basic texts and main structures in support of EBFM

(i) **Reference to the PA and EBFM principles in accordance to relevant rules of international fisheries governance**

Progress category assigned: FULL PROGRESS BY THE COMMISSION

The IATTC was established in 1949 and its Convention Agreement entered into force in 1950. Its Convention was replaced in 2008 by the Antigua Convention, which entered into force in 2010. The Convention Agreement primary objective is "to ensure the long-term conservation and sustainable use of the fish stocks covered by the Convention, in accordance with the relevant rules of international law" (Article II) (IATTC 2003). The fish stocks covered by the agreement are "stocks of tunas and tuna-like species and other species of fish taken by vessels fishing for tunas and tuna-like species in the Convention Area". The term tuna and tuna-like species includes the principal market tunas, the small tunas, the bonitos, the Spanish mackerels, and the billfishes. The Antigua Convention Agreements makes explicit reference to the application of the "precautionary approach, as described by relevant provisions of the Code of Conduct and/or the 1995 UN Fish Stocks Agreement, for the conservation, management and sustainable use of fish stocks covered by the Convention" (Article IV.1). It also makes reference to the adoption of "conservation and management measures, and recommendations for species belonging to the same ecosystem and that are affected by fishing for, or dependent on or associated with, the fish stocks covered by the Convention, with a view to maintaining or restoring populations of such species above levels at which their reproduction may become seriously threatened" (Article VII.f). Finally, it also promotes the "application of any relevant provision of the Code of Conduct and of other relevant international instruments including, *inter alia*, the International Plan of Actions adopted by FAO in the framework of the Code of Conduct" (Article VII.n).

In conclusion, the IATTC Convention Agreement makes explicit reference to the principle of the precautionary approach and promotes the use of relevant elements of the global instruments of fisheries governance. Therefore, it gives competence to the Commission to manage and conserve the target species in the context of the wider marine ecosystem and apply EBFM principles. Therefore, we assigned the progress category – Full progress by the Commission.

(ii) **Existence a lead entity or group to advance progress in EBFM and ecosystem science**

Progress category assigned: MODERATE PROGRESS BY THE COMMISSION.

IATTC has its own scientific capacity that carries out research, planning, execution, analysis and delivery of management advice to comply with the Convention Agreement. IATTC has four main research programs including a Stock Assessment Program, the Biology and Ecosystem Program, the combined Bycatch and International Dolphin Conservation Program, and the Data Collection and Database Program. All the programs conduct an extensive range of research activities to support EBFM. The Biology and Ecosystem Program in coordination with the Bycatch Program, develop conservation and management measures for species belonging to the same ecosystem that are affected by fishing for, or dependent on or associated with, the fish stocks covered by the IATTC Convention. The research programs are supported by a relative large group of permanent scientific staff of the Secretariat, which are in charge to carry out the research, analysis and recommendations for the Commission. Then the Scientific Advisory Committee (hereinafter called the Scientific Committee) reviews any relevant assessments, analyses, research as well as recommendations prepared by the scientific staff for the Commission before they are considered by the Commission, and provides additional advice if needed.

In the 1980s, the IATTC began to conduct some research on ecosystem issues, yet most of the ecosystem-related monitoring and research started at the end of the 1990s when IATTC became part of the International Dolphin Conservation Program (IDCP). Every year, the IATTC scientific staff prepares an Ecosystem Consideration Report summarizing the impact of tuna fisheries on target and bycatch species (tunas, billfishes, marine mammals, sea turtles, sharks and other teleost) (IATTC 2015b). This report also includes pertinent information on other major ecosystem components including forage organisms, trophic interactions, ecosystem modeling, ecological risk assessment and construction of aggregate indicators to track changes in the ecosystem. It also has a section summarizing the actions by IATTC addressing ecosystem considerations. The IATTC Scientific staff also prepares annually a set of recommendations for conservation measures to ensure the Convention Agreement goals are achieved (IATTC 2015d) and a report describing the current research activities and future planed activities to be carry out by the IATTC staff (IATTC 2015a).

Since the IATTC has its own scientific capacity that carries out research, planning, execution, analysis and delivery of management advice to comply with the convention goals, it is potentially capable of coordinating all the ecosystem related activities and integrate ecosystem considerations into the scientific advice provided by the Scientific Committee to the Commission. However, it has limited capacity or has partial authority to coordinate all relevant ecosystem research activities (pertaining to target and bycatch species, trophic relationships and habitats) needed to fully implement EBFM, as well as to effectively communicate them to the Commission. To our knowledge there is no effective mechanism to coordinate and integrate all ecosystem-relevant research or to ensure effective communication across all the programs exists and ensure effective communication to the Commission. This lack of coordination and capacity to fully integrate ecosystem considerations into science recommendations and management advice limits a full assessment of the cumulative impact of WCPFC fisheries on target and bycatch species and the effects of their removals from the ecosystem, limiting a comprehensive implementation of EBFM. We therefore assigned the progress category – Moderate progress by the Commission.

(iii) **Existence of an EBFM plan**

Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

IATTC has not formally developed and adopted an operational EBFM plan to account for ecosystem considerations derived from the main ecological elements (target, bycatch, trophic interactions and habitats) of EBFM, so these ecological elements are taken into account in management advice when managing fish stocks covered by the Convention and associated ecosystem in the Eastern Pacific Ocean. However, the IATTC staff prepares annually a document describing their current and future planned activities, regarding research, data and capacity building, which also include the current situation regarding outreach activities and outlines future activities and planned improvements (IATTC 2015a). The current and future planned research activities include research on stock assessments, tagging studies, life histories of species and ecosystem and bycatch studies, to ensure the IATTC research activities remains relevant and responsive to the Commission needs. The current and future planned research activities are revised by the Scientic Advisory Committee before is presented to the Commission. This initiative is seen as a major step forward towards preparing an EBFM plan. We therefore assigned the progress category – Slight progress by the Commission.

(iv) **Existence of a data collection program to support the implementation of EBFM**

Progress category assigned: MODERATE PROGRESS BY THE COMMISSION

The IATTC has not established data collection and monitoring programs to address comprehensively the impacts of fisheries on the ecosystem and support the implementation of EBFM. Instead, the existing data collection and monitoring programs were mainly designed to collect data for target species but some bycatch data is also collected at least in some relevant fisheries as requested by the Commission. The IATTC has an extensive standardized regional observer program for large purse-seine fisheries (greater than 363 metric tons). This program is fully coordinated by the IATTC Secretariat, with its own observers and also with the participation of national programs. IATTC started to place observers in purse seine fisheries as early as in the 1970s (Hall and Roman 2013). The large purse seine fleets have a requirement of 100% observer coverage under the Agreement on the International Dolphin

Conservation program (AIDCP) which main purpose is monitoring the incidental catch of dolphins and collect scientific data. Thus, the regional observer program for large purse-seine fisheries is administered by the IATTC for the AIDCP. The fully coordinated regional observer program is only required in the purse-seine fleets, while longline, troll and pole and line are exempt from the regional observer program. Yet some of its members do have national observer programs for their longline fisheries. Since 2013, there are requirements for 5% longline coverage for vessels >20m. Therefore, a regional observer program data base exist for some relevant fisheries. The data sets are comprised of records pooled directly from observer national fisheries programs in a standardized form that allows pooling. The raw observer data is not available in a standardized form, only aggregated or data summaries may be available. The data set is not open access to allow for EBFM analyses. Therefore, we assigned the progress category – Moderate progress by the Commission.

3.4.2. Review of main ecological components in support of EBFM

For each of the ecological components of target species, bycatch species, ecosystem properties and trophic relationships and habitats, we assess the following four elements: (1) whether conceptual and/or operational *objectives* have been formally stated, (2) whether there are measurable *indicators* associated to objectives to track the state and trend of each ecological component, (3) whether *reference points* for those indicators have been defined to activate management action, and (4) whether there are *management responses and measures* to ensure that those reference points are not exceeded.

Target species - Ecological component 1.

For practical reasons, we only considered in the assessment of progress under the ecological component of "Target Species" all principal market tunas and Swordfish. IATTC is responsible for the conservation and management of the following principal market tunas, Skipjack tuna *Katsuwonus pelamis*, Yellowfin tuna *Thunnus albacares*, Bigeye tuna *T. obesus*, Albacore tuna *T. alalunga* and Pacific bluefin tuna *T. orientalis*, and the conservation and management of Swordfish (*Xiphias gladius*) within its area of jurisdiction. The management and conservation of Pacific Albacore tuna, Pacific bluefin tuna and Swordfish is shared between the WCPFC and IATTC.

(i) **Objectives**

Progress category assigned: FULL PROGRESS BY THE COMMISSION

The IATTC Convention primary objective regarding target species is "to ensure the long-term conservation and sustainable use of fish stocks in accordance with the relevant rules of the international law" (Article II). Article IV also calls to "apply the precautionary approach, as described by relevant provisions of the Code of Conduct and/or the 1995 UN Fish Stocks Agreement, for the conservation, management and sustainable use of fish stocks covered by the Convention", and Article VII calls the adoption of "measures that are based on the best scientific evidence available to ensure the long-term conservation and sustainable use of the fish stocks covered by this Convention and to maintain or restore the populations of harvested species at levels of abundance which can produce the maximum sustainable yield" (IATTC 2003). Therefore, the IATTC Convention has explicitly defined a general long-term operational objective that applies to fish stocks covered by the Convention and especially to the harvested stocks. We therefore assigned the progress category – Full progress by the Commission.

(ii) **Indicators**

Progress category assigned: FULL PROGRESS BY THE COMMISSION

Fishery stock assessments have been conducted for all principal market tunas stocks (6 stocks/5 species) and Swordfish (2 stocks). Thus, all target stocks exploited by IATTC fisheries have been evaluated with fisheries stocks assessments to determine the effects of fishing on the individual stocks and determine their exploitation status. Indicators of population status including indicators of population size and fishing mortality over time and associated reference points are available and monitored regularly for these assessed stocks. These stock status indicators and

associated reference points are also explicitly associated to the aforementioned objective of maintaining populations at maximum sustainable yields. We therefore assigned the progress category – Full progress by the Commission.

(iii) **Reference points**

Progress category assigned: MODERATE PROGRESS BY THE COMMISSION

Stock-specific interim limit and target reference points associated with the biomass and fishing mortality rate indicators were adopted for Bigeye, Yellowfin and Skipjack tunas in 2014 (Maunder et al. 2015). The target reference points adopted are the biomass and fishing mortality rate corresponding to maximum sustainable yield, which have been the unofficial target reference points used in IATTC in managing tuna. The limit reference points were defined to ensure that recruitment is not substantially impacted. Limit points were associated with a 50% reduction in recruitment from the unfished level under a conservative assumption in the stock-recruitment relationship (when stepness is 0.75) (Maunder and Deriso 2014). Limit reference points have not been defined or adopted by IATTC for the rest of the target species including North Pacific Albacore tuna, Pacific bluefin tuna or Swordfish, for which reference points based on maximum sustainable yield remain to be used unofficially as targets. The management and conservation of North and South Pacific Albacore, Pacific bluefin tuna and Swordfish is shared between the WCPFC and IATTC. The WCPFC has established a limit reference point for South Pacific Albacore (see WCPFC section).

In conclusion, stock-specific limit and/or target reference points associated to pre-defined objectives and indicators have been defined and developed for some species, and adopted by the Commission. Stock-specific reference points are also under development for other species. Therefore, we assigned the progress category – Moderate progress by the Commission.

(iv) **Management responses and measures**

Progress category assigned: MODERATE PROGRESS BY THE COMMISSION

An interim harvest control rules was adopted in 2014 for tropical tuna species. The harvest control rule establishes the management response of reducing the fishing mortality to F_{MSY} if fishing mortality for Bigeye or Yellowfin tunas exceeds their respective F_{MSY} (Maunder et al. 2015). However, the management response is not automatically adopted, as the Commission would still need to agree on measures to reduce fishing mortality effectively. This adopted interim harvest control rule, although it is a positive step forward, it does not take uncertainty into account, or the probability of exciding the adopted limit reference points, lacks specific timeline for reductions and rebuilding timeframes to target F_{MSY}, and lacks automatic management responses to implement the reduction. In 2015, the IATTC Scientific Committee developed and recommended more complete harvest control rules to be adopted by the Commission (IATTC 2015c).

Several management measures (binding resolutions) have also been adopted by IATTC to ensure that the aforementioned management objective of maintaining target species at levels that permit maximum sustainable yields is achieved. We briefly summarize the most relevant binding conservation and management measures adopted by IATTC to manage target stocks. Resolution C-13-01 establishes annual time-area closures for purse seiners catching Bigeye, Yellowfin and Skipjack tunas, a full retention requirement of Bigeye, Yellowfin and Skipjack tunas for all purse seiners, and catch limits for Bigeye for the main longline fishing nations. There is also in place a capacity limitation program for large purse seine fisheries and close regional vessel registry (Resolution C-02-03).

For the north Pacific Albacore tuna stock, Resolution C-05-02 calls for members not to increase fishing effort beyond current levels. WCPFC, which also shares the management of North Pacific Albacore wuth IATTC, has a similar measure (CMM-2005-03). Resolution C-13-03 requires also the reporting of fishing vessel information for 2007-2012. For Pacific bluefin tuna, Resolution C-14-06 calls to limit commercial catches in 2015 and 2016. The WCPFC which also shares the management of Pacific bluefin tuna with IATTC, has also adopted CMM-2014-04 establishing a multi-annual rebuilding plan (starting in 2015) to rebuild the spawning biomass to its median levels by 2025 with at least 60% probability, and includes limits in total fishing effort, and reduction in catches of juveniles.

In conclusion, interim harvest control rules, although not fully implemented, have been adopted for some target species. Furthermore, several management measures have been adopted to ensure management objectives are achieved for majority of target stocks and species. We therefore assigned the progress category – Moderate progress by the Commission.

Bycatch species - Ecological component 2.

For practical reasons, we reviewed under the ecological component of "Bycatch species" all billfish species (except Swordfish), as well as sharks, seabirds, sea turtles, marine mammals, and other finfishes impacted by fisheries. Yet we stress several species of billfishes, sharks and other finfishes can also be target species at least in some fisheries.

(i) **Objectives**

Progress category assigned: FULL PROGRESS BY THE COMMISSION

The IATTC Convention mandate or Antigua Convention has explicit provisions addressing the impacts of fishing on bycatch (both fish and non-fish species) and associated or dependent species and concerning the reduction and minimization of impacts on these species. Article VII (1f) calls for the adoption of conservation and management measures for species belonging to the same ecosystem and that are affected by fishing for, or dependent on or associated with, the fish stocks covered by the Convention, with a view to maintaining or restoring populations of such species above levels at which their reproduction may become seriously threatened. Article IV (3) also calls where status of target stocks or non-target or associated or dependent species is of concern to enhance the monitoring in order to review status and efficacy of conservation and management measures. Furthermore Article IV(1) calls for the application of the precautionary approach as described in relevant international agreements such as the 1995 UN Fish Stocks Agreement (Article IV) (IATTC 2003). In relation to the impacts of fishing on marine mammals, the Agreement on the International Dolphin Conservation Program, a legally binding agreement, states to progressively reduce incidental dolphin mortalities in the tuna-purse seine fishery to levels approaching zero. Therefore, the IATTC Convention formally recognizes to address the impact of fisheries on bycatch species, and it formally states the operational objective of adopting conservation and management measures with a view to maintaining or restoring populations above levels at which their reproduction may become seriously threatened. We therefore assigned the progress category – Full progress by the Commission.

