Received: 25 August 2015

Preliminary review of ICCAT, WCPFC, IOTC and IATTC progress in applying ecosystem based fisheries management

Maria José Juan-Jordá [1,2], Haritz Arrizabalaga[1], Victor Restrepo[3], Nicholas K. Dulvy[2], Andrew B. Cooper[4] and Hilario Murua[1]

[1]AZTI Tecnalia, Marine Research Division, Herrera Kaia, Portualdea z/g E-20110, Pasaia, Gipuzkoa, Spain. Email address of lead author: mjuan@azti.es.
[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 650, Washington DC 20005, United States.
[4]School of Resource and Environmental Management, Simon Fraser University, Burnaby, BC, V5A 1S6, Canada.

ABSTRACT

Oceanic tuna, billfish and shark species, the structure of their communities and food webs they form provide and sustain important high-sea ecosystem services for human wellbeing. International instruments of fisheries governance such as the UN Fish Stock Agreement have changed slowly the expectations and roles of Regional Fisheries Management Organizations (RFMOs) in accounting for ecosystem considerations in their decision-making when managing tuna and tuna-like species and associated ecosystems. Our main objective is to evaluate the progress of tuna RFMOs in applying Ecosystem Based Fisheries Management (EBFM). We first develop a framework of a Conceptual Ecological Model for what could be considered a "role model" tuna RFMO. Second, we develop a criteria to evaluate the progress in applying EBFM against this idealized role model RFMO. In our criteria, we assess progress in the following four ecological components separately: (1) targeted species (2) bycatch species, (3) ecosystem properties and trophic interactions and (4) habitats. We use this framework and criteria to evaluate progress of ICCAT, WCPFC, IOTC and IATTC in applying EBFM. All 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 component of trophic relationships and habitats. All tuna RFMOs have adopted management measures to minimize the effects of fishing on target and by-catch species and none to account for the impacts of fishing on the trophic relationships and food web structure, and protections of habitats of special concern. Yet none of the adopted management measures have been linked to pre-agreed operational objectives, indicators and thresholds, precluding them to be activated when predefined thresholds are exceeded. All the tuna RFMOs share the same challenge of developing a formal mechanism to better integrate ecosystem considerations into management decisions. We plan to expand this review to include the five tuna RFMOs, so a baseline of progress in implementing EBFM can be established.

1. INTRODUCTION

Biodiversity underpins the well-being of human society by supporting ecosystem services (Millennium Ecosystem Assessment 2005). Ecosystem services are the products of healthy, diverse and functioning ecosystems and associated living organisms contributing to human wellbeing (Rogers et al. 2014). Tuna and billfish species, the structure of their communities and food webs they form provide and sustain many ecosystem services including provisioning, regulating, habitat and cultural services. Managing and preserving biodiversity to sustain the production of all its services is at the core of ecosystem-based management (Palumbi et al. 2009). The goal of ecosystem-based management is to maximize and sustain the delivery and production of ecosystems services. Thus, ecosystem based management requires to frame the management goals with respect to the conservation of ecosystem services and evaluations of their trade offs (Rosenberg and McLeod 2005). In a fisheries management context, the main goal of ecosystem-based management translates into ensuring the sustainability of catches without compromising the inherent structure and functioning of marine ecosystems and their delivery of ecosystem services for human society (Lodge et al. 2007).

Over the last decades, the development of international policy regarding the protection and management of highly migratory marine species including tunas and tuna-like species has grown and changed substantially. Multiple binding treaties and agreements have been adopted and have entered into force. The UN Fish Stock Agreement (UNFSA), and the FAO Compliance Agreement are the key legal binding instruments governing the management of highly migratory species (Meltzer 2009). These binding pieces of international law together establish the core principles and minimum standards making reference for the first time to the application of the Precautionary Approach, the Ecosystem Approach to Fisheries Management or Ecosystem Based Fisheries Management (EBFM). These binding international laws are supported by a series of non-legally binding international agreements, norms and guidelines, which were created to support and drive the implementation of the principles set in the laws. These include the FAO Code of Conduct for Responsible Fisheries and the FAO International Plans of Action (IPOAs) for sharks, seabirds, capacity, and illegal, unreported and unregulated fisheries, which main role is to support the implementation and enforcement of the UNFSA. These international laws and agreements are slowly changing the expectations of fisheries management, and the expectations and roles of Regional Fisheries Management Organizations (RFMOs) in accounting for ecosystem considerations in their management decisions (Lodge et al. 2007). Now, there is an increasing recognition and further expectations of the need for RFMOs managing and conserving tuna and tuna-like species (tuna RFMOs) to expand their focus to ensure they manage their fish stocks without compromising the ability to maintain a balance delivery of all ecosystem services provided by tuna and tuna-like species and associated marine ecosystems (Pikitch et al. 2004, Lodge et al. 2007). It is widely recognized that the sustainable use and exploitation of marine fisheries is linked to the ecological sustainability of marine ecosystem processes and structure, and the ecosystem services they provide (Gilman et al. 2014).

Tuna RFMOs provide a framework for states to cooperate on the management and conservation of highly migratory species including tuna and tuna-like species and associated ecosystems in the high seas. Thus, according to international laws and agreements, RFMOs have management and enforcement mandates to maintain sustainable populations and ensure sustainable fishing operations, taking into account the precautionary approach as well as ecosystem considerations in their management decisions (Meltzer 2009). There are five tuna RFMOs including the International Commission for the Conservation of Atlantic Tunas (ICCAT), the Indian Ocean Tuna Commission (IOTC), the Inter-American Tropical Tuna Commission (IATTC), the Western and Central Pacific Fisheries Commission (WCPFC), and the Commission for the Conservation of Southern Bluefin Tuna (CCSBT). Although the five tuna RFMOs are increasingly addressing the ecosystem effects of fishing, traditionally all tuna RFMOs have focused most of their resources and capacities to manage target tuna stocks to obtain maximum sustainable yields. The importance of implementing an ecosystem based fisheries management approach to manage tuna fisheries and associated ecosystems is widely accepted. Yet, in practice it has been proven challenging to successfully implement it. This is in part due to the difficulties of breaking with traditional management, connecting multiple disciplines and establishing realistic ecosystem reference point indicators, but also due to the perception that it is too complicated and that it requires huge amount of detailed information of biological processes (Tallis et al. 2010).

Our main objective is to evaluate the progress of tuna RFMOs in applying and implementing an EBFM approach to manage tuna and tuna-like species and associated ecosystems in their convention areas. 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, and reviewing the ecosystem science produced and how is being used by tuna RFMOs to support its implementation. Several strategies and frameworks have been developed to make the implementation of an EBFM approach more operational such as the Driver-Pressure-State-Ecosystem services-Response (DPSER) and the Integrated Ecosystem Assessment (IEA) frameworks (Levin et al. 2009b, Tallis et al. 2010, Kelble et al. 2013). 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, and proving that the implementation of EBFM can be feasible. Here, we first develop and describe a Conceptual Ecological Model based on the DPSER and IEA frameworks for what could be considered a “role model” tuna RFMO. Second, we develop a criteria to evaluate the progress in tuna RFMOs in applying EBFM against this idealized “role model” RFMO. Ultimately, we aim to establish a baseline of progress in implementing the ecological component of EBFM, also identify research activities, on-going examples of good practices that are currently being used in each RFMO that are progressing towards the implementation of EBFM, that could be transferred and shared among them. At the same time, we also aim to identify data and methodological needs, and limitations in capacities that hinder process. Finally, we seek to create discussion across the tuna RFMOs to inform potential developments of EBFM plans. Based on our developed Conceptual Ecological Model and criteria we here present progress of ICCAT, WCPFC, IOTC and IATTC in applying and implementing EBFM in the conservation and management of tuna and tuna-like species and associated ecosystems.

2. METHODS

First, we describe the development of a Conceptual Ecological Model based on the DPSER and IEA frameworks for what could be considered a "role model" tuna RFMO. Second, we develop a criteria to assess the progress of t- RFMOs in implementing EBFM against this idealized "role model" RFMO.

2.1 Development of a Conceptual Ecological Model of a role model tuna RFMO

Several strategies and frameworks have been developed to make the implementation of EBFM more operational. We use the following two frameworks, the Integrated Ecosystem Assessment (IEA) framework (Figure 1a) and the Driver-Pressure-State-Ecosystem services-Response (DPSER) framework (Figure 1b), to develop a Conceptual Ecological Model for what it could be considered a "role model" tuna RFMO which potentially could facilitate and guide the implementation of EBFM in the tuna RFMOs. 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). Next, we first describe briefly these two frameworks, and how we used them to build a Conceptual Ecological Model for a "role model" tuna RFMO. Finally, we define what it would be considered a "role model" tuna RFMO based on a review of the best practices in which different RFMOs are addressing ecosystem based management and implementing the precautionary approach (Lodge et al. 2007).