(ii) **Indicators**

Billfishes - Progress category assigned: MODERATE PROGRESS BY THE COMMISSION

Some billfish stocks and species, including blue marlin, striped marlin and sailfish are regularly assessed with traditional fishery stock assessments. Thus, indicators of stock status, including indicators of population size and fishing mortality over time, are regularly developed and are being monitored for these assessed species to provide management advice. Although traditional stock assessments have not been conducted for black marlin and shortbill spearfish, several simple indicators have been developed including trends in catches, effort and catch per unit of effort (CPUEs) (IATTC 2015b). In conclusion, a series of region-wide indicators of stock status (associated to pre-established objectives) are routinely developed and monitored only for some billfish species which are used to provide robust management advice to the Commission. We therefore assigned the progress category – Moderate progress by the Commission.

Sharks - Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

The IATTC Scientific Committee has attempted to assess Silky shark with traditional fishery stock assessment models in the Eastern Pacific Ocean, however the resultant assessments were considered unreliable due to major uncertainties in the fisheries data. Alternatively, IATTC has calculated a set of possible stock status indicators (or stability) indicators using fisheries data collected by all purse-seine type fisheries to indirectly assess status, but these simple indicators were not used to determine status or set catch limits (IATTC 2014b). These set of simple indicators include the spatial distribution of Silky shark per set in purse-seine sets on floating objects, standardized

CPUE in purse seine on floating objects, nominal proportions of positive sets in which Silky shark are caught for all purse seine set types, standardized indices of presence/absence of Silky sharks in purse-seine sets on dolphin and unassociated schools, and average length caught in all purse seine sets types (IATTC 2014b). However, purse seiners are not the most relevant fisheries, since Silky sharks are mostly taken by longline fisheries. Status indicators (or stability) indicators are incomplete for the rest of fisheries, including longline, small purse-seiner and pole and line fisheries. Additionally, Blue shark in the North Pacific was assessed with traditional fishery stock assessments in 2013 and in 2014 by the International Scientific Committee (ISC) for Tuna and Tuna-like species in the North Pacific Ocean (IATTC 2015b, ISC 2015). The ISC for Tuna and Tuna-like species in the North Pacific Ocean provides scientific advice on northern Pacific stocks to IATTC and WCPFC. The Blue shark stock assessment results, although uncertain, provided management advice to be considered by IATTC and WCPFC. Thus, indicators of stock status, including indicators of population size and fishing mortality over time, are now regularly being developed and monitored for this assessed species to provide management advice to IATTC and WCPFC. Furthermore, the Shortfin mako in the North Pacific, a stock considered also data poor, was also assessed with a series of indicators for the first time in 2015 by the International Scientific Committee for Tuna and Tuna-like species in the North Pacific Ocean. Four types of indicators were developed including proportion of positive sets, cpue indices, sex-ratio and size compositions, but they could not be used to determine the status of the stock since their validity was untested and important fisheries information was missing (ISC 2015).

In 2015 the IATTC Scientific Committee also conducted an ecological risk assessment (level 2 semi-quantitative assessment) productivity-susceptibility analysis for the three purse seine fisheries. This ecological risk assessment covered 32 species of target and bycatch species including tunas, billfishes, dolphins, other finfishes, rays, shark and turtles. It included 12 species of sharks and rays, thus providing an indicator of vulnerability of species to purse-seine fisheries. An ecological risk assessment has not been conducted for other fisheries including longline, pole and line, etc…(IATTC 2015b). The Commission has also requested to conduct species-specific ecological risk assessment for silky shark and hammerheads (IATTC 2014a).

In conclusion, indicators of stock status (associated to pre-established objectives) have only been derived for some vulnerable shark species and stocks. The type of indicators and their robustness to provide management to the Commission varies by species. At large, the developed indicators for Blue shark in the North Pacific, Silky shark in the Eastern Pacific Ocean, and Shortfin mako in the North Pacific Ocean are considered highly uncertain, and therefore they are used to provide weak management advice to the Commission, since they cannot be used directly to establish the exploitation status of species or set impact or catch limits. We therefore assigned the progress category – Slight progress by the Commission.

Seabirds - Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Region wide assessments and indicators of stock status or fishery impacts for seabirds impacted by IATTC fisheries have not been developed by the Scientific Committee or have been requested by the Commission. The IATTC Scientific Committee has focused its efforts on identifying areas of vulnerability to industrial longline fisheries for several species of albatross and proposing mitigation measures to reduce seabird mortality (IATTC 2015b). In 2005 a level 2 ecological risk assessment for seabirds was conducted in the IATTC Convention Area. This ecological risk assessment assessed the overlap of RFMOs areas with albatross distribution with longline fisheries, and determined that the IATTC area overlaps with albatross distribution indicating there are susceptible to IATTC longline fisheries (Small 2005). In 2015 IATTC also conducted a taxonomic wide level 2 ecological risk assessment (productivity-susceptibility analysis), which includes 32 species of target and bycatch species caught in the three purse seine fisheries, yet this assessment did not include any seabirds. Seabirds are more susceptible to being caught in longline fisheries, yet a more complete ecological risk assessment for the longline fisheries has not been conducted in the IATTC Convention Area. Since, region wide assessments and indicators of stock status or fishery impacts for seabirds impacted by IATTC fisheries have not been developed by the Scientific Committee or have been requested by the Commission, we assigned the progress category – Slight or no progress only by the Scientific Committee.

Sea turtles - Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Region wide assessments and indicators of stock status for sea turtles impacted by IATTC fisheries have not been developed by the Scientific Committee, or have been requested by the Commission. To date, the IATTC Scientific Committee has focused its efforts on monitoring the fishery impacts of purse seiners on sea turtles and reporting incidental catches using data derived from the purse seine observer program, yet these incidental catches have not been linked to their current population levels, which are unknown. Furthermore, purse seiners only occasionally catch sea turtles. Sea turtles are more susceptible to being caught in longline and gillnet fisheries. The Scientific Committee has also focused its efforts on developing and implementing mitigation programs to reduce sea turtle bycatch (IATTC 2015b). Furthermore, in 2015 IATTC conducted a level 2 semi-quantitative ecological risk assessment (productivity-susceptibility analyses), which included 32 species of target and bycatch species caught in the three purse seine fisheries and only included one species of turtle. While sea turtles are more susceptible to being caught in longline and gillnet fisheries, the information on these incidental mortalities are scarce and sporadic in time and space due to the lack of an IATTC longline regional observer program and the requirement for members to implement longline observer coverage of 5% only (IATTC 2015b). A region wide ecological risk assessment for the longline and gillnet fisheries has not been conducted in the IATTC Convention Area.

In conclusion, region-wide assessmetns and indicators of stock status for sea turtles impacted by IATTC fisheries have not been developed by the Scientific Committee, or have been requested by the Commission. The IATTC Scientific Committee monitors the impacts of purse seine fisheries and reports incidental catches. Yet the level of interaction between purse seiners and sea turtles is believed to be low and regional risk assessments and indicators have not been developed for the longline and gillnet fisheries where the impact of fishing is believed to be higher. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

Marine mammals - Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

The IATTC Agreement on the International Dolphin Conservation Program (AIDCP) is responsible for the assessment of dolphin population associated with purse-seine tuna fisheries, collect information on dolphin incidental mortality rates, and calculate indicators of population status to comply with the dolphin limit mortalities established by the AIDCP. IATTC has collected the most comprehensive data set available of dolphin interactions with IATTC purse seine fisheries. Trends of population size for several dolphin species, together with information on their distribution, herd size and herd composition, are available from several species spanning from 1986 to 2006 (Gerrodette et al. 2008). However, estimates of dolphins abundance in the Eastern Pacific Ocean were last estimated in 2006. IATTC monitors routinely the incidental mortality rates for dolphins in the large purse fisheries since the 1970s, but since 2006 these mortality estimates have not been linked to the abundance levels of the populations. There is not a similar program for other marine mammals or other fishing gears for which to establish indicator of stock status and fishery impacts. In conclusion, a series of indicators of stock status and/or fishery impacts (associated to pre-established objectives) have been estimated for some marine mammals in at least some fisheries, but because they have not been monitored since 2006, we assigned the progress category – Slight progress by the Commission.

Other finfishes - Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Region-wide assessments and indicators of stock status for finfish species other than tunas and billfishes impacted by IATTC fisheries have not been developed by the Scientific Committee or have been formally requested by the Commission. The IATTC Scientific Committee has focused its efforts on monitoring the fishery impacts of purse seiners and reporting incidental catches of finfishes using data derived from the purse seine observer program. Yet comprehensive assessments to assess if these incidental catches are sustainable have not been conducted. Moreover, the level 2 semi-quantitative ecological risk assessment (productivity-susceptibility analysis) conducted by IATTC in 2015, which includes 32 species of target and bycatch species caught in the three purse seine fisheries, includes 9 species of finfish, raking their vulnerability to purse seine fisheries. Moreover, the IATTC Scientific Committee is currently reviewing the current state of the dorado (*Coryphaena hippurus*), which is an important species caught by artisanal coastal fisheries, with a view of determining the impacts of fishing and developing indicators of stock status and recommend appropriate management and conservation measures (IATTC 2015e).

In conclusion, region-wide assessmetns and indicators of stock status for finfishes impacted by IATTC fisheries have not been developed by the Scientific Committee, or have been formally requested by the Commission. The IATTC Scientific Committee monitors the impacts of purse seine fisheries and reports incidental catches. Yet this

information is not used to provide robust management advice. Furthermore, the level of interaction with other fisheries such as the longline and gillnet is unknown. The recent initiative to determine the current state of knowledge of dorado (*Coryphaena hippurus*) in the Eastern Pacific Region is seen as a positive step forward. We assigned the progress category – Slight or no progress only by the Scientific Committee.

(iii) **Reference points**

Billfishes - Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

Limit reference points associated to the biomass and fishing mortality rate indicators have not been defined, developed or adopted for any of the assessed billfish stocks. B_{MSY} and F_{MSY} (or proxies) have been the unofficial implied target reference points used in IATTC for assessed billfishes. We therefore assigned the progress category – Slight progress by the Commission.

Sharks - Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

Limit reference points associated to the biomass and fishing mortality rate indicators have not been defined, developed or adopted for any of the assessed shark stocks. B_{MSY} and F_{MSY} (or proxies) have been the unofficial implied target reference points used in IATTC for assessed sharks. We therefore assigned the progress category – Slight progress by the Commission.

Seabirds - Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Target and/or limit reference points associated to indicators of stock status or bycatch rate estimates have not been defined, developed or adopted for any of the species, and are not under development or being discussed. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

Sea turtles - Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Target and/or limit reference points associated to indicators of stock status or bycatch rate estimates have not been defined, developed or adopted for any of the species, and are not under development or being discussed. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

Marine mammals - Progress category assigned: MODERATE PROGRESS BY THE COMMISSION

Incidental mortality limits for dolphins to levels that are insignificant relative to stock sizes in the eastern Pacific ocean purse-seine fishery under the AIDCP have been adopted by the Commission (AIDCP 2014). Target or limit reference points have not been adopted for other marine mammals. We therefore assigned the progress category – Moderate progress by the Commission.

Other finfishes - Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Target and/or limit reference points associated to indicators of stock status or bycatch rate estimates have not been defined, developed or adopted for any of the species, and are not under development or being discussed. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

(iv) **Management responses and measures**

IATTC has adopted an extensive list of conservation and management measures (binding Resolutions or non-binding Recommendation) for billfishes, sharks, seabirds, sea turtles, marine mammals and other finfishes. We briefly list them below and group them by taxonomic group. Overall the adopted measures have the main purpose to minimize the effects of fishing on by-catch species as for example with the modification of gears to avoid them or in the form of prohibition. The adopted measures also focus on establishing requirements for data reporting and conduct specific type of research. We find no management measure has been adopted to set a management response linked to pre-established operational objectives, indicators and reference points for any of the bycatch species impacted by IATTC fisheries (excluding marine mammals), precluding them to be activated when predefined reference points are exceeded. The adopted measures (mostly to mitigate impacts) are not known whether they are being effective to affect the current status of populations since they have not been linked to status indicators or reference points to judge whether the current state of species is acceptable. We therefore assigned the progress

category – Slight progress by the Commission to the taxonomic group of billfishes, sharks, seabirds, sea turtles and other finfishes.

For marine mammals, although no management measures has been adopted to establish limits or minimize the impacts of fisheries on marine mammals, the Agreement on the International Dolphin Conservation Program (AIDCP) establishes total per-stock and per-year limits on incidental dolphin mortality (DMLs), with a structured protocol for allocating and keeping track of DMLs using observers. A vessel must stop setting on dolphin associations for the rest of the year once its DML has been reached (AIDCP 2014). Since the 1980s the AIDCP to reduce or eliminate that impact of purse seine fisheries on dolphins has had considerable success. In purse seine fisheries, dolphin mortality is managed and closely monitored by AIDCP to reduce mortality levels approaching zero with mortality limits, real time 100% observer coverage and reporting, dolphin safety gear, and training program for vessels. This program was key to allow for a transition in the IATTC from just promoting the conservation of dolphins in tuna fisheries to have pre-agreed management rules and responses to ensure a predefined objective is achieved. Hence, IATTC is focused on reducing dolphin mortalities in purse seine fisheries, while measures have not been adopted to reduce mortalities on other marine mammals or reduce marine mammals mortalities for other fisheries such as longliners. A recent adopted measure requiring for national longline observer coverage (of at least 5%) do not call for recording of interactions with marine mammals (Clarke et al. 2014). We therefore assigned the progress category – Moderate progress by the Commission.

Measures	**Type of Measure**
Billfishes – Progress category assigned: Slight progress by the Commission	
Resolution C-04-05 – instructs the Director to seek funds for developing techniques and equipment to facilitate release of billfishes and to carry out experiments to estimate their survival.	-Binding -To minimize bycatch
Sharks - Progress category assigned: Slight progress by the Commission	
Resolution C-04-05 – instructs the Director to seek funds for developing techniques and equipment to facilitate release of sharks and rays and to carry out experiments to estimate their survival.	-Binding -To minimize bycatch
Resolution C-05-03 - discourages shark retention and establishes a limit in the amount of shark fins that can be landed, relative to the total weight of shark bodies that must be retained. Mandates reporting of shark catches to IATTC.	-Binding -To minimize bycatch
Resolution C-11-10 -prohibits the retention of oceanic whitetip sharks and requires the release of specimens that are alive when caught.	-Binding -To minimize bycatch
Resolution C-13-04 - calls for a transition to non-entangling FADs in purse seine fisheries to reduce the entanglement of sharks. Setting a purse seine on tuna associated with a live whale shark is prohibited, if animal is sighted prior to the set.	-Binding -To minimize bycatch
Seabirds - Progress category assigned: Slight Progress by the Commission	
Recommendation C-10-02 – reaffirmed the importance of implementing the IPOA-Seabirds for reducing the incidental catch of seabirds in longline fisheries. Require to use at least two of a set of eight mitigation measures listed. Encourages to establish national programs to place observers in longliners, and adopt measures to release seabirds captured alive.	-Non binding -To minimize bycatch
Resolution C-11-02 - reaffirmed the importance of implementing the IPOA-Seabirds for reducing the incidental catch of seabirds in longline fisheries. Requires logline vessels operating in high latitudes to employ at least two of the specified sea bird mitigation techniques such as night setting or weighted branch lines. Encourage to conduct research to refine mitigation methods and submit the results to IATTC. Encourages establishing national programs to place observers in longliners to gather information on the interactions of seabirds with the longline fisheries.	-Binding -To minimize bycatch
Sea turtles - Progress category assigned: Slight progress by the Commission	
Resolution C-04-05 – Contains provisions on releasing and handling of sea turtles captured in purse seiners. Instructs the Director to seek funds for developing techniques and equipment to facilitate release of sea turtles and to carry out experiments to estimate their survival.	-Binding -To minimize bycatch
Resolution C-04-07 - adopts a three-year program to mitigate the impact of tuna fishing	-Binding

on sea turtles, and includes requirements for data collection, mitigation measures, industry education, capacity building and reporting.	-To minimize bycatch
Resolution C-07-03 - requires to release sea turtles entangled in FADs or caught in longlines and to avoid encircling them with purse seine nets. Calls for research to mitigate sea turtle bycatch, especially with gear modifications. Calls for implementing observer programs that may have impacts on sea turtles.	-Binding -To minimize bycatch
Resolution C-13-04 - calls for a transition to non-entangling FADs in purse seine fisheries to reduce the entanglement of sea turtles.	-Binding -To minimize bycatch
Marine Mammals - Progress category assigned: Moderate progress by the Commission	
The AIDCP establishes total per-stock and per- year limits on incidental dolphin mortality (DMLs), with a structured protocol for allocating and keeping track of DMLs (using observers). A vessel must stop setting on dolphin associations for the rest of the year once its DML has been reached.	-This is not an adopted measure. Objectives were clearly defined in the AIDCP. -To limit bycatch
Other finfishes - Progress category assigned: Slight progress by the Commission	
Resolution 04-05 - requires the release of non-target species caught in purse seine fisheries.	-Binding -To minimize bycatch

Ecosystem properties and trophic relationships - Ecological component 3.

Under the ecological component of "Ecosystem Properties and Trophic Relationships", we valued the existence of ecosystem metrics (empirically and model based) and food web models depicting trophic interactions and interdependencies involving relevant species or components of ecosystems that are affected by fishing, and are relevant to maintain ecosystem structure and function, and how this information is being used to advance progress in implementing EBFM.

(i) **Objectives**

Progress category assigned: MODERATE PROGRESS BY THE COMMISSION

The IATTC Convention mandate or Antigua Convention has explicit provisions addressing the impacts of fishing on bycatch (both fish and non-fish species) and associated or dependent species. Article VII (1f) calls for the adoption of conservation and management measures for species belonging to the same ecosystem and that are affected by fishing for, or dependent on or associated with, the fish stocks covered by the Convention, with a view to maintaining or restoring populations of such species above levels at which their reproduction may become seriously threatened. Furthermore, Article IV (3) also calls where status of target stocks or non target or associated or dependent species is of concern to enhance the monitoring in order to review status and efficacy of conservation and management measures (IATTC 2003). Furthermore, the Biology and Ecosystem Research Program run by the IATTC staff establishes as a research objective to develop conservation and management measures for species belonging to the same ecosystem that are affected by fishing for, or dependent on or associated with, the fish stocks covered by the Convention, in order to maintain and restore such species above sustainable levels.

In conclusion, the Convention captures the broader impacts of fishing not only on target species but also on species belonging to the same ecosystem that are affected by fishing for, or dependent on or associated with, the fish stocks covered by the Convention (tuna and tuna-like species and other fish species taken by the fishing vessels), but it does not explicitly sets clear operational objective to minimize the impacts of fishing on trophic relationships, food web structure and ecosystems. We therefore assigned the progress category – Moderate progress by the Commission.

(ii) **Indicators**

Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

The IATTC Science Committee, as requested by the Commission through the Convention Agreement, has focused its effort to develop ecosystem indicators to understand the broader community based and ecosystem level consequences of purse seine fisheries, and also to develop pelagic ecosystem models to investigate food web dynamics and how fisheries and climate variability impact the upper and middle trophic levels in the eastern Pacific Ocean (IATTC 2015b). Ecosystem indicators or aggregated ecological indicators have been developed since 1993 to describe changes in the communities and ecosystem properties due to purse seine fishing. These ecological metrics include yearly catches of target and non-target (bycatch) species, both retained and discarded, by type of purse seine sets measures on the basis of replacement time, diversity, biomass (weight), number of individuals and trophic level. Thus, these ecological metrics are commonly referred as: (1) mean replacement time for total removals, (2) Shannon diversity index for total removals, (3) total removals measured in biomass, number of individuals and trophic-level units, (4) mean trophic level of catches (retained and discarded) (IATTC 2015b). Empirical-based ecological metrics derived from the impact of other fisheries such as longliners have not been developed.

Since the 1980s, there has been also a significant research program to understand and describe the trophic structures and interactions that involve the species impacted by fishing, including the likely effect of fishing on other dependent species, dependent predators or pray species (IATTC 2015b). The main research activities include: (1) development of a food-web model of the pelagic ecosystem in the tropical east Pacific ocean including the main functional species and group of species to describe trophic links, biomass flows through the food web; (2) development of multi-species pelagic ecosystem models in the tropical east Pacific Ocean to investigate how fisheries and climate variability impact species at the upper and middle trophic levels and to understand the main trophic links and biomass flows through the food web; and (3) development of diet studies of stomach contents and stable isotope analysis for multiple species including Yellowfin, Skipjack and Bigeye tunas, dolphins, pelagic sharks, billfishes, dorado, wahoo, rainbow runner and others. These diet studies are critical to investigate the key trophic connections in the pelagic eastern Pacific Ocean, which forms the basis for representing food web interactions in the ecosystem models. It is worth to highlight a comprehensive decadal analysis of the predation by Yellowfin tuna completed in 2013 and predation analysis for silky sharks completed in 2015 (IATTC 2015b).

In conclusion, IATTC recognizes the value of investigating the ecosystem effects of fishing by understanding the food web structure, trophic relationships and interactions involving species impacted directly and indirectly by fishing. The Scientific Committee has developed and monitors several ecosystem metrics and ecosystem models to understand the broader community based and ecosystem level consequences of fisheries as requested by the Commission through its Convention mandate. Yet the Scientific Committee has only focused on developing ecosystem metrics to monitor the impacts of purse seine fisheries on the ecosystem. Ecosystem metrics to monitor the impacts of longline fisheries or other fisheries have not been developed. These ecosystem products are available to the Commission since 2003 to assist in making its management decisions and ensure ecosystem considerations are parts of its agenda (IATTC 2015b). However, there is little evidence that these type of ecosystem products and considerations are taken into account to assist in management decisions. We therefore assigned the progress category – Slight progress by the Commission.

(iii) **Reference points**

Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Ecosystem and/or multispecies management plans (including harvest strategies) with pre-defined reference points for relevant species and components of ecosystems have not been developed and are not under discussion. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

(iv) **Management responses and measures**

Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Management measures have not been adopted to explicitly account for food web and multispecies interactions and maintain the structure and functioning of marine food webs, or have been linked to any pre-established ecosystem

model, and associated indicators and operational objectives. Some ecosystem/food web models are being developed and tested for some relevant species and components of ecosystems which could potentially be used in decision-making or incorporated in management measures. Yet a formal mechanism does not exist to accommodate multispecies and food web interactions and ecosystem modelling into the current management and potential management measures (e.g. multispecies harvest control rules, time-area closures, etc…). We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

Habitats – Ecological component 4.

Under the ecological component of "Habitats", we valued whether habitats of special concern (e.g. reproduction, migration, feeding, hotspots) and/or habitat utilization and preferences for relevant species have been formally investigated and delineated, and how this information is being used to advance progress in implementing EBFM.

(i) **Objectives**

Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

The IATTC Convention Agreement does not contain any specific provisions relevant to habitats of special concern for IATTC species. Habitats of special concern have not been formally defined or delineated by the Commission. Although the IATTC Scientific Committee recognizes the importance of habitat, it has not defined or stated clear conceptual or operational objectives relevant to habitats of special concern in their Terms of Reference or research agendas. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

(ii) **Indicators**

Progress category assigned: MODERATE PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE.

Habitats of special concern (e.g. reproduction, migration, feeding, hotspots) and/or habitat utilization and preferences for relevant IATTC species have not been formally delineated by the Commission, and indicators (associated to pre-established objectives) describing habitat needs and preferences have not been developed and used formally in setting management recommendations and advice. Yet some research activities and practices, particularly to identify habitat preferences and utilization, have been conducted by the Scientific Committee for the main target tropical tuna species in support of the implementation of EBFM. While habitat research focused on the habitat utilization and preferences of bycatch species has been scarce in the IATTC area.

The IATTC Scientific Committee has focused its habitats research activities and practices to study the effects of environmental conditions and climate variability on the distribution, abundance, recruitment and dynamics of tropical tunas and billfishes (IATTC 2015b). There is a research program in place to monitor the ocean environment. The ocean environment is monitored regularly at several time scales, from seasonal to interannual to decadal scales. This information is used to measures changes in the biological production, expansion of the oxygen minimum zone and suitable habitat and its effect on the distribution, abundance, recruitment and dynamics of tunas and billfishes. Some stock assessments have also incorporated oceanographic information to explore how it may affect the recruitment dynamics of species. For many years the National Marine Fisheries Service in the USA has been collecting larval fish samples with surface net tows in the EPO to investigate the occurrence, abundance and distributions of the key taxa in relation to the environment. Moreover, several studies using satellite and at-sea observation data have identified the importance of the IATTC area as critical foraging areas for several bird species including the waved, black-foored, laysan and black-browed albatrosses (IATTC 2015b). Furthermore, IATTC has also developed several tagging programs since the early fifties (Schaefer et al. 1961). These tagging programs have provided critical information on the biology, population dynamics and main status of main target tropical tuna species as well as on their habitat preferences and utilization (Schaefer and Fuller 2005, 2006, 2009, 2010). Despite these efforts and initiatives that recognize the importance of habitat research, the outcomes of these research studies have had a limited impact on formally identifying, delineating and protecting habitat of special concern for relevant species in the IATTC area and on developing indicators describing habitat needs and preferences for relevant species.

In conclusion, habitats of special concern have not been formally mapped or delineated for any species of interest by the Commission, yet for some species habitat utilization and preferences have been investigated or are under investigation by the IATTC Scientific Committee, which sets the basis towards advancing the habitat component of EBFM in IATTC. Indicators (not associated to pre-established to objectives) describing habitat needs and preferences are at the early states of development, but are not routinely monitored or used to assist in management advice. There is little evidence that these types of habitat products and considerations are taken into account to assist in management decisions at the Commission level. We therefore assigned the progress category – Moderate progress only by the Scientific Committee.

(iii) **Reference points**

Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Minimum habitat needs and requirements (linked to pre-established indicators and objectives) have not been identified and are not under discussion for any relevant species with habitats of special concern. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

(iv) **Management responses and measures**

Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Management measures have not been adopted to explicitly protect habitats of special concern for relevant species. Knowledge of habitats of special concern and habitat preferences and utilization is not under discussion to be used potentially in decision-making. There are no formal mechanism to accommodate minimum habitat needs and habitat protection into the current management or management decisions, and this is not under discussion by the Scientific Committee. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

3.5 Commission for the Conservation of Southern Bluefin tuna

3.5.1. Review of basic texts and main structures in support of EBFM

(i) **Reference to the PA and EBFM principles in accordance to relevant rules of international fisheries governance**

Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

The CCSBT was established in 1993 and entered into force in 1994. Its Convention Agreement primary objective is "to ensure, through appropriate management, the conservation and optimum utilization of Southern bluefin tuna". Hence, the Convention has not specific area of jurisdiction. Instead it applies to only one species, the Southern bluefin tuna (*Thunnus maccoyii*) throughout its range in the Southern Ocean and has no clear mandate for managing species other than Southern bluefin tuna. The Convention Agreement does not refer to the principles of the precautionary approach or the EBFM. However, the precautionary approach is implemented by CCSBT in the form of a management procedure developed for Southern bluefin tuna, which is a meta-rule or tool that helped to formally defined management reference points for Southern bluefin tuna, as well as expected stock trajectories and pre-agree course of actions while accounting for uncertainties (Garcia and Koehler 2014). The management procedure uses a precautionary approach to set target, limit and reference points levels at which action is triggered, and it accounts for uncertainties that have been tested through simulations, for example using management strategy evaluation. Some argue that CCSBT also had the ability to assimilate some elements of global instruments of fishery governance

(UNCLOS and UNFSA) through the adoption of conservation and management measures. CCSBT has adopted a non-binding measure which requires members to comply with all current binding and recommendatory measures aimed at the protection of ecologically related species including seabirds, sea turtles and sharks adopted by IOTC, WCPFC and ICCAT when operating in their Convention Area. Other voices claim CCSBT should adopt its own binding measures to manage and conserve the impacts of Southern bluefin tuna fisheries on ecologically related species. Ecologically related species is defined in the Convention Mandate as "living marine species which are associated with Southern bluefin tuna, including but not restricted to both predators and prey of Southern bluefin tuna" (CCSBT 1994).

Furthermore, CCSBT has also developed several Strategic Plans (the first one adopted in 2011 and the second adopted in 2015) establishing a common objective, vision and goals of the desired future state of the Commission, as well as strategies and approaches to achieve the desired future state. The Strategic Plan sets as a goal to improve knowledge of Southern bluefin tuna fisheries ecosystems, as well as to incorporate modern fisheries management standards including the precautionary appraoch and ecosystem management into the Convention and the Commission's decisions. CCSBT is also discussing the development of a management plan that would be complementary to the Strategic Plan, which will provide more operational details of how incorporate the precautionary approach and ecosystem considerations into management-advice (CCSBT 2015c).

In conclusion, the CCSBT Convention Agreement does not make reference to the principles of the precautionary approach or EBFM. The precautionary approach has only been implemented by CCSBT to manage Southern bluefin tuna when developing the management procedure. Furthermore, CCSBT has had the ability to assimilate some elements of international fisheries governance in the form of adoption of management measures. However, the main management measure adopted concerning ecologically related species call to follow the binding measures of other tRFMOs to minimize the impacts of Southern bluefin tuna fisheries on ecologically related species. The effectiveness and appropriateness of this measure has been debated in numerous occasions and some voices claim CCSBT should adopt its own binding measures. We therefore assigned the progress category – Slight progress by the Commission.