The DPSER conceptual framework (Figure 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 (Figure 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. 2009a, Tallis et al. 2010). *Scoping* and identifying the ecological 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 political step. It is difficult to reach consensus among the various stakeholders where commonly multiple interest collide. 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 consist in conducting *risk analyses* to analyze and quantify the links between 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 lasts steps consist in close *monitoring* of the indicators and *evaluation* of strategies to ensure the loop of the IEA is closed (Figure 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 IEA and the DPSER frameworks have not been used yet as a planning tool to develop an EBFM strategy in any of the tuna RFMOs. Yet many of the current practices, research products and programs conducted by the tuna RFMOs in support of an ecosystem 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 build a Conceptual Ecological Model for what it could be considered to be a "role model" tuna RFMO (Figure 2, Table 1). Our Conceptual Ecological Model 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 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 Conceptual Ecological Model which could be used as a starting point towards the development of an operational EBFM plan.

Our Conceptual Ecological Model for a role model tuna RFMO (Figure 2; Table 1) first illustrates the main *drivers* and associated *pressures* in the high seas. Human population growth and a rising demand for fish protein places fishing as one of the most important pressures on the high sea ecosystems. Fishing impacts the *state* of tuna and tuna-like species and associated ecosystems, which in turn affects the *ecosystem services* that benefit human society. 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). However, climate change and associated rising temperatures 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 system 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 associated 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) targeted species (2) bycatch species, (3) ecosystem properties and trophic interactions and (4) habitats (Lodge et al. 2007). Therefore, in our 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 consist 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 (Figure 2). At the end, our Conceptual Ecological Model illustrates the main elements and interactions to take into account to implement EBFM. 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 element, and develop management responses and strategies for each of them.

Last, we need to define what constitute a "role model" tuna RFMO. Our "role model" tuna RFMO is based on a review to identify best practices of almost 20 RFMOs in addressing EBFM and implementing the precautionary approach (Lodge et al. 2007). Lodge et al 2007 identifies best practices that address the key elements of UNFSA and the FAO Code of Conduct for Responsible Fishing. In table 1, we define and describe what would be the main elements ideally constituting the basic texts and main structure of a tuna RFMO 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-establish 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 1). With this general idealized Conceptual Ecological Model, we pretend to highlight how this planning tool could potentially be used as a framework to facilitate the implementation of EBFM in tuna RFMOs.

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

The general idealized Conceptual Ecological Model for a role model tuna RFMO (Figure 2, Table 1) provides a framework to evaluate the progress of tuna RFMOs in applying the four ecological components (target species, bycatch species, ecosystem properties and trophic relationships, and habitats) of EBFM to manage tuna and tuna-like species and associated ecosystems. To identify and assess progress towards applying EBFM in each tuna RFMO, we developed a criteria to organize all the information from the current actions and practices and supporting ecosystem science being produced by each tuna RFMO (Table 2). Our criteria to evaluate progress include a list of key elements that ideally would facilitate the progress of implementing and making more operational each of the four ecological components of EBFM in the tuna RFMOs. In our criteria to evaluate progress (Table 2), we first review the basic texts and main structure of the tuna RFMOs in support of EBFM. Second, for each of the four ecological components, we review and evaluate (1) whether operational *objectives* have been defined (2) whether there are measurable *indicators* associated to the operational objectives to track the state and trend of each ecological element, (3) whether *thresholds* for those indicators have been defined to activate management action, and (4) whether there are *measures and management responses* to ensure that those thresholds are not exceeded. When reviewing progress within the four ecological components of EBFM, there might not always be clear boundaries between them, as for example a species might sometimes be considered a target species in one fishery and by-catch species in other fisheries. Therefore for practical reasons, under the

ecological component of "Target Species", we only included in the review of progress the six principal market tunas (*Katsuwonus pelamis, Thunnus albacares, T. obesus, T. alalunga, T. maccoyyii, T. Thynnus and T. orientalis*) and swordfish, and assessed how these species are managed and conserve to advance progress in implementing EBFM. Under the ecological component of "Bycatch Species", we included in the review of progress all billfishes except swordfish, and also included sharks, seabirds, sea turtles, marine mammals and other finfish species, and assessed how these species are managed and conserve to advance progress in implementing EBFM. Under the ecological component of "Ecosystem Properties and Trophic Relationships", we evaluated the existence of ecosystem metrics (empirically and model based) and food web models depicting trophic interactions and interdependencies involving relevant species or group of species 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 assessed 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 qualitatively the progress of each element within each ecological component based on the assessment of specific actions by establishing six categories to evaluate progress (Table 2). Within the six categories of progress, we differentiated between progress done by the Commission and the Scientific Committees in each tuna RFMO. The six categories of progress are: Full Progress by the Commission (which we set as our role-model RFMO defined in Table 1), Moderate Progress by the Commission, Small Progress by the Commission, Full Progress only by the Scientific Committee, Moderate Progress only by the Scientific Committee, and Small or no progress only by the Scientific Committee. Thus, the six categories rank progress from the highest progress done by Commission (Category -Full progress by Commission) to the lowest progress done by the Scientific Committee (category -Small or no progress only by the Scientific Committee). Although, we assume that progress can be ranked linearly from the highest to the lowest category, there might be some exceptions and we highlight them in the text.

To evaluate progress done by the Commission, we mainly reviewed and evaluated the Convention Agreement Text, adopted management measures, adopted Strategic Research and Management Plans, Annual Summary Commission reports as well as Scientific Committee reports. We only evaluated actions, practices and supporting ecosystem science that were formally requested, considered and adopted by the Commission. 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 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. Thus, we distinguished between science products, good practices and recommendations that were formally considered by the Scientific Committee (e.g. clear recommendations, clear 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. Given its preliminary results, the Scientific Committee might not yet formally taken into account this work to provide management advice to the Commission, then we did not consider it as progress or as small progress by the Scientific Committee. In our criteria of progress, the Commission progress accounts for the questions addressed and requested by the Commission that have to be analyzed by the Scientific Committee in order to provide scientific advice to the Commission. In other words, the Commission progress includes the progress done by the Scientific Committee. On the other hand, the progress of the Scientific Committee addresses the advance done by the Scientific Committee without formal request or mandate from the Commission. In our analysis, the list of elements reviewed within the each of the four ecological components of EBFM and the list of actions, good practices and supporting ecosystem science products is not an exhaustive list, which could be easily expanded. Yet these elements are common practices already being or partially being used and implemented by some RFMOs (Lodge et al. 2007).

3. RESULTS AND DISCUSSION

3.1 Review of basic texts and main structures of RFMOs in support of EBFM

ICCAT

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

Category of progress 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" (ICCAT 2007). The ICCAT Convention Agreement does not formally recognize the adoption of the precautionary approach or an ecosystem approach to fisheries management or ecosystem based fisheries management. 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. 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 ecosystem based fisheries management principles, since its creation ICCAT had the ability to assimilate some elements of new 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. 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). 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 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 category of progress – Moderate progress by the Commission.

(ii) Existence a lead entity or group in charge of advancing progress in EBFM and ecosystem science and providing management advice on impacts of fishing on ecosystems

Category of progress assigned: MODERATE PROGRESS BY THE COMMISSION

The structure of ICCAT currently includes a Standing Committee on Research and Statistics (SCRS), which is the Scientific Committee responsible for developing and recommending to the Commission policy advice concerning fishing activities and the stocks are fished in the convention area. The SCRS 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-related research and associated activities as required by the SCRS to fulfill its advisory role to the Commission. The Sub-Committee on Ecosystems mostly focuses 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 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 SCRS regarding ecosystem and bycatch issues. 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. Traditionally, these working groups provide management advice for their focus species in a single-species management approach or context. Although billfishes, sharks and small tunas are assessed by their own working groups, in this study they are contemplated as an important bycatch group and activities derived from these groups might be relevant to the activities conducted by the Sub-Committee on Ecosystems. Although not done currently, the current research and management advice derived from these Species Working Groups could also potentially provide management advice on ecosystem issues derived from their respective species and fisheries to the Commission.

In conclusion, although the Sub-Committee on Ecosystems was created to better integrate ecosystem considerations into the scientific advice provided by the Scientific Committee to the Commission, it has limited capacity to coordinate all the 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. Billfish and Shark Working Groups). Currently, ICCAT lacks of a formal mechanism to coordinate the 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 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 category of progress – Moderate progress by the Commission.

(iii) Existence of an Ecosystem Based Fisheries Management plan

Category of progress assigned: SMALL 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 Science Strategic Plan for 2015-2020 which includes as a strategic goal to advance towards EBFM advice is a step forward (ICCAT 2015b). The 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 category of progress – Small progress by the Commission.

(iv) Existence of a long-term data collection programme to support the implementation of EBFM

Category of progress assigned: SMALL PROGRESS BY THE COMMISSION

ICCAT has not established a long-term data collection and monitoring programme designed to support the implementation of EBFM, nor has established a standardized Regional Observer Programme for any of its fisheries in place fully coordinated by the Secretariat. Instead, ICCAT requires member states to have national observer programmes. The data derived from these national programs must be submitted to the ICCAT Secretariat in the formats specified by SCRS and under the confidentially rules agreed by ICCAT (Rec. 11-10). In the national observer programmes, ICCAT requires at least 5% of observer coverage for longline fleets. 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. Moreover, 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 to be monitored and assessed through EBFM, and to include the collection of socio-economic information in the national sampling programmes. However, broad measurable targets were not defined to evaluate progress in the implementation of these ecosystem-related strategies in the SCRS Scientific Research Plan, nor specific deadlines were established. In conclusion, since a standardized regional data

collection and monitoring programme relevant to EBFM or even single-species fisheries management does not exist, yet multiple national observing programmes exist for certain fishing gears and fleets as requested by the Commission, we assigned the category of progress – Small progress by the Commission.