(ii) **Existence a lead entity or group to advance progress in EBFM and ecosystem science**

Progress category assigned: MODERATE PROGRESS BY THE COMMISSION

The current structure of CCSBT includes five subsidiary bodies, which provide advice on their areas of expertise. These include the Scientific Committee and Extended Scientific Committee, the Ecologically Related Species Working Group, the Strategy and Fisheries Management Working Group, the Compliance Committee and the Finance and Administration Committee. Other technical groups may be also created to support the work of the Scientific Committee such as the Operating Model and Management Procedure Technical Meeting or the Seabird Mitigation Measures Technical Group. CCSBT follows a scientific model similar to ICCAT and IOTC. General research and assessments are conducted by the Scientific Committee with the participation of member States. Working Group reports and outputs are reviewed by the CCSBT Scientific Committee with support from independent experts. The role of the independent experts is to facilitate consensus in the Scientific Committee. Then, the Scientific Committee is responsible for developing and recommending to the Commission policy advice concerning the Southern bluefin tuna fisheries.

The Commission established the Ecologically Related Species Working Group (ERSWG) in 1995. The ERSWG provides information and advice on issues relating to species associated with southern bluefun tuna, called Ecologically Related Species, to the Commission through the Scientific Committee. Ecologically related species is defined in the Convention Mandate as "living marine species which are associated with Southern bluefin tuna, including but not restricted to both predators and prey of Southern bluefin tuna" (CCSBT 1994). Hence, ecologically related species makes reference to species, both fish and non-fish, which may be affected by Southern bluefin tuna fisheries, and predator and prey species, which may affect the condition of Southern bluefin tuna stock. The Working Group has the tasks to monitor trends and review existing research on the population biology of ecologically related species and factors affecting their populations, provide recommendation of data collection programs and research programs, provide advice on measures to minimize fisheries effects on ecologically related species and enhance the management and conservation of ecologically related species (CCSBT). The ERSWG also

has a role of providing advice on best practice for educational activities such as the development of pamphlets. The ERSWG meets on average every two years and prepares a report summarizing the main information and advice on ecologically related species and generates a series of recommendations and advice for the Extended Commission. Additionally, the CCSBT Effectiveness of Seabird Mitigation Measures Technical Group was recently created in 2013 to provide advice on optimal approaches for measuring and monitoring the effectiveness of seabird bycatch mitigation measures in Southern bluefin tuna fisheries.

CCSBT also lacks an effective mechanism to coordinate all bycatch and ecosystem-relevant research, and ensure effective communication and exchange of information pertaining to ecosystem issues among all the working groups, which limits a full assessment of the cumulative impact of souther bluefin fisheries on bycatch species and the effects of their removals from the ecosystem, limiting a comprehensive implementation of EBFM. Although it lacks of a formal mechanism to coordinate all ecosystem-relevant research, the ERSWG in its annual meetings has recently started to refer matters pertaining the ecologically related species for consideration by CCSBT subsidiary bodies to coordinate its activities with other working groups.

In conclusion, the Ecologically Related Species Working Group was created to provide information and advice on issues relating to species associated with southern bluefun tuna through the Scientific Committee to the Commission. However, it has limited capacity or has partial authirty to coordinate and integrate all relevant bycatch and ecosystem research activities (pertaining to target and bycatch species, trophic relationships and habitats) needed to fully implement EBFM, since it was created to coordinate only some of the ecological elements of a comprehensive EBFM framework. To our knowledge, CCSBT lacks an effective mechanism to coordinate and integreate all ecosystem-relevant research and to ensure effective communication among the relevant Working Groups and to the Commission. This lack of coordination, capacity and communication among the working groups limits a full assessment of the cumulative impact of CCSBT fisheries on target and bycatch species and the effects of their removals from the ecosystem, limiting a comprehensive implementation of EBFM. We therefore assigned the progress category – Moderate progress by the Commission.

(iii) **Existence of an EBFM plan**

Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

CCSBT has not formally developed and adopted an operational EBFM plan to ensure that ecosystem considerations derived from the main ecological elements (target, bycatch, trophic interactions and habitats) of EBFM are taken into account in management advice when managing Southern bluefin tuna and the impact of Southern bluefin tuna fisheries on the ecosystem. However, CCSBT has adopted in 2015 an updated Strategic Plan for 2015-2020 which reflects the vision, goals and strategies that the Commission intends to follow to ensure its overarching conservation and management goals are achieved. The Strategic Plan sets as a goal to incorporate modern fisheries management standards including the precautionary approach and ecosystem management into the commission's decisions, and the Commission identifies as an opportunity the application of EBFM into CCSBT management (CCSBT 2015b). Furthermore, the Commission is currently discussing a Fisheries Management Plan for its focus species, the Southern bluefin tuna. The elaboration of such a plan is on the agenda of the adopted Strategy Plan. These recent developments are viewed as a major step forward towards developing an EBFM plan.

In conclusion, CCSBT has either adopted or developed an operational EBFM plan or Fisheries Management Plan for its focus species, the Southern bluefin tuna or Ecologically Related Species impacted by the Southern bluefin tuna fishery. Yet, the recent development and adoption of the Strategic Plan and current discussion of a Fisheries Management Plan for its focus species are seen as a major step forward towards developing an operational EBFM plan. We therefore assigned the progress category – Slight progress by the Commission.

(iv) **Existence of a data collection program to support the implementation of EBFM**

Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

CCSBT has not established data collection and monitoring programs to address comprehensively the impacts of fisheries on the ecosystem and support the implementation of EBFM. Instead, the existing data collection and monitoring programs were mainly designed to collect data for target species but some bycatch data is also collected at least in some relevant fisheries as requested by the Commission. The CCSBT requires members have their own national scientific observer programs as part of the CCSBT Scientific Research Plan. Each CCSBT member is required to have an onboard observer coverage target of 10% for each fishery. The CCSBT recently adopted in the 2015 Commission meeting the CCSBT Scientific Observer Program Standard (SOPS) (CCSBT 2015b). The minimum performance standards for the implementation of the CCSBT Scientific Observer Program Standards (SOPS) focus essentially on the collection of data for Southern bluefin tuna, with a small focus on ecologically related species. A regional observer program database does not exist for any relevant fisheries or fleets. The national observer program data sets are not pooled together or hold together by the CCSBT Secretariat. The primary data are commonly not reported to the CCSBT Secretariat and the level of observer coverage is as well too low to generate quality data to support joint regional assessments relevant to bycatch and ecosystem issues. We therefore assigned the progress category – Slight progress by the Commission.

3.5.2. Review of main ecological components in support of EBFM

For each of the ecological components of target species, bycatch species, ecosystem properties and trophic relationships and habitats, we assess the following four elements: (1) whether conceptual and/or operational *objectives* have been formally stated, (2) whether there are measurable *indicators* associated to objectives to track the state and trend of each ecological component, (3) whether *reference points* for those indicators have been defined to activate management action, and (4) whether there are *management responses and measures* to ensure that those reference points are not exceeded.

Target species - Ecological component 1.

For practical reasons, we only considered in the assessment of progress under the ecological component of "Target Species" all principal market tunas and Swordfish. CCSBT is only responsible for the conservation and management of Southern bluefin tuna (*Thunnus maccoyii*) throughout its range in the Southern Ocean.

(i) **Objectives**

Progress category assigned: MODERATE PROGRESS BY THE COMMISSION

The CCSBT Convention primary objective is "to ensure, through appropriate management, the conservation and optimum utilization of Southern bluefin tuna"**.** The term "optimum utilization" is not defined in the Convention Agreement, plus it is seen as a vague and outdated concept (Garcia and Koehler 2014). The convention does not make explicit mention of maintaining Southern bluefin tuna at levels capable of producing maximum sustainable yield. However, the 2011 adopted Strategy Plan states as a high priority the short-term operational objective to rebuild Southern bluefin tuna to biomass levels that supports maximum sustainable yields. CCSBT has adopted a formal management strategy (management procedure) to ensure the rebuilding of Southern bluefin tuna, which is currently overfished. The current rebuilding strategy adopted includes total allowable catch settings in accordance to the management procedure so the spawning biomass is recovered to 20% levels from virgin biomass with a 70% probability by 2015 (Garcia and Koehler 2014). Therefore, although an operational objective has not been formally stated in the Convention agreement of CCSBT, CCSBT has adopted a management strategy with the short-term operational objective to rebuild Southern bluefin tuna. CCSBT still needs to define and adopt a long-term operational objective for Southern bluefin tuna. We therefore assigned the progress category – Moderate progress by the Commission.

(ii) **Indicators**

Progress category assigned: FULL PROGRESS BY THE COMMISSION

The Southern bluefin tuna is routinely assessed to determine the effects of fishing on the stock and determine its exploitation status. Thus, indicators of population status including indicators of population size, fishing mortality over time and associated reference points are available and monitored regularly for this stock. The current Southern bluefin tuna stock assessment uses a management procedure to account for past and present uncertainties in the data and processes. The stock status indicators and associated reference points are also explicitly associated to the aforementioned objective of rebuilding Southern bluefin tuna. We therefore assigned the progress category – Full progress by the Commission.

(iii) **Reference points**

Progress category assigned: MODERATE PROGRESS BY THE COMMISSION

The CCSBT adopted in 2011 a management procedure, which is a meta-rule or tool that helped to formally defined management reference points for Southern bluefin tuna, as well as expected stock trajectories and pre-agree course of actions while accounting for uncertainties. A 20% of the unfished biomass is used as an interim target reference point to be achieved with 70% probability by 2035 (CCSBT 2015c). Limit reference points have not been adopted. We therefore assigned the progress category – Moderate progress by the Commission.

(iv) **Management responses and measures**

Progress category assigned: FULL PROGRESS BY THE COMMISSION

CCSBT has developed and adopted a short-term harvest control rule through the setting of a total allowable catch**.** Southern bluefin tuna is managed primarily through an annual total allowable catch with the short-term objective of rebuilding the stock to 20% of unfished levels by 2035(CCSBT 2015c). A management procedure is used to set the total allowable catch and specify management actions to be taken depending on the status of the stock to ensure that the rebuilding objective is met. We therefore assigned the progress category – Full progress by the Commission.

Bycatch species - Ecological component 2.

For practical reasons, we reviewed under the ecological component of "Bycatch species" all billfish species (except Swordfish), as well as sharks, seabirds, sea turtles, marine mammals, and other finfishes impacted by fisheries. Yet we stress several species of billfishes, sharks and other finfishes can also be target species at least in some fisheries.

(i) **Objectives**

Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

The Convention mandate does not make explicit provisions addressing the impacts of Southern bluefin tuna fisheries on by-catch or dependent species and ecosystems. Although the mandate establishes the collection and exchange of information of ecologically related species. Moreover, it remains to be resolved among the CCSBT members whether or not the CCSBT mandate includes the management and conservation of ecologically related species and whether the mandate supports the adoption of binding measures for these species (CCSBT 2007).

Nevertheless, since its creation CCSBT has adopted few measures to mitigate the effects of fishing on bycatch species (see below the section on Responses and Management Measures). One of the measures specifies that members should follow the management measures of IOTC, ICCAT and WCPFC in relation to ecologically related species when fishing for Southern bluefin tuna in those Convention Areas. However, the adopted measures of IOTC, ICCAT and WCPFC in relation to ecologically related species do not state clear operational objectives to reduce the

impacts of fishing on bycatch species. Furthermore, the updated Strategic Plan for 2015-2020 adopted by the Commission contains as a medium-high priority goal to identify and manage the risks to ecologically related species caused by fishing for Southern bluefin tuna (CCSBT 2015b). The Ecologically Related Species Working Group has also the task to review and analyze matters relevant to bycatch, and non-target species impacted by Southern bluefin tuna fisheries including sharks, marine turtles, seabirds, mammals and other fishes. Their workplan as March 2015 includes as a high research priority to implement the recommendation to mitigate the impact on ecologically related species of fishing for Southern bluefin tuna, agree on data provisions requirements for ecologically related species that ensure full reporting of bycatch and mitigation measures used in each fishery (CCSBT 2015a).

In conclusion, CCSBT has not formally adopted in the Convention Agreement a set of operational objectives to account for the impacts of Southern bluefin tuna fisheries on bycatch species. Yet conceptual objectives have been stated in the recently adopted Strategic Plan for 2015-2020, in the Terms of Reference and workplan of the Ecologically Related Species Working Group, and have also been vaguely stated in several adopted management measures of IOTC, ICCAT and WCPFC which CCSBT needs to follow. We therefore assigned the progress category – Slight progress by the Commission.

(ii) **Indicators**

Billfishes - Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Regional assessments of stock status or risk-based impact assessments of the effects of fishing on billfishes impacted by Southern bluefin tuna fisheries have not been developed or are under discussion by the Scientific Committee or has been requested by the Commission. The Southern bluefin tuna longline fisheries are known to interact little with billfish species, primarily small Swordfish, but the level of interactions is unknown (CCSBT 2008). Members do not follow the guidance on data reporting formats, and data are insufficient to calculate species-specific gear interactions, total mortality rates, or indicators of stock status for Ecologically Related Species including billfishes. Therefore, we assigned the progress category – Slight or no progress only by the Scientific Committee.

Sharks - Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

The Scientific Committee through the ERSWG is tasked to review on a continuous basis information on stock status, ecological risk assessments, estimates of total mortalities and associated uncertainty, and assessments of mitigation measures for shark species impacted by Southern bluefin tuna fisheries. Yet its progress has been limited. Traditional fisheries stock assessments and region wide assessment of total mortality estimates have not been conducted for any shark species impacted by Southern bluefin tuna fisheries. Therefore, indicators of stock status, including indicators of population size and fishing mortality over time, have not been developed to determine the exploitation status of any sharks species and to provide management advice. Nonetheless local assessments of the stock status for porbeable shark have been conducted in the WCPFC area and New Zealand EEZ (CCSBT 2015a). There have also been several attempts to develop status indicators for blue shark, shortfin mako shark and porbeagle shark at the national level for national tuna longline fisheries (e.g New Zealand, Japan, etc.) and other countries like Australia are willing to further work on indicators analysis, which are seen as the first steps towards a region wide assessment. Moreover, in response to a request from CCSBT in 2015 (CCSBT 2015a), the ABNJ Common Oceans – Tuna Project and the WCPFC Secretariat have agreed to coordinate a southern hemisphere porbeagle stock status assessment which is now under development (Clarke and Nicol 2015). (CCSBT 2012a, 2015a)Porbeagle shark is seen as a high priority stock to conduct stock assessments in the Pacific Ocean and globally in the southern hemisphere. The CCSBT ERSWG has already initiated the work to identify what data sets are known to be available and potential data sources to pursue to support the porbeagle stock assessment (CCSBT 2013a).

A joint regional ecological risk assessment focusing on sharks species does not exist. Most available ecological risk assessments including shark species have been made at the national level by CCSBT members. The ERSWG has noted that the ecological risk assessments for shark species conducted in other tRFMOs, particularly IOTC, ICCAT and WCPFC, are useful source of information for the ERSWG. Similarly, several NPOA for sharks have also been developed at the national level (e.g New Zealand, Japan), but a Regional Plan of Implementation (RPOIs) has not been attempted (CCSBT 2015a). The ERSWG has also developed educational material on shark bycatch to help fishermen identify sharks when they are caught (ERSWG4, 2004). Finally, the Scientific Committee through the

ERSWG has also reviewed mitigation methods for sharks, but progress in research and advice on mitigation measures has been limited.

In conclusion, joint-regional ecological risk assessments, stock assessments or indicators of stock status have not been developed for any shark species impacted by Southern bluefin tuna fisheries by the Scientific Committee in order to provide management advice to the Commission. We therefore assigned the progress category – Slight or no progress by the Scientific Committee.

Seabirds - Progress category assigned: SLIGHT PROGRESS BY THE COMMISSION

The CCSBT Scientific Committee through the ERSWG is tasked to review information on stock status, ecological risk assessments, estimates of total mortalities and associated uncertainty, and assessments of mitigation measures for seabird species impacted by CCSBT fisheries, but its progress on these tasks has been mixed. To date, the CCSBT Scientific Committee has focused its efforts on monitoring the impacts of southern Bluefin fisheries on seabirds, identifying areas of vulnerability to industrial longline fisheries for seabirds, assessing their relative risk to longline fisheries, proposing mitigation measures and developing educational material to help fishermen identify birds when they are caught. Birdlife International and ACAP have had a key role providing relevant data and information in relation to CCBST fisheries and seabird interactions. Birdlife International has provided an analysis of seabird distribution and overlap with CCBST longline fishing effort, and ACAP provides routinely information on the updated status and trends of species of seabirds likely to be caught in the Southern bluefin tuna fisheries. Moreover, since 2012 the ERSWG is conducting through new Zealand- a CCSBT regional wide ecological risk assessment (semi-quantitative level 2 ecological risk assessment) for seabirds interactions in surface longline fisheries managed under CCSBT, which was last updated in 2015 and is planning to continue and improve it (CCSBT 2012b, 2015a). An older level 2 ecological risk assessment also exists, which overlapped 14 RFMOs areas with albatross distributions and longline fisheries to identify seabird-fisheries interactions (Small 2005). Other ERAs for seabird interactions with commercial fisheries have also been done at the national levels, for example in New Zealand and Australia. Similarly, several NPOA for seabirds have also been developed at the national level (e.g New Zealand, Japan), but a Regional Plan of Implementation (RPOIs) has not been attempted.

The ERSWG has been unable to conduct region wide assessment of total mortality estimates for seabirds from Southern bluefin tuna fisheries in part because members provide these estimates in an aggregated form and without temporal and spatial information. The ERSWG recommends reporting by members should be standardized in their annual reports to allow better monitoring of the level of bycatch in the fisheries and allow to estimate total seabird mortality. While the reported aggregated data may be useful to monitor overall trends, spatially and temporally desegregated data are needed to specify effective mitigation measures. The ERSWG has noted that a key element to conduct region wide assessments and estimates total mortalities and uncertainties for seabirds requires co-operation with other RFMOs and NGOs such as Birdlife International as seabirds species have wide distributions which overlap in the area of jurisdiction of other RFMOs. The ERSWG has taken the initiative to lead a global assessment of impacts of Southern bluefin tuna fishing on seabirds which has been endorsed by the Commission (CCSBT 2012a).

The ERSWG has also initiated work to measure the effectiveness of currently seabird mitigation measures and develop methods to do it. The Commission in 2013 decided to create a Working Group on the Effectiveness of Seabird Mitigation Measures in longline fisheries to provide advice to the group on feasible, practical, timely and effective technical approaches for measuring and monitoring the effectiveness of seabird mitigation measures in SBT longline fisheries (CCSBT 2013a).

In conclusion, in 2012 the Scientific Committee started a to conduct a region wide ecological risk assessment (level 2) for seabirds interactions in surface CCSBT longline fisheries. This seabird assessment is considered preliminary and is currently being updated and reviewed by the Scientific Committee. The current assessment and derived products are not used yet to provide robust management advice. Since the region-wide assessments and indicators of stock status or fishery impacts for seabirds impacted by CCSBT fisheries are still under development, we assigned the progress category – Slight or no progress only by the Scientific Committee. The recent creation of the Working Group on the Effectiveness of Seabird Mitigation Measures in longline fisheries and the initiative to lead a global

assessment of impacts of Southern bluefin tuna fishing on seabirds, which has been endorsed by the Commission, are seen as important steps forward.

Sea turtles - Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Region-wide assessments and indicators of stock status or fishery impacts for sea turtles impacted by Southern bluefin tuna fisheries have not been developed by the Scientific Committee, or have been requested by the Commission. The Southern bluefin tuna longline and purse serine fisheries are believed to interact little with sea turtles, but the level of interactions is unknown (CCSBT 2013a). At large, data are insufficient and the lack of a central database coordinated by the Secretariat makes it impossible to calculate species-specific gear interactions, total mortality rates, or indicators of stock status. Regional wide Ecological Risk Assessments have not been conducted on sea turtles, although several national ERAs have included several species of turtles. For example, Australia conducted an ecological risk assessment to assess the ecological effects of purse seine fishing for Southern bluefin tuna fishery across all CCSBT Ecologically Related Species including sharks, seabirds, marine mammals, sea turtles and teleost (Hobday et al. 2007). The level 2 ecological risk assessment included two species of sea turtles which were classified as medium risk against the rest of taxonomic groups. These assessmetns are too coarsed to provide robust management advice. Since region-wide assessments and indicators of stock status or fishery impacts for sea turtles impacted by CCSBT fisheries have not been developed, we assigned the progress category – Slight or no progress only by the scientific committee.

Marine mammals - Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Region-wide assessments and indicators of stock status or fishery impacts for marine mammals impacted by Southern bluefin tuna fisheries have not been developed by the Scientific Committee, or have been requested by the Commission. Bycatch and interactions with marine mammals are believed not to be problematic in the Southern bluefin tuna longline and purse serine fisheries, yet the level of interactions is unknown (Garcia and Koehler 2014). Data are insufficient and the lack of a central database coordinated by the Secretariat makes it impossible to calculate species-specific gear interactions, total mortality rates, or indicators of stock status. Region wide Ecological Risk Assessments have not been conducted on marine mammals, although several national ecological risk assessments have included several species of marine mammals. For example, Australia conducted an ecological risk assessment to assess the ecological effects of purse seine fishing for Southern bluefin tuna fishery across all Ecologically Related Species including sharks, seabirds, marine mammals, sea turtles and teleost (Hobday et al. 2007). The level 2 ecological risk assessment included 47 species of marine mammals, which were found to be at low or medium risk with regard to the impacts of fishing. In conclusion, since region-wide assessments and indicators of stock status or fishery impacts for marine mammals impacted by Southern bluefin tuna fisheries have not been developed by the Scientific Committee, we assigned the progress category – Slight or no progress only by the Scientific Committee.

Other finfishes - Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Region-wide assessments and indicators of stock status or fishery impacts for finfish species other than tunas and billfishes impacted by Southern bluefin tuna fisheries have not been developed by the CCSBT Scientific Committee or have been formally requested by the Commission. The SBT longline fisheries is known to interact little with finfishes, but the level of interactions is unknown (Garcia and Koehler 2014). Data are insufficient and the lack of a central database coordinated by the Secretariat makes it impossible to calculate species-specific gear interactions, total mortality rates, or indicators of stock status. Region wide ecological risk assessments have not been conducted on finfishes other than tunas and billfishes, although several national ecological risk assessments have included several species of finfishes. For example, Australia conducted an ecological risk assessment to assess the ecological effects of purse seine fishing for Southern bluefin tuna fishery across all Ecologically Related Species including sharks, seabirds, marine mammals, sea turtles and teleost (Hobday et al. 2007). The level 2 ecological risk assessment found the majority of teleost to be at low risk with regard to the impacts of fishing.

Since region-wide assessments and indicators of stock status or fishery impacts for finfish species have not been developed by the Scientific Committee, we assigned the progress category – Slight or no progress only by the scientific committee.

(iii) **Reference points**

Billfishes - Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Target and/or limit reference points associated to indicators of stock status or bycatch rate estimates have not been defined, developed or adopted for any of the species, and are not under development or being discussed. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

Sharks - Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Target and/or limit reference points associated to indicators of stock status or bycatch rate estimates have not been defined, developed or adopted for any of the species, and are not under development or being discussed. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

Seabirds - Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Target and/or limit reference points associated to indicators of stock status or bycatch rate estimates have not been defined, developed or adopted for any of the species, and are not under development or being discussed. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

Sea turtles - Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Target and/or limit reference points associated to indicators of stock status or bycatch rate estimates have not been defined, developed or adopted for any of the species, and are not under development or being discussed. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

Marine mammals - Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Target and/or limit reference points associated to indicators of stock status or bycatch rate estimates have not been defined, developed or adopted for any of the species, and are not under development or being discussed. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

Other finfishes - Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Target and/or limit reference points associated to indicators of stock status or bycatch rate estimates have not been defined, developed or adopted for any of the species, and are not under development or being discussed. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

(iv) **Management responses and measures**

CCSBT has adopted two conservation and management measures to protect ecologically related species, including seabirds, sharks and sea turtles, and none for billfishes, marine mammals and for other finfishes. We briefly list them below. The first measure is a binding measure for mitigating the impacts of longliners on seabirds. The second is a non-binding measure which requires members to comply with all current binding and recommendatory measures aimed at the protection of ecologically related species which includes seabirds, sea turtles and sharks adopted by IOTC, WCPFC and ICCAT when operating in their Convention Area. Therefore, binding conservation and management measures adopted by ICCAT, IOTC and WCPFC are binding to CCSBT members that are parties to ICCAT, IOTC and WCPFC if they are fishing for SBT in their Convention Areas. In a sense CCSBT does not have its own binding measures on Ecologically Related Species and some voices have claimed that CCSBT should adopt its own binding measures to protect Ecologically Related Species in addition to those already adopted by other tRFMOs (Garcia and Koehler 2014).

The adopted measures of ICCAT, IOTC and WCPFC in relation to seabirds, sharks and turtles have the main purpose to minimize the effects of fishing on these by-catch species as for example with the modification of gears to avoid them or in the form of prohibitions, and to establish requirements for data reporting and conduct specific type

of research. None of these management measures have been adopted to set a management response linked to pre-established operational objectives, indicators and reference points for any of the bycatch species, precluding them to be activated when predefined reference points are exceeded. Thus, the measures are not known whether they are being effective to affect the current status of populations since they have not been linked to status indicators or reference points to judge whether the current state of species is acceptable. We therefore assigned the progress category – Slight progress by the Commission to the taxonomic group of sharks, seabirds and sea turtles. No management measures have been adopted or are under discussion by the Commission or Scientific Committee to minimize the impacts of fisheries on billfishes, marine mammals and other finfishes, therefore, we assigned the progress category – Slight or no progress only by the Scientific Committee" to these taxonomic groups.

Measures	**Type of Measure**
General measures	
Recommendation 2011 to Mitigate the Impact on Ecologically Related Species of Fishing for Southern bluefin tuna encourages to members and Cooperating Non-members: *–to implement IPOA-Seabirds, IPOA-Sharks, and the FAO guidelines to reduce sea turtle mortality in fishing operation.* *-to comply with all current binding and recommendatory measures aimed at the protection of ecologically related species, including seabirds, sharks and sea turtles adopted by ICCAT, IOTC and WCPFC when fishing in their areas of jurisdiction.* *-to collect and report data on ecologically related species to the Extended Commission and its subsidiary bodies.*	-Non-binding -To minimize bycatch
Soft specifications in the Compliance Policy Guideline 1 which stipulates the Minimum Performance Requirements to meet CCSBT obligations (revised in CC22 2015).	
Billfishes – Progress category assigned: Slight or no progress only by the Scientific Committee	
CCSBT does not have binding measures specific for billfishes in place.	
Sharks - Progress category assigned: Slight progress by the Commission	
CCSBT does not have its own binding measures specific for sharks in place. Instead SBT vessels have to comply with binding conservation and management measures adopted by ICCAT, IOTC and WCPFC in relation to sharks if they are fishing for SBT in their Convention Areas.	-Non-binding -To minimize bycatch
Seabirds - Progress category assigned: Slight progress by the Commission	
In 1997 a measure to mitigate seabird bycatch in longline Southern bluefin tuna fisheries. *Mandatory use of Tori lines is required by all CCSBT members in all longline fisheries south of 30^{o} S. Furthermore,* SBT vessels have to comply with binding conservation and management measures adopted by ICCAT, IOTC and WCPFC in relation to seabirds if they are fishing for SBT in their Convention Areas.	-Binding and non-binding -To minimize bycatch
Sea turtles - Progress category assigned: Slight progress by the Commission	
CCSBT does not have its own binding measures specific for sea turtles in place. Instead, SBT vessels have to comply with binding conservation and management measures adopted by ICCAT, IOTC and WCPFC in relation to sharks if they are fishing for SBT in their Convention Areas.	-Non-binding -To minimize bycatch
Marine mammals - Progress category assigned: Slight or no progress only by the Scientific Committee	
CCSBT does not have its own binding measures specific for marine mammals in place.	
Other finfish - Progress category assigned: Slight or no progress only by the Scientific Committee	

CCSBT does not have its own binding measures specific for other finfish in place.	

Ecosystem properties and trophic relationships - Ecological component 3.

Under the ecological component of "Ecosystem Properties and Trophic Relationships", we valued the existence of ecosystem metrics (empirically and model based) and food web models depicting trophic interactions and interdependencies involving relevant species or components of ecosystems that are affected by fishing, and are relevant to maintain ecosystem structure and function, and how this information is being used to advance progress in implementing EBFM.

(i) **Objectives**

Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

The CCSBT Convention Agreement and adopted conservation and management measures do not contain any specific provisions addressing the impact of fisheries on ecosystems to ensure the maintenance of trophic interactions and interdependencies involving relevant species or components of ecosystems, and maintain the structure and functioning of marine food webs and ecosystem health. The updated Strategic Plan for 2015-2020 adopted by the Commission contains as medium-high priority goals to improve knowledge of Southern bluefin fisheries ecosystems and monitor the predator and prey species which may affect the condition of Southern bluefin tuna (CCSBT 2015b). Yet, CCSBT has not defined or stated clear objectives or has described the main research activities to ensure those tasks are accomplished.

In conclusion, the CCSBT Convention Agreement and the adopted conservation and management measures do not contain any specific provisions addressing the impacts of Southern bluefin tuna fisheries on trophic interactions and interdependencies involving relevant species or components of ecosystems. The Scientific Committee has not yet established a research agenda to ensure ecosystem considerations including the maintenance of trophic interactions and interdependencies involving relevant component of ecosystems and the impacts of fisheries on marine food webs are incorporated in decision-making. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

(ii) **Indicators**

Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

To date the Scientific Committee has conducted research and reviewed studies on predator and prey species that may affect the condition of Southern bluefin tuna. The Scientific Committee routinely evaluates diet studies of highly migratory fish species conducted by CCSBT members in the Southern Ocean (CCSBT 2015a). The Scientific Committee has not conducted or reviewed any research activities on food web interactions, ecosystem modelling, and development of indicators to track ecosystem change or impacts of fishing on ecosystems. Hence, ecosystem models or multispecies and ecosystem indicators are not currently used to provide management advice. However, the Scientific Committee has discussed the potential uses of the diet studies and related research in support of developing ecosystem models centered on highly migratory species, their key prey species and the ecosystem resource needed to support their prey (CCSBT 2015a). The Scientific Committee recommends and emphasizes the importance of cooperation among the CCSBT members to understand the feeding ecology, digestive rates and growth rates of SBT for the whole distribution area and the while of its life history (CCSBT 2009). In conclusion, ecosystem metrics and food web models with interactions of relevant species and components of ecosystems have not been developed to understand broader community-based and ecosystem level consequences of fishing in CCSBT. Empirically- based and/or model-based ecosystem indicators are not available or monitored to track the impacts of fisheries on ecosystems and to assist the Commission in making its management decisions and ensure ecosystem considerations are part of its agenda. Overall, the ecosystem-related research activities have been relatively scarce in CCSBT. Therefore, we assigned the progress category – Slight or no progress only by the Scientific Committee.