WCPFC

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

Category of progress assigned: FULL PROGRESS BY THE COMMISSION

The WCPFC was established in 2004 by the Convention for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean. 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 tuna RFMO 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 (UNCLOS). 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 formally recognizes the precautionary approach and EBFM principles in its Convention Agreement. Therefore, we assigned the category of progress – Full progress by the Commission.

(ii) Existence a lead entity or group in charge of advancing progress in EBFM and ecosystem science and providing management advice on impacts of fishing on ecosystems

Category of progress assigned: MODERATE PROGRESS BY THE COMMISSION

The WCPFC created 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. The Scientific Committee comprises the following Specialist Working Groups (SWG): Assessment SWG, Fishing technologies SWG, Methods SWG, Biology SWG, Ecosystem and By-catch SWG, and Statistics SWG. The Ecosystem and Bycatch SWG, now also referred as the Ecosystem and Bycatch Mitigation Theme, has met annually since 2005 to review relevant issues related to bycatch and ecosystem modelling (WCPFC 2009). The Ecosystem and Bycatch SWG prepares an annual report summarizing the main research activities conducted during the year and prepares a series of recommendations for the Scientific Committee regarding bycatch, ecosystem impacts and ecosystems modeling. The WCPFC has also identified potential overlaps of functions and responsibilities between all the Specialist Working Groups to ensure the Commission overall objectives are met. For example, the environmental variability discussed in the Ecosystem and By-catch SWG might be of interest to the Stock Assessment SWG, now Stock Assessment Theme, since it may be needed to be accounted for in the assessments themselves. The Stock Assessment SWG has the responsibility of evaluating the status of stocks of interests and critically review the assessments for not only target stocks, but also non-target stocks.

Moreover, most of the science requested by the WCPFC is produced by the capabilities of the Secretariat of the Pacific Community –Ocean Fisheries Programme (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) provides scientific support for the northern Pacific stocks, and follows a Working Group model similar to ICCAT and IOTC.

In conclusion, the Ecosystem and By-catch SWG 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. The Ecosystem and By-catch SWG has clear objectives and identifies a priory potential overlaps of responsibilities with other SWG, and it appears it has the capacity to coordinate all the ecosystem research activities needed (pertaining to target and bycatch species, trophic relationships and habitats) interacting with the rest of SWG to fully implement EBFM. Yet, to our knowledge there is no a formal established mechanism to coordinate all ecosystem-relevant research, and ensure effective communication and exchange of information pertaining to ecosystem issues among all the SWGs, which 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 category of progress – Moderate progress by the Commission.

(iii) Existence of an Ecosystem Based Fisheries Management plan

Category of progress assigned: SMALL 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 requires that the Scientific Committee recommend 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 step forward towards preparing an EBFM plan. We therefore assigned the category of progress – Small progress by the Commission.

(iv) Existence of a long-term data collection programme to support the implementation of EBFM

Category of progress assigned: MODERATE PROGRESS BY THE COMMISSION

The WCPFC has not established a long-term data collection and monitoring programme to support the implementation of EBFM. Yet, there is an extensive standardized Regional Observer Programme in place since 2009 coordinated by the SPC/OFP and therefore held centrally by the WCPFC secretariat. Prior to 2009, a broad scale observer programme 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. 2014b).

The Regional Observing Programme only process data from the purse seine and longline fleets. Currently, the purse seine fleet operating in the high seas or between two or more EEZs has a requirement of 100% observer coverage, and longliners a 5% observer coverage (CMM 2012-01). Since, a standardized regional monitoring programme coordinated by RFMO secretariat exists at least for some fishing fleets, we assigned the category of progress – Moderate progress by the Commission.

IOTC

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

Category of progress 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 the management, conservation and optimum utilization of stocks covered by in the agreement. The Agreement specifies 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 precautionary approach or the ecosystem approach to fisheries management (IOTC 2009). However, since its creation IOTC had the ability to assimilate some elements of new 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 to call for the application of the precautionary approach in accordance to relevant guidelines set in the UNFSA. 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. Since, the IOTC has had the ability to assimilate some EBFM principles of international fisheries governance in the form of adoption of formal management measures, we assigned the category of progress – Moderate progress by the Commission.

(ii) Existence a lead entity or group in charge of advancing progress in EBFM and ecosystem science and providing management advice on impacts of fishing on ecosystems

Category of progress assigned: MODERATE PROGRESS BY THE COMMISSION

Similar to ICCAT, 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-related 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 2014a). 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.

The current research and management advice derived from the single species groups, the Working Parties on Temperate Tunas, on Tropical Tunas, on Neritic Tunas, and Billfish, provides mostly advice with a single-species focus, but these groups could also potentially provide management advice on ecosystem issues to the Commission. IOTC also lacks of a formal mechanism to coordinate all ecosystem-relevant research, and ensure effective communication and exchange of information pertaining to ecosystem issues among all the groups, 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, although 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, it has limited capacity to coordinate 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). We therefore assigned the category of progress – Moderate progress by the Commission.

(iii) Existence of an Ecosystem Based Fisheries Management plan

Category of progress assigned: SMALL OR NO 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. Neither the Scientific Committee did develop

yet a Strategic Research Plan nor the WPEB a work plan including ecosystem considerations to guide the development of ecosystem research or ecosystem considerations and ecosystem management advice to ensure it remains responsive to the Commission needs. Therefore, since an EBFM plan has not been developed by IOTC and its development is not under discussion by the Scientific Committee or the Commission, we assigned the category of progress – Small or no progress only by the Scientific Committee.

(iv) Existence of a long-term data collection programme to support the implementation of EBFM

Category of progress assigned: MODERATE PROGRESS BY THE COMMISSION

IOTC has not established a long-term data collection and monitoring programme to support the implementation of EBFM. Yet, it established in 2010 a regional observer programme required in vessels >24 meters operating in the IOTC area of competence, and extended it to vessels less than 24 m operating outside national waters in January 2013. There is a requirement of 5% coverage for the number of operations/sets for each gear type by fleet for each member country. Regional or National Observing Programmes supply the observers and the data collected by the observing programmes must be submitted to the IOTC secretariat. Since, a regional monitoring programme held centrally and partially coordinated by the IOTC secretariat exists, we assigned the category of progress – Moderate progress by the Commission.

IATTC

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

Category of progress 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 adoption of conservation and management measures, as necessary, to ensure the sustainable use of fish stocks and dependent and associated species belonging to the same ecosystem that are affected by fishing (Article VII.f). It also makes reference to the precautionary approach as described in the relevant provisions of the Code of Conduct and/or the 1995 UN Fish Stock Agreement (Article IV). It also promotes the application of any relevant provision of the Code of Conduct and of other relevant international instruments including the International Plan of Actions adopted by FAO in the framework of the Code of Conduct (Article VII.n). Therefore, we assigned the category of progress – Full progress by the Commission.

(ii) Existence a lead entity or group in charge of advancing progress in EBFM and ecosystem science and providing management advice on impacts of fishing on ecosystems

Category of progress assigned: FULL 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 goals. 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 staff of the Secretariat, which are in charge to carry out the research, analysis and advice for the Commission. 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 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 also prepares annually a set of recommendations for conservation measures to ensure the Convention Agreement Objective is achieved (IATTC 2015c) 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 capable to coordinate all the ecosystem related activities and integrate ecosystem considerations into the scientific advice provided by the Scientific Committee to the Commission. Therefore, we assigned the category of progress – Full progress by the Commission.

(iii) Existence of an Ecosystem Based Fisheries Management plan

Category of progress assigned: SMALL 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 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. This initiative is seen as a step forward towards preparing an EBFM plan. We therefore assigned the category of progress – Small progress by the Commission..

(iv) Existence of a long-term data collection programme to support the implementation of EBFM

Category of progress assigned: MODERATE PROGRESS BY THE COMMISSION

The IATTC has not established a long-term data collection and monitoring programme to support the implementation of EBFM. Yet, it has an extensive standardized Regional Observer Programme for large purse-seine fisheries fully coordinated by IATTC secretariat. 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). The fully coordinated Regional Observing Programme is only required in the purse-seine fleets, while longline, troll and pole and line are exempt from the regional observing programme, but requirements for 5% longline coverage for vessels >20m have been implemented since 2013. Since, a standardized Regional Observer Programme coordinated by RFMO secretariat exist at least for some fishing fleets, we assigned the category of progress – Moderate progress by the Commission.

3.2 Review of main ecological components in support of EBFM

3.2.1. Review of elements in Ecological Component 1: target species.

ICCAT

(i) Objectives:

Category of progress assigned: MODERATE 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". Therefore, ICCAT has explicitly defined a general-species operational objective that applies to all tuna and tuna-like species and this objective is generally applied

to the main target ICCAT species, yet species-specific operational objectives have not been developed. 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 and it is seen as an important initiative to assist in the progress of developing species-specific conservation and management objective. We therefore assigned the category of progress – Moderate progress by the Commission.