(iii) **Reference points**

Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Ecosystem and/or multispecies management plans (including harvest strategies) with pre-defined reference points for relevant species and components of ecosystems have not been developed and are not under discussion. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

(iv) **Management responses and measures**

Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Management measures have not been adopted to explicitly account for the impacts of fishing on trophic interactions and the food web in order to maintain the structure and functioning of marine ecosystems, or have been linked to any pre-established ecosystem model, ecosystem indicators and operational objectives. Conceptual ecosystem models or multispecies management plans have not been developed and their used evaluated in decision-making and addressed in management measures. No formal mechanisms exist to accommodate multispecies and food web interactions and ecosystem modelling into the current management and conservation of target or bycatch species and associated ecosystems. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

Habitats – Ecological component 4.

Under the ecological component of "Habitats", we valued whether habitats of special concern (e.g. reproduction, migration, feeding, hotspots) and/or habitat utilization and preferences for relevant species have been formally investigated and delineated, and how this information is being used to advance progress in implementing EBFM.

(i) **Objectives**

Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

The CCSBT Convention Agreement and adopted conservation and management measures do not contain any specific provisions relevant to habitats of special concern for Southern bluefin tuna or its Ecologically Related Species. Habitats of special concern have not been formally defined or delineated by the Commission. To date the Scientific Committee has not defined or stated clear conceptual or operational objectives relevant to habitats of special concern. The CCSBT strategic plan 2015-2020 does not recognize the importance of habitat research setting the basis towards advancing the habitat component of EBFM. The work program of the Ecologically Related Species Working Group has not planned any activities regarding habitat research. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

(ii) **Indicators**

Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Habitats of special concern (e.g. reproduction, migration, feeding, hotspots) and/or habitat utilization and preferences for Southern bluefin tuna or ecologically relevant species have not been formally investigated and delineated by the Commission or Scientific Committee. Indicators (associated to pre-established objectives) describing habitat needs and preferences have not been formally developed, monitored or being used to provide management advice to the Commission.

To date, no habitat or environmental studies have been conducted under the coordination of CCSBT. The Scientific Committee does not have any planned activities regarding habitat research in the research program of the ERSWG.

Although the Scientific Committee has recommended in the past to use of environmental covariates in several CPUE standardization techniques, particularly for Southern bluefin tuna. At the national levels, CCSBT members have conducted some research activities and practices to identify habitats of special concern and habitat preferences and utilization for relevant species. For example, Japan has conducted tagging programs for highly migratory fish species including tunas and sharks to study their distribution and migration patterns (CCSBT 2009) . Furthermore, few CCSBT activities such as the CCSBT tagging program started in 2001 involving both conventional and archival tagging and pop-up tag deployment for biological research could also potentially support habitat research. The data obtained from the tagging program has been routinely used in the stock assessments for Southern bluefin tuna and less to conduct habitat research. Habitat research focused on the habitat utilization and preferences of ecologically related species has also been very scarce.

In conclusion, habitats of special concern (e.g. reproduction, migration, feeding, hotspots) and habitat preferences and utilization have not been formally mapped or delineated for Southern bluefin tuna or any other ecologically related species of interest to the Commission, and indicators describing habitat needs and preferences have not been developed or are under discussion by the Scientific Committee. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

(iii) **Reference points**

Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Minimum habitat needs and requirements (linked to pre-established indicators and objectives) have not been identified and are not under discussion for any relevant species with habitats of special concern. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

(iv) **Management responses and measures**

Progress category assigned: SLIGHT OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Management measures have not been adopted to explicitly protect habitats of special concern for relevant species. Knowledge of habitats of special concern and habitat preferences and utilization is not under discussion to be used potentially in decision-making. There are no formal mechanisms to accommodate minimum habitat needs and habitat protection into the current management or management decisions and this is not under discussion by the Scientific Committee. We therefore assigned the progress category – Slight or no progress only by the Scientific Committee.

4. Main findings and conclusions

We evaluated the progress of tRFMOs in applying the ecological component of EBFM against an idealized “role model” RFMO. In global terms, although their overall performance varies across the ecological components, we find tRFMOs have made considerable progress within the ecological component of target species, moderate progress in the ecological component of bycatch species, and little progress in the components of ecosystem properties and trophic relationships and habitats. We also find that the elements reviewed have been implemented in a patchy way, without a long-term vision of what needs to be achieved and a formalized plan of implementation. We find that all tRFMOs have adopted a myriad of management measures to manage target species and minimize the effects of fishing on bycatch species, yet no measures have been adopted to account for and minimize the impacts of fishing on the trophic relationships and food web structure, and protect of habitats of special concern. Furthermore, none of the management measures adopted for target or bycatch species have been linked to pre-established operational objectives, associated indicators and thresholds, precluding them to be activated when predefined thresholds are exceeded, with the exception for Southern bluefin tuna in CCSBT and for some dolphin species in IATTC. These findings reveal that the low-hanging fruit have been picked as we observe that some of the key elements to make operational EBFM are present, yet, the hard but important tasks of actually managing both target and bycatch species with pre-established management responses linked to clear operational objectives, indicators and thresholds needs to be urgently addressed. All the tRFMOs share the same challenges of coordinating effectively all ecosystem research activities, developing an effective mechanism to better integrate ecosystem research and advice into

management decisions, and communicating them to the Commission. If RFMOs were ambitious about implementing EBFM we envisage a practical next step would be to develop EBFM plans to set up a path to guide and advance towards its full implementation. Furthermore, we believe its implementation should be seen as a step-wise adaptive process which should be supported with the best ecosystem science. With this comparative review of progress we hope to create discussion across the tRFMOs to inform the much-needed development of operational EBFM plans.

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6. Figures

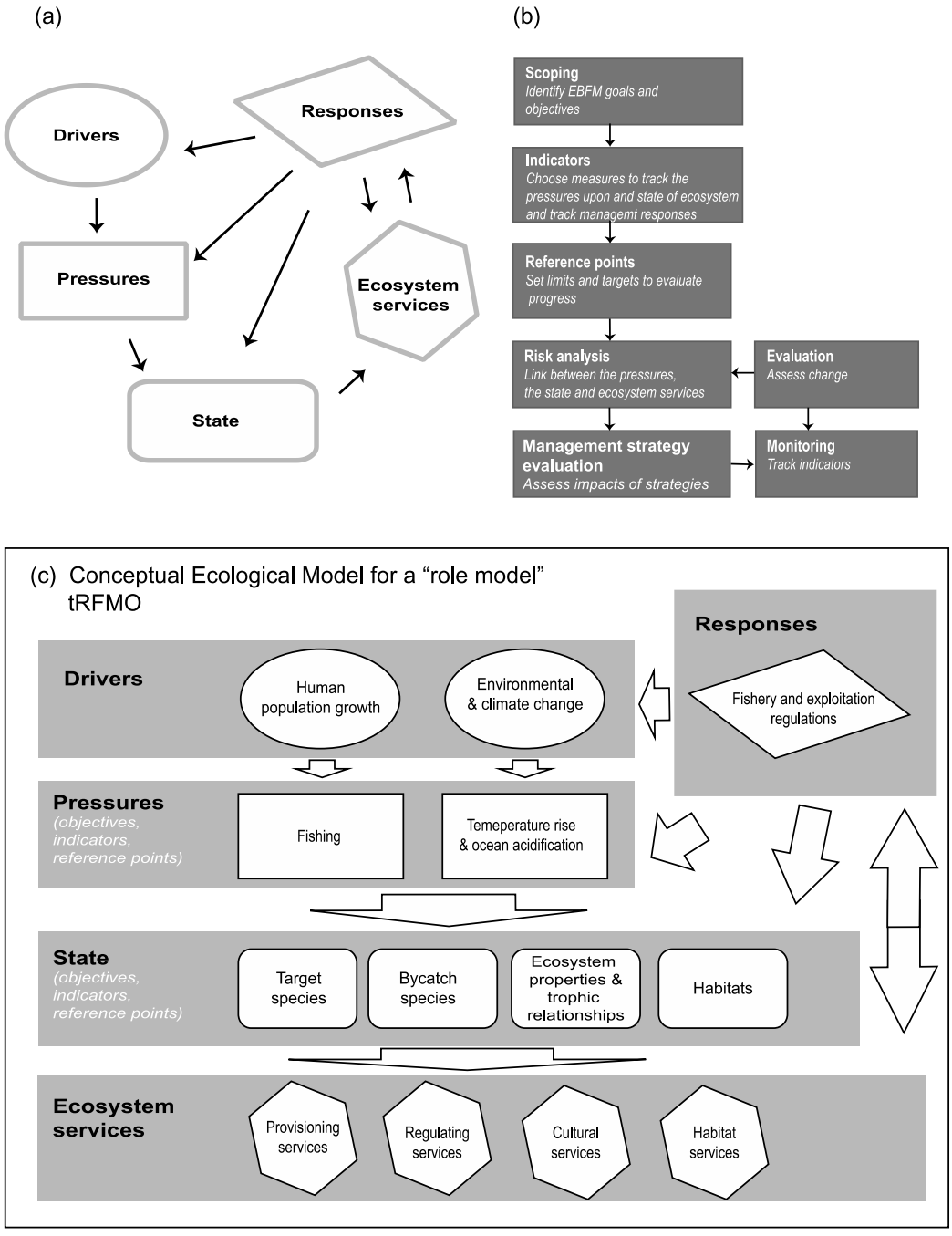

Figure 1. A Conceptual Ecological Model for a "role model" tuna RFMO based on two frameworks to make the implementation of EBFM more operational. (a) The Driver-Pressure-State-Ecosystem services-Response (DPSER) framework (based on Kelble et al 2013). (b) The Integrated Ecosystem Assessment (IEA) framework (Based on Levin et al 2009; Tallis et al 2010). (c) The Conceptual Ecological Model for a "role model" tuna RFMO based on the DPSER and IEA frameworks.

PROGRESS CATEGORIES	
Full progress by the Commission (role model tRFMO)	FP - by C
Moderate progress by the Commission	MP - by C
Slight progress by the Commission	SP - by C
Full progress only by the Scientific Committee	FP - only by SC
Moderate progress only by the Scientific Committee	MP - only by SC
Slight or no progress only by the Scientific Committee	SP or NP - only by SC

REVIEW OF BASIC TEXTS AND MAIN STRUCTURES OF RFMOs IN SUPPORT OF EBFM					
Elements	**ICCAT**	**IOTC**	**WCPFC**	**IATTC**	**CCSBT**
1. Reference to EBFM and PA					
2. Lead entity exist to advance progress of EBFM and ecosystem science					
3. EBFM plan exist					
4. Data collection programme exists to support the implementation of EBFM					
REVIEW OF MAIN ECOLOGICAL COMPONENTS IN SUPPORT OF EBFM					
Target species – Ecological component 1					
5. Objectives					
6. Indicators					
7. Reference points					
8. Measures					
Bycatch species – Ecological component 2					
9. Objectives					
10. Indicators – billfishes					
10. Indicators – sharks					
10. Indicators – seabirds					
10. Indicators – sea turtles					
10. Indicators – marine mammals					
10. Indicators – other finfishes					
11. Reference points – billfishes					
11. Reference points – sharks					
11. Reference points – seabirds					
11. Reference points – sea turtles					
11. Reference points – marine mammals					
11. Reference points – other finfishes					
12. Measures – billfishes					
12. Measures – sharks					
12. Measures – seabirds					
12. Measures – sea turtles					
12. Measures – marine mammals					
12. Measures – other finfishes					
Ecosystem properties and trophic relationships – Ecological component 3					
13. Objectives					
14. Indicators					
15. Reference points					
16. Measures					
Habitats – Ecological component 4					
17. Objectives					
18. Indicators					
19. Reference points					
20. Measures					

Figure 2. Progress of tuna RFMOs in applying the ecological component of EBFM.

7. Tables

Table 1. Towards developing a Conceptual Ecological Model for a "role model" tuna RFMO based on the IEA and DPSER frameworks. The Ecological Conceptual Model for the "role model" tuna RFMO is based on the best conservation and management practices of RFMOs for addressing EBFM. In this table, we define what could be the main elements and ecological components of a role model tuna RFMO in addressing EBFM, including (1) the overall overarching objective of a "role model" RFMO and supporting basic text and structure, and (2) the four ecological components enabling the implementation of EBFM. Table 1 also provides examples of potential operational objectives for each ecological component, potential associated indicators to track the state and trend of each ecological component, potential thresholds for those indicators, and potential management and conservation measures and responses to ensure that those thresholds are not exceeded.