(ii) Indicators:

Category of progress assigned: FULL PROGRESS BY THE COMMISSION

Fishery stock assessments have been conducted for all principal market tunas stocks (9 stocks in 5 species) and for swordfish (3 stocks, 1 species). Thus, all target stocks (all principal market tuna stocks and swordfish stocks) harvested 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, fishing mortality over time and associated thresholds are available and monitored regularly for these assessed stocks. These stock status indicators and associated thresholds are also explicitly associated to the aforementioned objective of maintaining populations at maximum sustainable yields. We therefore assigned the category of progress – Full progress by the Commission.

(iii) Thresholds:

Category of progress assigned: SMALL PROGRESS BY COMMISSION

Limit reference points associated with the biomass and fishing mortality rate indicators have not been adopted for any of the target stocks. Bmsy and F_{MSY} (or proxies such as B_{01} and F_{01}) are generally used as target reference points for all the target stocks. However, limit reference points have been proposed and are being defined and under development for north Atlantic albacore and swordfish by the Scientific Committee as requested by the Commission. 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). We therefore assigned the category of progress – Small progress by the Commission.

(iv) Responses and management measures:

Category of progress assigned: MODERATE PROGRESS BY COMMISSION

Harvest control rules have not been developed and adopted for any of the target species. Although harvest control rules have not been adopted for any of ICCAT species, Recommendation 11-13 sets the principles and the decision framework to achieve ICCAT Convention objectives of maintaining the stock in maximum sustainable yield. Based on this framework, harvest control rules are being defined and are under development for north Atlantic albacore and swordfish. 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.

However, 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. Management measures have been adopted for all target species when the status of the stock was considered to be overfished. We briefly summarize the most relevant conservation and management measures adopted by ICCAT to manage target stocks: A series of TACs have been adopted for bigeye tuna, yellowfin tuna, north and south Atlantic albacore, western and eastern and Mediterranean bluefin, north and south swordfish, white and blue marlins; a record vessels for fishing have been established for bigeye, yellowfin, north Atlantic albacore tuna; a capacity limitation scheme has been established for the number of longliners and purse seiners for bigeye tuna; a temporary time-area closure (with a prohibition of FAD fishing on floating objected) with 100% observer coverage for bigeye tuna and yellowfin tuna has been established that also affects east Atlantic skipjack stock; there is a requirement for annual submission of FAD management plans for bigeye and yellowfin tuna; there are minimum size limits for swordfish, bluefin and marlins; a rebuilding plan for eastern and Mediterranean bluefin tuna stock has been established that includes TACs, fishing and farming capacity adjustments, time-area closures, minimum sizes, establishment of records of authorized fishing vessels and

farming facilities, requirement of weekly or monthly catch reports to national agencies and ICCAT, 100% observer coverage for purse seiners and transfers to farming cages, requirements of vessel monitoring system with transmission to ICCAT, prohibition of trade without valid catch documents, establishment of procedures for at-sea boarding and inspection; a rebuilding plan for western bluefin tuna stock has been established that includes TACs, minimum sizes and the prohibition of directed fisheries in the Gulf of Mexico.

In conclusion, although harvest control rules have not been adopted for any target species despite being discussed by the Commission for some species, management measures have been adopted to ensure management objectives are achieved for majority of target stocks and species when needed. We therefore assigned the category of progress – Moderate progress by the Commission.

WCPFC

(i) Objectives:

Category of progress assigned: MODERATE 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 5 (a) 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", and Article 6.1 (a) of the Convention 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." Therefore, the Convention has explicitly defined a general-specific operational objective that applies to highly migratory species and especially to main target species. The recent establishment of the Management Objective Workshops in the WCPFC to enhance dialogue between fisheries managers and scientists is 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 category of progress – Moderate progress by the Commission.

(ii) Indicators:

Category of progress 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 stocks, and swordfish stocks) harvested 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 thresholds are available and monitored regularly for these assessed stocks. These stock status indicators and associated thresholds 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 category of progress – Full progress by the Commission.

(iii) Thresholds:

Category of progress assigned: MODERATE PROGRESS BY COMMISSION

A limit reference point (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. 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, skipjack, and South Pacific albacore tunas. Yet for bigeye tuna achieving $F \leq F_{MSY}$ by 2017 is implied as an interim target, and for skipjack tuna a target reference point of 40%, 50%, and 60% of unfished spawning biomass are being considered. Limit and target reference points have not been defined for North Pacific albacore tuna, Pacific bluefin tuna or swordfish.

The Scientific Committee is currently assessing 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, three 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 MOW, 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).

Since limit and/or target reference points (associated to pre-defined objectives and indicators) have only been developed and adopted for some target species, we assigned the category of progress – Moderate progress by the Commission.

(iv) Responses and management measures:

Category of progress assigned: MODERATE PROGRESS BY COMMISSION

Harvest control rules have not been developed and adopted for any of the target species. Yet a conservation and management measure in 2014 calls for the WCPFC to develop and implement a harvest strategy approach that includes target reference points, harvest control rules and other elements. The Management Objective Workshops are also used to discuss the establishment and development of a management frameworks based on a harvest strategy approach, and determining risk levels and target reference points for skipjack and south Pacific albacore. The last Commission in 2014 agreed to continue supporting the development of a MOW Workplan to progress on the development of a management framework for key WCPO tuna species.

However, several management responses or measures (binding - conservation and management measures) have been adopted by WCPFC to ensure that aforementioned management objective is achieved. Next we briefly summarize the most relevant conservation and management measures adopted by WCPFC to manage target stocks. Several measures have been adopted to reduce or freeze fishing mortality for bigeye, yellowfin and skipjack tunas including time area closures for FAD fishing, limits on the number of FAD sets, limits on the number of vessel days, requirements to submit FAD management plans, requirements for a full-retention in purse-seiners, 100% regional observer coverage for all purse seiners in several settings, limits on the number of purse seiners and longliners with freezing capacity. Furthermore, catch limits are in place for bigeye tuna caught by longliners, and catches are not allowed to increase for yellowfin. For the north Pacific albacore tuna stock, the WCPFC has a conservation and management measure calling members not to increase fishing effort beyond current levels. For the south Pacific albacore tuna stock, the WCPFC has a conservation and management measure to limit fishing mortality by establishing a capacity limitation scheme and set a cap on the number of fishing vessels for some members. For Pacific bluefin tuna, a conservation and management measure by the WCPFC has established a multi-annual rebuilding plan (starting in 2015) to rebuild the spawning biomass to healthy levels, and includes limits in total fishing effort, and reduction in catches of juveniles.

In conclusion, harvest control rules have not been adopted for any target species, but for some species are under discussion by the Commission. Management measures have been adopted to ensure management objectives are achieved for majority of target stocks and species. We therefore assigned the category of progress – Moderate progress by the Commission.

IOTC

(i) Objectives:

Category of progress 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". Therefore, IOTC has explicitly defined a general-species operational objective that applies to all stocks of tuna and tuna-like species and this objective is generally applied to the main target IOTC species, yet species-specific operational objectives have not been developed. We therefore assigned the category of progress – Moderate progress by the Commission.

(ii) Indicators:

Category of progress 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 harvested 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 thresholds are available and monitored regularly for these assessed stocks. These stock status indicators and associated thresholds are also explicitly associated to the implicit aforementioned objective of maintaining populations at maximum sustainable yields. We therefore assigned the category of progress – Full progress by the Commission.

(iii) Thresholds:

Category of progress assigned: MODERATE PROGRESS BY COMMISSION

Interim limit and target reference points associated with the biomass and fishing mortality rate indicators have been adopted for bigeye, yellowfin, skipjack, albacore tunas and swordfish. We therefore assigned the category of progress – Moderate progress by the Commission.

(iv) Responses and management measures:

Category of progress assigned: SMALL PROGRESS BY 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. 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.

However, IOTC has adopted relatively few management measures (binding-resolutions) in comparison to other tuna RFMOs to ensure the aforementioned management objective is achieved. We briefly summarize the most relevant conservation and management measures adopted by IOTC to manage target species. There are no quota conservation measures established by the IOTC for any of the main target tuna species or swordfish. There is a capacity limitation scheme for countries fishing in the IOTC area and temporary time-area closure for purse seiners and longliners were used until 2014. A resolution in 2014 calls for members to implement a quota allocation systems based on the recommendations from the Scientific Committee, however, it was not specified how this will be done.

In conclusion, harvest control rules have not been adopted for any target species, but for some species are under discussion by the Commission. Relative few management measures have been adopted (mostly focused to regulate fishing effort) to ensure management objectives are achieved. We therefore assigned the category of progress – Small progress by the Commission.

IATTC

(i) Objectives:

Category of progress assigned: MODERATE PROGRESS BY THE COMMISSION

The 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 calls to be precautionary when information is uncertain by applying the precautionary approach and Article VII calls the 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". Therefore, the IATTC Convention has explicitly defined a general-specific operational objective that applies to fish stocks covered by the Convention and especially to the harvested stocks, yet species-specific operational objectives have not been developed. We therefore assigned the category of progress – Moderate progress by the Commission.