"ROLE MODEL" TUNA RFMO				
Overarching objective: The main goal of an EBFM approach is to ensure the sustainability of catches without compromising the inherent structure and functioning of marine ecosystems, which deliver ecosystem services for human society (Lodge et al 2007). **Basic texts and main structure** A role model tuna RFMO formally recognizes in its Convention Agreement the main principles of a PA and an EBFM approach established in major international fisheries agreements and guidelines. It has a lead entity or group to advance the progress and implementation of EBFM and it has developed and adopted an operational EBFM plan. Finally, it also has a long-term data collection and monitoring programme to support the implementation of EBFM.				
Principal ecological components of EBFM	**Operational objectives**	**Associated state indicators**	**Associated thresholds**	**Associated measures and management responses**

Ecological Component 1: Target species	Operational objectives have been formally stated in Convention Agreement -objectives are species-specific. E.g. Maximize sustainable harvest of target species applying the precautionary approach.	All target species are regularly evaluated, and indicators of stock status have been developed, adopted by Commission, and are routinely monitored. E.g. -Biomass trends relative to B_{MSY} or Bo -Fishing mortality rate trends relative to F_{MSY} -Size/age structure trends	Species-specific limit and target reference points have been developed and adopted by Commission -for all species. E.g. -Target and limit reference points are defined for population biomass and fishing mortality (B_{MSY} and F_{MSY} or proxies)	Management responses including harvest control rules and/or conservation and management measures have been put in place and adopted by the Commission for all species. Theses measures are linked to pre-established management objectives, indicators and thresholds. E.g. -Harvest control rule -Recovery plans -Capacity-reduction plans -Time-area restrictions
Ecological Component 2: Bycatch species	Operational objectives have been formally stated in Convention Agreement - for all species or main taxonomic groups E.g. Maintain and restore populations of bycatch species above levels at which their reproduction may become seriously threatened	Assessments of status are conducted routinely for all vulnerable species; A series of indicators of species status have been adopted and are routinely developed and monitored -for all vulnerable species and all relevant fisheries. E.g. -Population size trends -Size/age structure trends -Catch trends -Vulnerability of a species to overfishing	Species-specific limit and target reference points have been developed and adopted by Commission -for most vulnerable species. E.g. -TAC and bycatc limits allocated to vulnerable species -In absence of information apply the PA	Management measures (mostly binding) associated with pre-established management objectives, indicators and thresholds have been adopted by the Commission that include limits to be avoided in order to reduce impacts of fisheries on bycatch species and achieve management objectives -for all or majority of vulnerable species. E.g. -Bycatch limits or caps for species or groups -Time-area restrictions -Gear modifications and practices to reduce bycatch -Adoption of good practices by crews and release of capture life

				animals following protocol
Ecological Component 3: Ecosystem properties and trophic relationships	Operational objectives have been formally stated in Convention Agreement for relevant species and components of ecosystems. E.g. Maintain viable trophic interactions and interdependencies involving species that are affected by fishing	Ecosystem metrics and food web models with interactions of relevant species and components of ecosystems have been developed to understand broader community-based and ecosystem level consequences of fishing. Empirically- based and/or model-based ecosystem indicators have been developed and adopted by Commission and are routinely monitored to provide management advice. E.g. -Species composition of the catch -Size based indicators -Trophic level based indicators -Diversity indices -Relative catch of a species or group -Trophic links and biomass flows	Ecosystem and/or multispecies management plans (including harvest strategies) with pre-defined thresholds have been developed and adopted for all relevant species and component species of ecosystems. Thresholds need to ensure the ecological role of the species is maintained, and to account for the needs of other dependent species E.g. -Limit reference point for the impacts of fishing on key stone predators and preys in the ecosystem -In absence of knowledge, precautionary reference point values based on general expectations	Conceptual ecosystem or foodweb models and multispecies management plans have been developed and their use evaluated in decision-making and incorporated in management measures. Management measures (mostly binding) have been adopted to accommodate multispecies and food web interactions in all relevant components of ecosystems. E.g. - Multispecies management plans (e.g. one bycatch specie limiting the catch of other target species) -Mitigation measures
Ecological Component 4: Habitats	Operational objectives have been formally stated in Convention Agreement to recognize	Habitats of special concern (e.g. reproduction, migration, feeding, hotspots) and/or habitat utilization and preferences for all relevant species	Minimum habitat needs and requirements have been identified and adopted for all relevant	Knowledge of habitats of special concern for all relevant species is used in decision-making. Management measures (binding)

	the importance of identifying and protecting habitats of special concern. E.g. Describe, identify and protect habitats of special concern	have been formally investigated and delineated. Indicators describing habitat needs and preferences have been developed and adopted by the Commission, and are routinely monitored and used in management advice. E.g. -Identification and mapping of habitats of special concern -Spawning habitat area -Habitat shifts and range contractions -Habitat suitability index -Habitat size (e.g. O2 minimum zones)	species with habitats of special concern E.g. -Minimum habitat needs for population viability	have been adopted by Commission to accommodate knowledge of habitats of special concern for all relevant species to ensure pre-establish objectives are met. E.g. -Restriction or limit fishing on habitats of special concern such as spawning and nursery habitats. -Time/area closures.

Table 2 Criteria to evaluate progress in tuna RFMOs towards applying EBFM against the idealized "role model" RFMO presented in Figure 2 and Table 1.

CATEGORIES OF PROGRESS	
Full progress by the Commission ("role model" tuna RFMO)	FP - by C
Moderate progress by the Commission	MP - by C
Slight progress by the Commission	SP - by C
Full progress only by the Scientific Committee	FP- only by SC
Moderate progress only by the Scientific Committee	MP- only by SC
Slight or no progress only by the Scientific Committee	SP or NP - only by SC

REVIEW OF BASIC TEXTS AND MAIN STRUCTURES OF RFMOs IN SUPPORT OF EBFM	
1. Does the RFMO refer to the principles of the PA and EBFM in accordance to relevant rules of international fisheries governance?	
Categories of progress	**Description of categories**
FP - by C	Formal recognition of the PA and EBFM principles in the Convention Agreement.
MP - by C	Formal recognition of some principles regarding the PA and EBFM in the form of adoption of management measures.
SP - by C	The adoption of some principles regarding the PA and EBFM in the current management of some species or are under discussion by the Commission.
FP- only by SC	Formal consideration and recognition of some principles regarding the PA and EBFM in adopted Scientific Committee Reports.
MP- only by SC	Adhoc consideration and recognition of some principles regarding the PA and EBFM in adopted Scientific Committee Reports.
SP or NP -only by SC	Not under discussion.
2. Has the RFMO designated a lead entity or group to advance the progress and implementation of EBFM, advance progress on ecosystem science and provide advice on impacts of fishing on marine ecosystems?	

FP - by C	Lead entity or working group exists to better integrate ecosystem considerations into the scientific advice provided by the Scientific Committee to the Commission. There exist a mechanism in place facilitating the group the coordination of all the ecosystem-related research activities needed to implement EBFM and provide management advice to the Commission. The group oversees and coordinates all relevant ecosystem research activities derived from all four ecological elements of a comprehensive EBFM framework including target species, bycatch and sensitive species, trophic interactions and habitats.
MP - by C	Lead entity or working group exists to better integrate ecosystem considerations into the scientific advice provided by the Scientific Committee to the Commission. However, there does not exist a mechanism in place to coordinate all the ecosystem related research and the group has a limited capacity to coordinate all relevant ecosystem research activities (pertaining to target and bycatch species, trophic relationships and habitats) needed to fully implement EBFM or it was created to coordinate only some of the ecological elements of a comprehensive EBFM framework.
SP - by C	The creation of a lead entity or working group to better integrate ecosystem considerations into the scientific advice provided by the Scientific Committee to the Commission is being discussed by the Commission, or it does not exist.
FP- only by SC	Not applicable
MP- only by SC	Not applicable
SP or NP -only by SC	Not applicable
3. Has the RFMO developed and adopted an operational EBFM plan?	
FP - by C	An operational EBFM plan has been adopted by the Commission. The plan covers all relevant ecological elements of the ecosystem (target species, bycatch species, trophic interactions and habitats) in order to fully implement the ecological component of EBFM.
MP - by C	An EBFM plan has been adopted by the Commission. The plan might cover only some of the relevant ecological elements of the ecosystem (target species, bycatch species, trophic interactions and habitats) in order to fully implement EBFM. The plan may also lack specific guidelines to make it operational as it might have not clearly established a priori operational objectives, associated indicators, reference points and management responses to ensure the objectives are met.
SP - by C	An EBFM plan has not been adopted by the Commission. Yet, Fisheries Management Plans or Science Strategic Plans have been developed and adopted by the Commission that include some management or research actions related to ecosystems (but less comprehensive than a EBFM plan). An EBFM plan might has been requested by the Commission or might be under discussion.
FP- only by SC	An EBFM plan has been developed by the Scientific Committee
MP- only by SC	Fisheries Management Plans or Science Strategic Plans have been developed by the Scientific Committee that include some management or research actions related to ecosystems (but less comprehensive than a EBFM plan). An EBFM plant might be under development and under discussion.
SP or NP -only by SC	An EBFM plan has not been developed and is not being discussed.

4. Does it exist a long-term data collection and monitoring program to support the implementation of EBFM?	
FP - by C	A standardized regional data collection and monitoring program fully coordinated by the RFMO Secretariat or its science provider exists to support the implementation of EBFM as requested by the Commission.
MP - by C	A standardized regional data collection and monitoring program fully coordinated by the RFMO Secretariat or its science provider exists, but not necessarily in support of implementing EBFM, as requested by the Commission. A regional monitoring program coordinated by RFMO secretariat exist at least for some fishing fleets and it was design to support mainly the conservation and management of stocks covered by the RFMO, and not necessarily to address comprehensively the impacts of fisheries on the ecosystem in order to fully implement EBFM.
SP - by C	A standardized regional data collection and monitoring program fully coordinated by the RFMO Secretariat or its science provider does not exist to support the implementation of EBFM. Instead multiple national data collection and monitoring programs exist conducted by individual member countries for some fishing gears and fleets as requested by the Commission. Data from the monitoring programs is submitted to the RFMO secretariat, so it can be assembled and managed. Yet, the countries might not provide necessarily standardized data according to the requirements by the RFMO, therefore the Scientific Committe is unable or partially able to use the national data collection programs to conduct joint regional assessments relevant to bycatch and ecosystem issues.
FP- only by SC	A standardized regional data collection and monitoring program in support of EBFM has been developed by the Scientific Committee, yet not adopted by Commission.
MP- only by SC	A standardized regional data collection and monitoring program in support of EBFM is under development by the Scientific Committee.
SP or NP -only by SC	A standardized regional data collection and monitoring program in support of EBFM is not under discussion.
REVIEW OF MAIN ECOLOGICAL COMPONENTS IN SUPPORT OF EBFM	
ECOLOGICAL COMPONENT 1: TARGET SPECIES	
Objectives 5. Have conceptual and operational objectives been formally stated relevant to target species?	
FP - by C	Conceptual and operational objectives have been formally stated in Convention Agreement.
MP - by C	At least conceptual objectives are formally stated in Convention Agreement and operational objectives might have been formally recognized in adopted conservation and management measures or adopted through a formal management strategy (management procedure).
SP - by C	At least conceptual objectives are formally stated in the Convention Agreement or in adopted conservation and management measures.

FP- only by SC	Objectives are formally contemplated in Science Research Plans or Scientific Committee reports.
MP- only by SC	Adhoc consideration of objectives in Scientific Committee reports.
SP or NP -only by SC	Not under discussion.
Indicators 6. Have target species been assessed, and have indicators of stock status been developed (associated to pre-established objectives) and are being monitored, including indicator of trends (e.g. time series of biomass, size and age structure) and current state (e.g. current biomass, size or age relative to initial state, or other reference points)?	
FP - by C	Fisheries stock assessments are regularly conducted for all species as requested by the Commission; a series of indicators of stock status (associated to pre-established objectives) have been adopted and are routinely developed and monitored for all species.
MP - by C	Fisheries stock assessments are regularly conducted for some species as requested by the Commission; a series of indicators of stock status (associated to pre-established objectives) have been adopted and are routinely developed and monitored (at least twice over time) for some species.
SP - by C	Fisheries stock assessments are regularly conducted for some species as requested by the Commission; a series of indicators of stock status have been adopted (but not associated to pre-established objectives) and may not be routinely developed and monitored for some species.
FP- only by SC	Fisheries stock assessments are regularly conducted for majority species; a series of indicators of stock status (associated to pre-established objectives) have been developed and are being monitored for majority of species.
MP- only by SC	Fisheries stock assessments are regularly conducted for some species; a series of indicators of stock status are being developed for some species.
SP or NP -only by SC	Fisheries stock assessments and indicators of stock status under discussion or not discussed.
Reference points 7. Have reference points, including target and limit reference points, been defined, developed and linked to pre-established objectives and indicators?	
FP - by C	Stock-specific limit and target reference points (associated to pre-established objectives and indicators) have been defined, developed and adopted for all species.
MP - by C	Stock-specific limit and/or target reference points (associated to pre-defined objectives and indicators) have been defined, developed and adopted for some species. Stock-specific reference points might be under development for other species.
SP - by C	General limit and/or target reference points (associated to pre-defined objectives and indicators) have been defined, developed and adopted for some species or are being discussed by the Commission. In some cases, the biomass and fishing mortality rate corresponding to maximum sustainable yield might have been the unofficial target reference points used in assessed stocks, although not formally adopted.
FP- only by SC	Stock-specific limit and/or target reference points have been defined, developed and tested by the Scientific Committee for all

	species.
MP- only by SC	General species limit and/or target reference points have been defined and developed for some species and under development and under discussion for others. Stock-specific reference points might be also under development and being tested for some species.
SP or NP -only by SC	Limit and/or target reference points have not been developed. Reference points might be under discussion or not being discussed.
Management responses and measures 8. Have management responses including harvest control rules or conservation and management measures been put in place and linked to pre-established management objectives, indicators and reference points?	
FP - by C	Harvest control rules have been developed and adopted for all species.
MP - by C	Harvest control rules have been developed and adopted for some species and are under discussion for others by the Commission.
SP - by C	Harvest control rules are being developed and are under discussion for some species by the Commission. Management measures have been adopted (mostly binding) for majority of species to ensure management objectives are achieved.
FP- only by SC	Harvest control rules have been developed and tested for majority species.
MP- only by SC	Harvest control rules are being developed for some species.
SP or NP -only by SC	Harvest control rules or other type of management and conservation measures are under discussion or not being discussed.
ECOLOGICAL COMPONENT 2: BYCATCH SPECIES	
Objectives 9. Have conceptual and operational objectives been formally stated relevant to bycatch species?	
FP - by C	Conceptual and operational objectives have been formally stated in Convention Agreement for all species or taxonomic groups.
MP - by C	At least conceptual objectives are formally stated in Convention Agreement and operational objectives might have been formally recognized in adopted conservation and management measures for some species or taxonomic groups.
SP - by C	At least conceptual objectives are formally stated in the Convention Agreement or in adopted conservation and management measures.
FP- only by SC	Objectives are formally stated in Science Research Plans or Scientific Committee reports.
MP- only by SC	Adhoc consideration of objectives in Scientific Committee reports.