(ii) Indicators:

Category of progress 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 harvested 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 thresholds are available and monitored regularly for these assessed stocks. These stock status indicators and associated thresholds are also explicitly associated to the aforementioned objective of maintaining populations at maximum sustainable yields. We therefore assigned the category of progress – Full progress by the Commission.

(iii) Thresholds:

Category of progress assigned: MODERATE PROGRESS BY COMMISSION

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 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 for the rest of the target species, 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. We therefore assigned the category of progress – Moderate progress by the Commission.

(iv) Responses and management measures:

Category of progress assigned: MODERATE PROGRESS BY 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 Fmsy if fishing mortality for bigeye or yellowfin tunas exceeds their respective Fmsy (Maunder et al. 2015). However, the management response is not automatically adopted, as it still needs to be discussed by the Commission in order to agree and adopt the measures to be implemented for the reduction. This adopted interim harvest control rule, although it is a step towards more precautionary and sustainable management, it does not take uncertainty into account, nor the probability of exciding the adopted limit reference points, lacks specific timeline for reductions and rebuilding timeframes to target Fmsy, and lacks automatic management responses to implement the reduction. In 2015, the IATTC Scientific Committee developed and recommended more complete harvest control rules, but have not been adopted by the Commission.

Furthermore, several management measures (binding resolutions) have been adopted by IATTC to ensure that the management objective of maintaining target species at levels that permit maximum sustainable yields is achieved. We briefly summarize the most relevant conservation and management measures adopted by IATTC

to manage target stocks. Management measures include time-area closures for purse seiners catching bigeye, yellowfin and skipjack tunas and catch limits for bigeye for some fishing gears. There is also in place a capacity limitation program for large purse seine fisheries and close regional vessel registry.

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 category of progress – Moderate progress by the Commission.

3.2.2. Review of elements in Ecological Component 2: bycatch species.

ICCAT

(i) Objectives:

Category of progress assigned: SMALL PROGRESS BY THE COMMISSION

The ICCAT Convention mandate does not make explicit provisions concerning the impact of target 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) to mitigate the effects of fishing on bycatch species including sharks, seabirds and turtles (see section Responses and Management Measures), but these measures do not state clear operational objectives to reduce the impacts of fishing on these groups of 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 calls for monitoring and improve information on interactions of 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 fisheries on by-catch species (ICCAT 2005). These type of initiatives by the Scientific Committee are seen as a positive step towards defining conceptual and operational objectives to reduce the impact of fisheries and ecosystems. In conclusion, ICCAT has not formally adopted a set of operational objectives to account for the impacts of fisheries on bycatch species, but at least conceptual objectives have been stated in the recently adopted SCRS Science Research Plan and have also been vaguely stated in several adopted management measures. We therefore assigned the category of progress – small progress by the Commission.

(ii) Indicators:

Billfishes - Category of progress 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. Historically, the assessments of billfishes were initiated by the Scientific Committee, but now these assessments and derived management advice are routinely requested by and presented to the Commission. We therefore assigned the category of progress – Moderate progress by the Commission.

Sharks - Category of progress assigned: MODERATE PROGRESS BY THE COMMISSION

A level 2 Ecological Risk Assessment (ERA) was conducted by the Scientific Committee for 16 sharks species (20 stocks) in 2012. This ERA consisted in a productivity-susceptibility risk assessment of 20 stocks of sharks to ICCAT longline fisheries. The ERA provided a stock- level index of vulnerability to longline fisheries, which allowed the identification of those species most vulnerable (ICCAT 2013). The ERA was used to prioritize research and management measures. In addition to the ERA, a small group of shark species (two stocks of blue shark, two stocks of shortfin mako, and three stocks of porbeagle) has been assessed with traditional fishery stock assessments. Thus, indicators of stock status, including indicators of population size and fishing mortality over time, have been developed to monitor the exploitation 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). Similar to billfishes, the shark evaluations were initiated by the Scientific

Committee, but now shark assessments and derived management advice are routinely requested and presented the Commission. We therefore assigned the category of progress – Moderate progress by the Commission.

Seabirds - Category of progress assigned: SMALL 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 has conducted a seabird assessment, which included (1) the identification of seabird species most at risk from fishing with an ERA 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 ERA (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 ERA 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 ERA (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 ERA level 3 assessments. In conclusion, the seabird assessment conducted by the Scientific Committee as requested by the Commission has provided a series of preliminary indicators which quantify for the first time the impacts of ICCAT longline fisheries on seabird populations. Yet, these 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 and their derived indicators have not been adopted by the Commission to routinely evaluate the status of seabird species most at risk or evaluate the efficacy of current adopted mitigation measures. Therefore, we assigned the category of progress – Small progress by the Commission.

Sea turtles - Category of progress assigned: SMALL PROGRESS 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. Members do not follow the guidance on data reporting formats, and data is insufficient to calculate species-specific gear interactions, mortality rates, or indicators of stock status. The Scientific Committee has not been able to conduct a region wide ERA-productivity-susceptibility analysis for sea turtles to assess the impact of longline and purse seine fisheries on turtle populations. Efforts are being hindered by insufficient data quality and quantity. Not all members are submitting the required data and those submitted the data do not report on mortalities associated with the reported interactions. However, in the year 2010, the Scientific Committee conducted a taxonomic-wide ERA, comprising target tuna species as well as bycatch species, which included four species of sea turtles (Arrizabalaga et al. 2011). This ERA consisted in 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 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, indicators of stock status for sea turtles impacted by ICCAT fisheries have not been developed by the Scientific Committee or adopted by the Commission for sea turtles. The attempt to conduct a region-wide level 2 ERA for sea turtles has been slow and hindered by insufficient data quality and quantity. Therefore, we assigned the category of progress – Small progress or no progress only by the scientific committee.

Marine mammals - Category of progress assigned: SMALL PROGRESS OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Indicators of stock status have not been developed by the Scientific Committee for marine mammals impacted by ICCAT fisheries, nor have been requested by the Commission. Members do not follow the guidance on data reporting formats, and data is insufficient to calculate species-specific gear interactions, mortality rates, or indicators of fishery impacts and insufficient to apply mitigation techniques to reduce incidental mortalities. Even the most basic information on marine mammal distributions and how it overlaps with fishing effort is lacking. However, 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 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, ICCAT is unable to assess the risk of marine mammal bycatch and develop indicators of fishery impacts, constraining its ability to develop any needed mitigation measures. Therefore, we assigned the category of progress – No progress or small progress only by the scientific committee.

Other finfishes - Category of progress assigned: *SMALL PROGRESS OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE*

Assessments and indicators of stock status have not been developed by the Scientific Committee for finfish other than tunas and billfishes impacted by ICCAT fisheries due to the lack of data being submitted by CPCs, nor have been requested by the Commission. Members do not follow the guidance on data reporting formats, and data is insufficient to calculate species-specific gear interactions, total mortality rates, or indicators of stock status. Pertaining to other finfish species, the ICCAT Scientific Committee has focused its efforts on assessing their relative risk to longline and purse seine fisheries in comparison to other taxonomic groups. One taxonomic-wide level 1 and 2 ERA has been conducted to assess the relative risk of both target and bycatch species including 16 species of finfish being impacted by ICCAT fisheries (Arrizabalaga et al. 2011). These finfishes were included in the level 2 semi-quantitative productivity-susceptibility risk analyses for the EU purse-seine fishery and US pelagic longline fishery. Another level 2 ERA – 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). Furthermore, the commission adopted in 2012 a ICCAT Small Tunas Research Programme which main objective was the recovery of historical fisheries and biological data in the main fishing areas and longterm goal of carrying assessment of stock status and provide management advice. Therefore, we assigned the category of progress – No progress or small progress only by the scientific committee.

(iii) Thresholds:

Billfishes - Category of progress assigned: SMALL PROGRESS BY THE COMMISSION

Limit reference points associated with the biomass and fishing mortality rate indicators have not been adopted for any of the assessed billfish stocks. Bmsy and F_{MSY} (or proxies such as B_{01} and F_{01}) have been the unofficial target reference points used in ICCAT for assessed billfishes. We therefore assigned the category of progress – Small progress by the Commission.

Sharks - Category of progress assigned: SMALL PROGRESS BY THE COMMISSION

Limit reference points associated with the biomass and fishing mortality rate indicators have not been adopted for any of the assessed shark stocks. Bmsy and F_{MSY} (or proxies such as B_{01} and F_{01}) have been the unofficial target reference points used in ICCAT for assessed sharks. We therefore assigned the category of progress – Small progress by the Commission.

Seabirds - Category of progress assigned: SMALL OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

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

Sea turtles - Category of progress assigned: SMALL OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

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

Marine mammals - Category of progress assigned: SMALL OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

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

Other finfishes - Category of progress assigned: SMALL OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

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

(iv) Responses and management measures:

ICCAT has adopted an extensive list of conservation and management measures (binding recommendation or non-binding resolution) 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. The adopted measures have the main purpose to minimize the effects of fishing on by-catch species and to establish requirements for data reporting and conduct specific type of research. Overall, we find no management measure has been adopted to set a management response linked to pre-established operational objectives, indicators and thresholds for any of the bycatch species impacted by ICCAT fisheries. We therefore assigned the category of progress "Small progress by Commision" to the taxonomic group of sharks, seabirds and sea turtles. We made an exception with billfishes, and assigned the category "Moderate progress by 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 Bmsy 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 category of progress "Small or no progress only by the Scientific Committee".

Measures related to the conservation and management of bycatch species	**Type of Measure**
Billfishes – Category of progress assigned: Moderate progress - by the Commission	
Recommendation 12-04 – Recalls a rebuilding plan is in place and sets catch limits for blue marlin and white marlin/spearfish for 2013, 2014, and 2015 by country.	-Binding -Sets catch limits
Sharks - Category of progress assigned: Small 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 sharks	-Binding -Data submission to 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 imporve 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 - In order to minimize the ecological impact of FADs, in particular the entanglement of sharks, turtles and other non-targeted species, CPCs shall replace by 2016 existing FADs with non-entangling FADs in line with the guidelines under Annex 6 of this Recommendation. CPCs shall report to ICCAT Secretariat on an annual basis on the steps undertaken to comply with this provision.	-Binding -Minimize bycatch -Data collection
Seabirds – Category of progress assigned: Small 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 – Category of progress assigned: Small 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 survival.	-Binding -Minimize bycatch -Data collection -Assess impact
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 - In order to minimize the ecological impact of FADs, in particular the entanglement of sharks, turtles and other non-targeted species, CPCs shall replace by 2016 existing FADs with non-entangling FADs in line with the guidelines under Annex 6 of this Recommendation. 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 – Category of progress assigned: Small or no progress - only by the Scientific Committee	
No measures	
Other finfishes – Category of progress assigned: Small or no progress - only by the Scientific Committee	
No measures	

WCPFC

(i) Conceptual and operational objectives:

Category of progress assigned: MODERATE PROGRESS BY COMMISSION

The WCPFC Convention has several Articles requiring the minimization of the impacts of fisheries on bycatch species. These include Article 6.1 (c) which tasks the members of the Commission to "develop data collection and research programmes 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 10.1(c) 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). Although the WCPFC Convention formally recognizes to account for the impact of fisheries on bycatch and sensitive species when taking management decisions, and aims to maintain populations above levels at which their reproduction may become seriously threatened, the WCPFC has not defined clearly or explicitly a set of species-specific or taxonomic-specific operational objectives to minimize impacts of fishing for specific taxonomic groups of bycatch species. We therefore assigned the category of progress – Moderate progress by the Commission.

(ii) Indicators:

Billfishes - Category of progress 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. Historically, the assessments of billfishes were initiated by the Scientific Committee ,but now these assessments and derived management advice are routinely requested and presented to the Commission. We therefore assigned the category of progress – Moderate progress by the Commission.

Sharks - Category of progress assigned: MODERATE PROGRESS BY THE COMMISSION

The WCPFC is the first tuna RFMO to establish a formal 2010-2014 Shark Research Plan (adopted in 2010). By 2014, Shark Research Plan has delivered the evaluation of the exploitation status for three key shark stocks (North Pacific blue shark, WCPO silky shark and oceanic whitetip) using age structure stock assessments. Thus, indicators of stock status, including indicators of population size and fishing mortality over time, have been developed to monitor the exploitation status of these assessed species in order to provide management advice. Additionally, catch estimates from 1992 have been estimated for these key species of sharks (blue, mako, silky, oceanic whitetip, thresher and porbeagle) and several indicators of stock status that integrated catch rate, size, sex, maturity, distribution and species composition have also been estimated for those key shark species using the WCPFC's Regional Observer Programme data (Harley et al. 2013). Similar to billfishes, the shark evaluations were initiated by the Scientific Committee, but now shark assessments and derived management advice are routinely requested and presented the Commission. We therefore assigned the category of progress – Moderate progress by the Commission.

Seabirds - Category of progress assigned: SMALL OR NO PROGRESS ONLY THE BY THE SCIENTIFIC COMMITTEE

Assessments and indicators of stock status for seabirds impacted by WCPFC fisheries have not been developed by the Scientific Committee, nor have been requested by the Commission. Members do not follow the guidance on data reporting formats, and data is insufficient to calculate species-specific gear interactions, mortality rates, or indicators of stock status. The WCPFC Scientific Committee has focused its efforts on identifying areas of vulnerability to industrial longline fisheries for seabirds, assessing their relative risk to longline fisheries, and proposing mitigation measures. Several taxonomic-wide level 2 ERA productivity-susceptibility analyses have been conducted for the WCPFC-managed longline and purse seine tuna fisheries which included seabird species in addition to bony fish, sharks, rays, mammals, and turtles (Kirby 2006, Kirby and Hobday 2007). An earlier seabird-focused partial level 2 ERA also assessed the overlap of WCPFC longline fisheries with albatross distributions (Small 2005). Therefore, we assigned the category of progress – Small or no progress only by the Scientific Committee..

Sea turtles - Category of progress assigned: SMALL OR NO PROGRESS ONLY THE BY THE SCIENTIFIC COMMITTEE

Indicators of stock status for sea turtles impacted by WCPFC fisheries have not been developed by the Scientific Committee, nor have been requested by the Commission. Members do not follow the guidance on data reporting formats, and data is insufficient to calculate species-specific gear interactions, mortality rates, or indicators of stock status. The WCPFC Scientific Committee has focused its efforts on assessing their relative risk to longline fisheries, and proposing mitigation measures. Several taxonomic-wide level 2 ERA productivity-susceptibility analyses have been conducted for the WCPFC-managed 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). 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. Therefore, we assigned the category of progress – Small or no progress only by the Scientific Committee.

Marine mammals - Category of progress assigned: SMALL OR NO PROGRESS ONLY THE BY THE SCIENTIFIC COMMITTEE

Indicators of fishery impacts for marine mammals affected by WCPFC fisheries have not been developed by the Scientific Committee, nor have been requested by the Commission. Members do not follow the guidance on data reporting formats, and data is insufficient to calculate species-specific gear interactions, mortality rates, or indicators of stock status and insufficient to apply mitigation techniques to reduce incidental mortalities. Even the most basic information on marine mammal distributions and how it overlaps with fishing effort is lacking. 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. Therefore, we assigned the category of progress – small or no progress only by the Scientific Committee.

Other finfishes - Category of progress assigned: SMALL OR NO PROGRESS ONLY THE BY THE SCIENTIFIC COMMITTEE

Indicators of stock status for finfish other than tunas and billfishes impacted by WCPFC fisheries have not been developed by the Scientific Committee, nor have been requested by the Commission. Members do not follow the guidance on data reporting formats, and data is insufficient to calculate species-specific gear interactions, mortality rates, or indicators of stock status. Pertaining to other finfish species, the WCPFC Scientific Committee has focused its efforts on assessing their relative risk to longline fisheries in comparison to other taxonomic groups. Several taxonomic-wide level 2 ERA productivity-susceptibility analyses have been conducted for the WCPFC-managed 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). Therefore, we assigned the category of progress – Small or no progress only by the Scientific Committee.

(iii) Thresholds:

Billfishes- Category of progress assigned: SMALL PROGRESS BY THE COMMISSION

Limit reference points associated with the biomass and fishing mortality rate indicators have not been adopted for any of the assessed billfish stocks. Bmsy and F_{MSY} (or proxies such as B_{01} and F_{01}) have been the unofficial target reference points used in WCPFC for assessed billfishes. We therefore assigned the category of progress – Small progress by the Commission.

Sharks - Category of progress assigned: SMALL PROGRESS BY THE COMMISSION

Limit reference points associated with the biomass and fishing mortality rate indicators have not been adopted for any of the assessed shark stocks. Bmsy and F_{MSY} (or proxies such as B_{01} and F_{01}) have been the unofficial target reference points used in WCPFC for assessed sharks. Moreover, the Scientific Committee is also working to specify the values for limit reference points for key shark species to ensure consistency with article 10.1 (c) of the convention. In 2014 the Scientific Committee recommended to the Commission to support a tiered species-specific approach (based on availability of information) to develop management thresholds for sharks similar to that adopted for target species to ensure consistency with article 10.1 (c) of the Convention. In 2014, the Commission 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 2014). We therefore assigned the category of progress – Small progress by the Commission.

Seabirds - Category of progress assigned: SMALL OR NO PROGRESS ONLY THE BY THE SCIENTIFIC COMMITTEE

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

Sea turtles - Category of progress assigned: SMALL OR NO PROGRESS ONLY THE BY THE SCIENTIFIC COMMITTEE

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

Marine mammals- Category of progress assigned: SMALL OR NO PROGRESS ONLY THE BY THE SCIENTIFIC COMMITTEE

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

Other finfishes - Category of progress assigned: SMALL OR NO PROGRESS ONLY THE BY THE SCIENTIFIC COMMITTEE

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

(iv) Responses and management measures:

The WCPFC has adopted an extensive list of conservation and management measures (non-binding resolutions and binding-Conservation and Management measures) 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. The adopted measures have the main purpose to minimize the effects of fishing on by-catch species and to establish requirements for data reporting and conduct specific type of research. Overall, we find no management measure has been adopted to set a management response linked to pre-established operational objectives, indicators and thresholds for any of the bycatch species impacted by WCPFC fisheries. We therefore assigned the category of progress "Small progress by Commission" to the taxonomic group of sharks, seabirds, sea turtles and marine mammals. We made an exception with billfishes, and assigned the category "Moderate progress by Commission", since 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. 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 category of progress "Small or no progress only by the Scientific Committee".