SP or NP -only by SC	Not under discussion
Indicators 10. Have bycatch species been evaluated, and have indicators of stock status been developed (associated to pre-established objectives) and are being monitored?	
FP - by C	Regional assessments of sock status or risk-based impact assessments of the effects of fishing are conducted routinely for all vulnerable species as requested by the Commission. The relative vulnerability of species to fishing has been identified. A series of indicators of stock status and/or fishery impacts (associated to pre-established objectives) have been adopted and are routinely developed and monitored for all vulnerable species and all relevant fisheries. The developed indicators are robust and can be used directly to set stock status and provide strong management advice (e.g. establish level of exploitation status and set catch limits).
MP - by C	Regional assessments of sock status or risk-based impact assessments of the effects of fishing are conducted routinely for some vulnerable species as requested by the Commission. A series of indicators of stock status and/or fishery impacts (associated to pre-established objectives) have been adopted and are routinely developed and monitored (at least twice over time) for some vulnerable species and relevant fisheries. The developed indicators are robust and can be used directly to set stock status and provide robust management advice (e.g. establish level of exploitation status and set catch limits).
SP - by C	Regional assessments of sock status or risk-based impact assessments of the effects of fishing and the development of indicators have been requested by Commission. A series of simple indicators of stock status or fishery impacts have been developed for few vulnerable species, but those indicators are not routinely developed or monitored over time or have not been adopted by the Commission. Alternatively, the developed indicators might be used as proxies or indirect indicators of stock status and fishery impacts and might be very preliminary and uncertain. These indicators are used to provide weak management advice, since they cannot be used to determine level of exploitation or set limits. For example, indicators of catch rates, size-based, or level 1 and 2 ecological risk assessment derived indicators are considered proxy indicators.
FP- only by SC	Regional assessments of status or risk-based impact assessments of the effects of fishing have been conducted for all vulnerable species and relevant fisheries. The relative vulnerability of species to fishing has been identified. A series of indicators of stock status or fishery impacts (associated to pre-established objectives) have been developed and are being monitored for all or most vulnerable species caught in all relevant fisheries. The developed indicators are robust and can be used directly to set stock status and provide robust management advice (e.g. establish level of exploitation status and set catch limits).
MP- only by SC	Regional assessments of sock status or risk-based impact assessments of the effects of fishing have been conducted for some vulnerable species and relevant fisheries. A series of indicators of stock status or fishery impacts have been developed, but are not being monitored, for some vulnerable species caught in some (but not all) fisheries. The developed indicators have the potential to be used to provide management advice.
SP or NP -only by SC	Regional risk-based impact assessments (at least level 1 and 2 ERAs) of the effects of fishing have been conducted or are being developed for some vulnerable species and relevant fisheries. The indicators derived from ERAs are usually proxies or indirect indicators of stock status, that might be used to provide weak management advice, since they cannot be used to determine level

	of exploitation or set limits. The development of robust indicators of stock status and fishery impacts might be under discussion or not being discussed.
Reference points 11. Have reference points, including target and limit reference points, been defined, developed and linked to pre-established objectives and indicators?	
FP - by C	Stock-specific or taxonomic-specific limit and target reference points (associated to pre-established objectives and indicators) have been defined, developed and adopted for all vulnerable species and relevant fisheries.
MP - by C	Stock-specific or taxonomic-specific limit and/or target reference points (associated to pre-defined objectives and indicators) have been defined, developed and adopted for some vulnerable species and relevant fisheries. Stock-specific reference points might be under development for other species.
SP - by C	General limit and/or target reference points have been defined, developed and adopted for some vulnerable species or are being discussed by the Commission. In some cases, the biomass and fishing mortality rate corresponding to maximum sustainable yield might have been the unofficial target reference points used in assessed stocks, although not formally adopted.
FP- only by SC	Stock-specific limit and/or target reference points have been defined, developed and tested by the Scientific Committee for majority of vulnerable species and relevant fisheries.
MP- only by SC	General species limit and/or target reference points have been defined and developed for some vulnerable species and under development and under discussion for others. Stock-specific reference points might be also under development and being tested for some vulnerable species.
SP or NP -only by SC	Limit and/or target reference points have not been developed. Reference points might be under discussion or not being discussed.
Management responses and measures 12. Have management responses and measures been put in place and linked to pre-established management objectives, indicators and reference points?	
FP - by C	Management measures (mostly binding) associated to pre-established management objectives, indicators and reference points have been adopted that include limits to be avoided and targets to be achieved in order to reduce impacts of fisheries on bycatch species and achieve management objectives for all or majority of vulnerable species.
MP - by C	Management measures (mostly binding) associated to pre-established management objectives, indicators and reference points have been adopted that include limits to be avoided or targets to be achieved in order to reduce impacts of fisheries on bycatch species and achieve management objectives for some vulnerable species.
SP - by C	Management measures (binding and non-binding) have been adopted to minimize impacts of fishing (with no established limits to be avoided or targets to achieved) on bycatch species for some vulnerable species, and/or to establish requirements for data reporting and conduct specific type of research.
FP- only by SC	Management measures that include limits to be avoided or targets to be achieved in order to reduce impacts of fisheries on bycatch species have been developed or are being developed and tested to be proposed to the Commission for some vulnerable species.

MP- only by SC	Management measures to minimize impacts of fisheries (with no established limits or targets) are being developed and being tested for some vulnerable species.
SP or NP -only by SC	Management measures to minimize impacts of fisheries and establish limits to be avoided and/or targets to be achieved on bycatch species are under discussion or not being discussed.
ECOLOGICAL COMPONENT 3: ECOSYSTEM PROPERTIES AND TROPHIC RELATIONSHIPS	
Objectives 13. Have conceptual and operational objectives been formally stated relevant to ecosystem properties and trophic relationships?	
FP - by C	Conceptual and operational objectives have been formally stated in Convention Agreement.
MP - by C	At least conceptual objectives are formally stated in Convention Agreement.
SP - by C	At least conceptual objectives are formally stated in adopted conservation and management measures.
FP- only by SC	Objectives are formally stated in Science Research Plans or Scientific Committee reports.
MP- only by SC	Adhoc consideration of objectives in Scientific Committee reports.
SP or NP -only by SC	Not under discussion
Indicators 14. Have food web models with interactions of relevant species and components of the ecosystem been developed, and multispecies and ecosystem level indicators been developed (associated to pre-established objectives) and are being monitored?	
FP - by C	Ecosystem metrics and food web models with interactions of relevant species and components of ecosystems have been developed to understand broader community-based and ecosystem level consequences of fishing as requested by the Commission. Empirically- based and/or model-based ecosystem indicators (associated to pre-established objectives) have been adopted and are routinely developed and monitored to provide management advice.
MP - by C	Ecosystem metrics and food web models with interactions of relevant species and components of ecosystems have been developed to understand broader community-based and ecosystem level consequences of fishing as requested by the Commission. Empirically- based and/or model-based ecosystem indicators (associated to pre-established objectives) have been adopted and developed, but not routinely monitored or used for management advice.
SP - by C	Ecosystem metrics and food web models with interactions of relevant species and components of ecosystems have been developed to understand broader community-based and ecosystem level consequences of fishing as requested by the Commission. Empirically- based and/or model-based ecosystem indicators (not necessarily associated to pre-established objectives) have been developed, but not adopted or routinely monitored or used for management advice.
FP- only by SC	Ecosystem metrics and food web models with interactions of relevant species and components of ecosystems have been developed to understand broader community-based and ecosystem level consequences of fishing. Empirically- based and/or

	model-based ecosystem indicators (associated to pre-established objectives) have been developed and are being monitored.
MP- only by SC	Ecosystem metrics and food web models with interactions of relevant species and components of ecosystems have been developed to understand broader community-based and ecosystem level consequences of fishing. Some empirically- based and/or model-based ecosystem indicators (not necessarily associated to pre-established objectives) have been developed and others are under development, but not being monitored.
SP or NP -only by SC	Ecosystem metrics and food web models with interactions of relevant species and components of ecosystems are being developed or are under discussion or not discussed. Empirically- based and/or model-based ecosystem indicators are being developed or under discussion, or not discussed.
Reference points 15. Have ecosystem and/or multispecies management plans (including harvest strategies) been developed with pre-defined reference points and are being used for management advice?	
FP - by C	Ecosystem and/or multispecies management plans (including harvest strategies) with pre-defined reference points (associated to pre-established objectives and indicators) have been developed and adopted for all relevant species and components of ecosystems. Reference points need to ensure the ecological role and sustainability of the species is maintained and to account for the needs of other dependent species.
MP - by C	Ecosystem and/or multispecies management plans (including harvest strategies) with pre-defined reference points have been developed as requested by the Commission, but not adopted, for some relevant species and components of ecosystems. Multi-species management plans might be under development for other components or species.
SP - by C	Ecosystem and/or multispecies management plans (including harvest strategies) with pre-defined reference points are being developed and being discussed as requested by the Commission.
FP- only by SC	Ecosystem and/or multispecies management plans (including harvest strategies) with pre-defined reference points (associated to pre-established objectives and indicators) have been developed for all relevant species and component of ecosystems. Reference points need to ensure the ecological role and sustainability of the species is maintained and to account for the needs of other dependent species. They are used to provide management advice.
MP- only by SC	Ecosystem and/or multispecies management plans (including harvest strategies) with pre-defined reference points have been developed for some relevant species and component of ecosystems. They might or not be used to provide management advice.
SP or NP -only by SC	Ecosystem and/or multispecies management plans (including harvest strategies) with pre-defined reference points are under discussion for some relevant components of ecosystems or are not being discussed.
Management responses and measures 16. Have ecosystem and/or foodweb models and multispecies management plans been developed and their use evaluated in decision-making and incorporated in management measures to ensure pre-established objectives are met? ?	
FP - by C	One or more conceptual ecosystem/foodweb models and multispecies management plans have been developed to understand broader community-based and ecosystem level consequences of fishing, and their used evaluated in decision-making. Management measures (e.g. multispecies harvest control rules, time-area closures, etc…) associated to pre-established

	management objectives, indicators and reference points have been adopted (mostly binding) to accommodate multispecies and food web interactions into the current management of relevant target and bycatch species and associated ecosystems.
MP - by C	One or more conceptual ecosystem/foodweb models and multispecies management plans have been developed to understand broader community-based and ecosystem level consequences of fishing, and their use evaluated in decision-making. Management measures (e.g. multispecies harvest control rules, time-area closures, etc…) have been adopted (binding or non binding) to accommodate multispecies and food web interactions into the current management of some relevant target species and bycatch species and associated ecosystems.
SP - by C	One or more conceptual ecosystem/foodweb models and multispecies management plans have been developed to understand broader community-based and ecosystem level consequences of fishing and their use evaluated in decision-making. Management measures (e.g. multispecies harvest control rules, time-area closures, etc…) are being discussed by the Commission to accommodate multispecies and food web interactions into the current management of some relevant target species and bycatch species and associated ecosystems.
FP- only by SC	Ecosystem/food web models and multispecies management plans/scenarios developed and tested to understand broader community-based and ecosystem level consequences of fishing, and support decision-making and management measures. A formal mechanism exist to accommodate multispecies and food web interactions and ecosystem modelling into current management. Management measures (e.g. multispecies harvest control rules, time-area closures, etc…) to accommodate multispecies and food web interactions into the current management of some relevant target species and bycatch species and associated ecosystems have been developed or are being developed and tested to be proposed to the Commission.
MP- only by SC	Ecosystem/food web models or multispecies management plans/scenarios are being developed and tested for some relevant species and components of ecosystems to be used in decision-making or incorporated in management measures. A formal mechanism does not exist to accommodate multispecies and food web interactions and ecosystem modelling into current management. Management measures (e.g. multispecies harvest control rules, time-area closures, etc…) to accommodate multispecies and food web interactions into the current management are being discussed.
SP or NP -only by SC	The development of ecosystem/food web models and multispecies management plans are under discussion to be used in decision-making, or is not under discussion. Management measures (e.g. multispecies harvest control rules, time-area closures, etc…) to accommodate multispecies and food web interactions into the current management are not being discussed.
ECOLOGICAL COMPONENT 4: HABITATS	
Objectives 17. Have conceptual and operational objectives been formally stated relevant to habitats of special concern?	
FP - by C	Conceptual and operational objectives have been formally stated in Convention Agreement.
MP - by C	At least conceptual objectives are formally stated in Convention Agreement.
SP - by C	At least conceptual objectives are formally stated in adopted conservation and management measures or is under discussion by the Commission.

FP- only by SC	Objectives are formally contemplated in Science Research Plans or Scientific Committee reports.
MP- only by SC	Adhoc consideration of objectives in Scientific Committee reports.
SP or NP -only by SC	Not under discussion.
Indicators 18. Have habitat of special concern and/or habitat utilization and preferences been investigated, and habitat indicators been developed (associated to pre-established objectives) and are being monitored?	
FP - by C	Habitats of special concern (e.g. reproduction, migration, feeding, hotspots) and/or habitat utilization and preferences for all relevant species have been formally investigated and delineated as requested by the Commission. Indicators (associated to objectives) describing habitat needs and preferences have been adopted, developed and are routinely monitored and used to provide management advice.
MP - by C	Habitats of special concern (e.g. reproduction, migration, feeding, hotspots) and/or habitat utilization and preferences for some relevant species have been formally investigated and delineated as requested by the Commission. Indicators (associated to objectives) describing habitat needs and preferences have been adopted and developed, but are not routinely monitored or used to provide management advice.
SP - by C	Habitats of special concern (e.g. reproduction, migration, feeding, hotspots) and/or habitat utilization and preferences for some relevant species have been formally investigated and delineated as requested by the Commission. Indicators (not associated to objectives) describing habitat needs and preferences are under development.
FP- only by SC	Habitats of special concern (e.g. reproduction, migration, feeding, hotspots) and/or habitat utilization and preferences for all relevant species have been investigated and delineated. Indicators (associated to objectives) describing habitat needs and preferences have been developed and are routinely monitored and used to provide management advice.
MP- only by SC	Habitats of special concern (e.g. reproduction, migration, feeding, hotspots) and/or habitat utilization and preferences for some relevant species have been investigated and delineated. Indicators (not associated to objectives) describing habitat needs and preferences have been developed or are under development, but are not routinely monitored or used to provide management advice.
SP or NP -only by SC	Habitats of special concern (e.g. reproduction, migration, feeding, hotspots) and/or habitat utilization and preferences for some relevant species are under discussion or not discussed. Indicators describing habitat needs are under discussion or not being discussed.
Reference points 19. Have minimum habitat needs and requirements (linked to pre-established indicators and objectives) been identified and adopted for relevant species with habitats of special concern?	
FP - by C	Minimum habitat needs and requirements (linked to pre-established indicators and objectives) have been identified as requested by Commission and adopted for all relevant species with habitats of special concern.

MP - by C	Minimum habitat needs and requirements (linked to pre-established indicators and objectives) have been identified as requested by Commission and adopted for some relevant species with habitats of special concern.
SP - by C	Minimum habitat needs and requirements are being identified for some relevant species with habitats of special concern as requested by Commission
FP- only by SC	Minimum habitat needs and requirements (linked to pre-established indicators and objectives) have been identified for all relevant species with habitats of special concern.
MP- only by SC	Minimum habitat needs and requirements (linked to pre-established indicators and objectives) have been identified or are under development for some relevant species with habitats of special concern.
SP or NP -only by SC	Minimum habitat needs and requirements for some relevant species with habitats of special concern are under discussion or not discussed.
Management responses and measures 20. Have habitats of special concern and/or habitat utilization and preferences of relevant species been delineated and their use evaluated in decision-making to ensure pre-established objectives are met?	
FP - by C	Habitats of special concern are known for all relevant species and this knowledge is used in decision-making. Management measures (binding) have been adopted to accommodate knowledge of habitats of special concern for all relevant species to ensure pre-establish objectives are met.
MP - by C	Habitats of special concern are known for some relevant species and this knowledge is used in decision-making. Management measures (binding or non-binding) have been adopted to accommodate knowledge of habitats of special concern for some relevant species to ensure pre-establish objectives are met.
SP - by C	The Commission has requested to conduct research to identify habitats of special concern. Management measures are under discussion to accommodate knowledge on habitats of special concern for some relevant species. Yet knowledge on habitat of special concern not used in decision-making and not incorporated in management measures.
FP- only by SC	Habitats of special concern are known for all relevant species and the Scientific Committee has developed and tested mechanisms to use this type of information in decision-making, but not used yet in decision-making or incorporated in management measures.
MP- only by SC	Habitats of special concern are known for some relevant species and the Scientific Committee is developing mechanisms to use this type of information in decision-making, but not used yet in decision-making or incorporated in management measures.
SP or NP -only by SC	What constitutes habitats of special concern for some relevant species is under discussion by the Scientific Committee to be used potentially in decision-making, or not being discussed. Mechanisms to incorporate this type of information into decision-making are under discussion or not being discussed.