Measures	**Type of Measure**
Billfishes – Category of progress assigned: Moderate 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 - Category of progress assigned: Small 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 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	-Binding

requires reporting of interactions.	-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 - Category of progress assigned: Small 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 - Category of progress assigned: Small 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 - Category of progress assigned: Small progress – by the Commission	
CMM 2011/03 -prohibits purse seiners sets around cetaceans and requires reporting of interactions	-Binding -Minimize bycatch
Other finfish - Category of progress assigned: Small 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

IOTC

(v) Operational objectives:

Category of progress assigned: SMALL PROGRESS BY COMMISSION

The IOTC Convention mandate does not make explicit provisions concerning the impact of target 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) to mitigate the effects of fishing on bycatch species including sharks, seabirds, marine mammals and turtles (see section Responses and Management Measures). 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 also 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. In 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 2014a). In conclusion, IOTC has not formally adopted in the Convention Agreement a set of operational objectives to account for the impacts of fisheries on bycatch species, but 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 category of progress – Small progress by the Commission.

(vi) Indicators:

Billfishes - Category of progress 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 are being monitored for these assessed species to provide management advice. Historically, the assessments of billfishes were initiated by the Scientific Committee, but now these assessments and derived management advice are routinely requested and presented to the Commission. We therefore assigned the category of progress – Moderate progress by the Commission.

Sharks - Category of progress assigned: SMALL PROGRESS BY THE COMMISSION

Formal fisheries stock assessments have not been conducted for any shark species impacted by IOTC fisheries. Therefore, indicators of stock status, including indicators of population size and fishing mortality over time, have not been developed yet to determine the exploitation status of sharks species and set limits in order to provide management advice. However, the Scientific Committee is currently 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 consist in evaluating the temporal patterns of several standardized CPUE from several longline fleets for these three species of sharks which is work in progress, which is a 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 WPEB, 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. Moreover, in 2012 the Scientific Committee conducted a preliminary Ecological Risk Assessments 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 ERA 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. Historically, the Scientific Committee initiated the assessments of sharks, but now these routine assessments are requested and presented to the Commission. We therefore assigned the category of progress – Small progress by the Commission.

Seabirds - Category of progress assigned: SMALL OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Assessments and indicators of stock status for seabirds impacted by IOTC fisheries have not been developed by the Scientific Committee due to the lack of data being submitted by CPCs, nor have been requested by the Commission (IOTC 2014b). Members do not follow the guidance on data reporting formats, and data is insufficient to calculate species-specific gear interactions, mortality rates, or indicators of stock status. 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 ERA, and proposing effective bycatch mitigation measures (IOTC 2014b). Although longline interaction with seabirds is the most relevant source of incidental mortalities, seabirds are also known to be taken by gillnet fisheries. In the Indian Ocean, coastal gillnet may be also be a relevant source of incidental mortalities on sea bird populations, yet information is lacking to evaluate the extent of the impacts of these fisheries on seabirds. 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). In this risk assessment, forty seabird populations were identified as high priority. The ERA 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 ERA 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 ERA have not been undertaken yet. Therefore, we assigned the category of progress – Small or no progress only by the Scientific Committee.

Sea turtles - Category of progress assigned: SMALL OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Assessment and indicators of stock status for sea turtles impacted by IOTC fisheries have not been developed by the Scientific Committee due to the lack of data being submitted by CPCs, nor have been requested by the Commission (IOTC 2014b). Members do not follow the guidance on data reporting formats, and data is insufficient to calculate species-specific gear interactions, total bycatch mortality rates, or indicators of stock status. 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 measures (IOTC-SC17 2014). A level 2 Ecological Risk Assessment – productivity-susceptibility analysis, 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). The ERA indicated gillnets posed a greater threat to sea turtles, followed by longliners and to lesser extent by purse seiner. Therefore, we assigned the category of progress – small or no progress only by the Scientific Committee.

Marine mammals - Category of progress assigned: SMALL OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Assessments and indicators of fishery impacts for marine mammals impacted by IOTC fisheries have not been developed by the Scientific Committee due to the lack of data being submitted by CPCs, nor have been requested

by the Commission . Members do not follow the guidance on data reporting formats, and data is insufficient to calculate species-specific gear interactions, total bycatch mortality rates, or indicators of stock status and insufficient to apply 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 PS. The Scientific Committee has noted that gillnets are a major impacts on marine mammals, which needs to be addressed to understand the ecosystem effects of these fleets. Currently marine mammals are a lower priority than sharks, seabirds and turtles for the Scientific Committee. 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. The IOTC programme seems to have focused on depredation rates from marine mammals, and less regarding interactions, hooking or entanglement of marine mammals with longline gears. IOTC endorsed a five year research program one marine mammal depredation on tuna caught with longline gear in 1999. Yet no management measures have been adopted to minimize these interactions. Currently, IOTC is unable to assess the risk of marine mammal bycatch and develop indicators of impacts, constraining its ability to develop any needed conservation measure. Therefore, we assigned the category of progress – small or no progress only by the Scientific Committee.

Other finfishes - Category of progress 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 that have become as important or more important as the three tropical principal market tuna species to most IOTC coastal states. The six species of neritic tunas and mackerel include bullet tuna, frigate tuna, kawakawa, longtail tuna, Indo-Pacific king mackerel and narrow-barred Spanish mackerel. Quantitative assessments have been conducted 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.

Furthermore, 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 ERA – 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 productivity-susceptibility analysis 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 few (four species) neritic tunas and mackerels, and although preliminary and uncertain at this stage, the Scientific Committee is working to improve the current assessments and expand these assessments to more neritic tunas and mackerels species. Therefore, we assigned the category of progress – Moderate progress by the Commission.

(vii) Thresholds:

Billfishes - Category of progress assigned: SMALL PROGRESS BY THE COMMISSION

Limit reference points associated with the biomass and fishing mortality rate indicators have not been adopted for any of the billfish stocks. Bmsy and F_{MSY} (or proxies such as B_{01} and F_{01}) have been the unofficial target reference points used in IOTC for assessed billfishes. We therefore assigned the category of progress – Small progress by the Commission.

Sharks - Category of progress assigned: SMALL OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

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

Seabirds - Category of progress assigned: SMALL OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

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

Sea turtles - Category of progress assigned: SMALL OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

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

Marine mammals - Category of progress assigned: SMALL OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

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

Other finfishes - Category of progress assigned: SMALL PROGRESS BY THE COMMISSION

Limit reference points associated with the biomass and fishing mortality rate indicators have not been adopted for any of the finfish stocks. Bmsy and F_{MSY} (or proxies such as B_{01} and F_{01}) 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 category of progress – Small progress by the Commission.

(viii) Responses and management 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. The adopted measures have the main purpose to minimize the effects of fishing on by-catch species and to establish requirements for data reporting and conduct specific type of research. Overall, we find no management measure has been adopted to set a management response linked to pre-established operational objectives, indicators and thresholds for any of the bycatch species impacted by ICCAT fisheries. We therefore assigned the category of progress "Small progress by the Commision" to the taxonomic group of sharks, seabirds, sea turtles and marine mammals. We made an exception with billfishes, and assigned the category "Moderate progress by Commission", since 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. 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 category of progress "Small or no progress only by the Scientific Committee".

Measures	**Type of Measure**
Billfishes – Category of progress assigned: Moderate 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	-Binding -Minimize bycatch

average catches for the period between 2009-2014.	
Sharks - Category of progress assigned: Small 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 - Category of progress assigned: Small 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 - Category of progress assigned: Small 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 - Category of progress assigned: Small progress – by the Commission	
Res 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 - Category of progress assigned: Small 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

IATTC

(i) Operational objectives

Category of progress assigned: MODERATE PROGRESS BY THE COMMISSION

The IATTC Convention mandate or Antigua Convention, has explicit provisions concerning the reduction and minimization of impacts on bycatch species (both fish and non-fish species), calling for adoption of 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 (IATTC 2003). The Antigua Convention also makes reference to the implementation of the precautionary approach. Moreover, 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, while a conceptual objective aiming to

reduce the impact of IATTC fisheries on bycatch has been clearly articulated, species-specific or taxonomic-specific objectives have not been clearly defined yet, with the exception on dolphins. We therefore assigned the category of progress – Moderate progress by the Commission.

(ii) Indicators:

Billfishes - Category of progress 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 created including trends in catches, effort and catch per unit of effort (CPUEs) (IATTC 2015b). Historically, the Scientific Committee initiated the assessments of billfishes, but now these routine assessments are requested and deliberated by the Commission. We therefore assigned the category of progress – Moderate progress by the Commission.

Sharks - Category of progress assigned: SMALL PROGRESS BY THE COMMISSION

Formal fisheries stock assessments have only been conducted for two sharks species, including blue shark and silky shark, to assess the impact of bycatch on the status of these species (IATTC 2015b). 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. However, the assessment of silky shark was considered unreliable due to major uncertainties in the fisheries data. Alternatively, a set of possible stock status indicators (or stability) indicators have been calculated using fisheries data collected by all purse-seine type fisheries to indirectly assess status, but cannot be used to determine status or set catch limits (IATTC 2014). These 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 2014). However, purse seiners are not the most relevant fisheries, since silky sharks are mostly taken by LL fisheries. Status indicators (or stability) indicators are incomplete for the rest of fisheries, including longline, small purse-seiner and pole and line fisheries. Moreover, an ERA (level 2 semi-quantitative assessment) productivity-susceptibility analysis for the three purse seine fisheries, conducted in 2015, focusing on 32 species of target and bycatch species including tunas, billfishes, dolphins, other finfishes, rays, shark and turtles, included 12 species of sharks and rays, thus providing an indicators of vulnerability of species to purse-seine fisheries. An ERA has not been conducted for other fisheries including longline, pole and line, etc…(IATTC 2015b). The Commission has requested to conduct species-specific ERA for silky shark and hammerheads. Historically, the Scientific Committee initiated the assessments of sharks, but now these routine assessments are requested and deliberated by the Commission. We therefore assigned the category of progress – Small progress by the Commission.

Seabirds - Category of progress assigned: SMALL OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Indicators of population status for seabirds impacted by IATTC fisheries have not been requested by the Commission or prepared by the IATTC . The IATTC Scientific Committee has focused its efforts on identifying areas of vulnerability to industrial longline fisheries for several species of albatross and has proposed mitigation measures (IATTC 2015b). In addition, one ERA for seabirds has been conducted in the IATTC convention area. In 2005, a performance review of RFMOs in fulfilling their obligations to reduce bycatch of seabirds included a partial level 2 ERA, by assessing the overlap of RFMOs areas with albatross distribution, and determined that the IATTC area overlaps with albatrosses distribution, indicating there are susceptible to IATTC longline fisheries (Small 2005). The level 2 semi-quantitative ERA productivity-susceptibility analysis conducted by IATTC in 2015, which includes 32 species of target and bycatch species caught in the three purse seine fisheries, did not include seabirds. Seabirds are susceptible to being caught in longline fisheries, yet a more complete ERA for the longline fisheries has not been conducted in the IATTC convention area. We therefore assigned the category of progress – Small or no progress only by the Scientific Committee.

Sea turtles - Category of progress assigned: SMALL OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Indicators of population status for sea turtles impacted by IATTC fisheries have not been requested by the Commission or prepared by the IATTC Scientific Committee. The IATTC Scientific Committee has focused its

efforts on developing and implementing mitigation programs to reduce sea turtle bycatch (IATTC 2015b). The Purse Seine Observing Programm has recorded turtle incidental mortalities since 1990, yet purse seiners only occasionally catch sea turtles. The level 2 semi-quantitative ERA productivity-susceptibility analysis conducted by IATTC in 2015, which includes 32 species of target and bycatch species caught in the three purse seine fisheries, only included one species of turtle. Sea turtles are more susceptible to being caught in longline and gillnet fisheries, yet information on these incidental mortalities are scarce and sporadic in time and space due to the lack of an IATTC longline observer programme and the requirement for members to implement longline observer coverage of 5% only (IATTC 2015b). A region wide ERA for the longline and gillnet fisheries has not been conducted in the IATTC convention area. We therefore assigned the category of progress – Small or no progress by the Scientific Committee.

Marine mammals - Category of progress assigned: MODERATE 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. Therefore, 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 almost 20 years. Incidental mortality rates for dolphins in the large purse fisheries have been estimated since the 1970s. As there is not similar program for other marine mammals for which to establish indicator of fishery impacts, we assigned the category of progress – Moderate progress by the Commission.

Other finfishes - Category of progress assigned: SMALL OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Indicators of population status for finfishes other than tunas and billfishes impacted by IATTC fisheries have not been requested by the Commission or prepared by the IATTC Scientific Committee. The Purse Seine Observing Programme has recorded finfish incidental catch since 1990. The level 2 semi-quantitative ERA 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 recommend appropriate management and conservation measures. We therefore assigned the category of progress – Small or no progress only by the Scientific Committee.

(iii) Thresholds:

Billfishes - Category of progress assigned: SMALL PROGRESS BY THE COMMISSION

Limit reference points associated with the biomass and fishing mortality rate indicators have not been adopted for any of the assessed billfish stocks. Bmsy and F_{MSY} (or proxies such as B_{01} and F_{01}) have been the unofficial target reference points used in IATTC for assessed billfishes. We therefore assigned the category of progress – Small progress by the Commission.

Sharks - Category of progress assigned: SMALL PROGRESS BY THE COMMISSION

Limit reference points associated with the biomass and fishing mortality rate indicators have not been adopted for any of the assessed shark stocks. Bmsy and F_{MSY} (or proxies such as B_{01} and F_{01}) have been the unofficial target reference points used in IATTC for assessed sharks. We therefore assigned the category of progress – Small progress by the Commission.

Seabirds - Category of progress assigned: SMALL OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

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

Sea turtles - Category of progress assigned: SMALL OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

No thresholds have been associated to indicators of stock status or bycatch rate estimates. Limit and target reference points have not been defined or adopted for any of the species, or are under development or are being

discussed. We therefore assigned the category of progress – Small or no progress only by the Scientific Committee.

Marine mammals - Category of progress 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 Commission. Thresholds have not been adopted for other marine mammals. We therefore assigned the category of progress – Moderate progress by the Commission.

Other finfishes - Category of progress assigned: SMALL OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

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

(iv) Responses and management measures:

IATTC has adopted an extensive list of conservation and management measures (binding resolution 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. The adopted measures have the main purpose to minimize the effects of fishing on by-catch species and to establish requirements for data reporting and conduct specific type of research. Overall, we find no management measure has been adopted to set a management response linked to a pre-established management objectives, indicators and thresholds for any of the bycatch species impacted by IATTC fisheries. We therefore assigned the category of progress "Small progress by Commision" 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. 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. Thus, IATTC is focused on reducing dolphin mortalities in purse seine fisheries, while measures have not been adopted to 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. 2014b). We therefore assigned the category of progress – Moderate progress by the Commission.

Measures	**Type of Measure**
Billfishes – Category of progress assigned: Small progress – by 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 - Category of progress assigned: Small progress – by 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	-Binding

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.	-To minimize bycatch
Seabirds - Category of progress assigned: Small Progress – by 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 - Category of progress assigned: Small progress – by 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 on sea turtles, and includes requirements for data collection, mitigation measures, industry education, capacity building and reporting.	-Binding -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 - Category of progress assigned: Moderate progress – by 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 - Category of progress assigned: Small progress – by Commission	
Resolution 04-05 - requires the release of non-target species caught in purse seine fisheries.	-Binding -To minimize bycatch

3.2.3. Review of elements in Ecological Component 3: Ecosystem properties and trophic relationships.

ICCAT

(i) Operational objectives:

Category of progress assigned: MODERATE PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

The ICCAT Convention Agreement does not contain any specific provisions concerning the impact of fisheries on trophic interactions and interdependencies involving relevant species or components of ecosystems, and concerning the impacts of fisheries on the structure and functioning of marine food webs and ecosystem health (ICCAT 2007). However, the recently adopted 2015-2020 SCRS Science Research Plan contains as a strategic objective to advance ecosystem-based fisheries management advice by developing ecosystem status reports with relevant ecosystem indicators, and developing management advice that incorporates and considers these critical indicators (ICCAT 2015b). Moreover, the Terms of Reference for the Sub-committee on Ecosystems 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. Yet, it does not make any reference to investigate the relevance of trophic interactions involving bycatch species or dependent species belonging to the same ecosystem. The Terms of Reference also call for modeling mixed fisheries, multispecies, bycatch and ecosystem issues, in order to develop mechanisms to better integrate ecosystem considerations into management advice.

In conclusion, ICCAT has not formally adopted conceptual or operational objectives to account for the impacts of fisheries on trophic interactions and interdependencies of relevant species and groups and maintain the structure and functioning of marine food webs and ecosystems. The Convention mandate or the Terms of Reference of the Sub-committee on Ecosystems do not define or makes reference to trophic interactions of relevant ecosystem components and species. Nevertheless its recent adopted SCRS Science Research Plan establishes the objective to advance ecosystem science to be able to include ecosystem considerations into management advices with the support of ecosystem indicators, we therefore assigned the category of progress – Moderate progress only by the Scientific Committee.

(ii) Indicators:

Category of progress assigned: SMALL OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Ecosystem or food web models with interactions of relevant species and components of ecosystems and ecosystem indicators have not been requested by Commission or have been developed 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. 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 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. 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). We therefore assigned the category of progress – Small or no progress only by the Scientific Committee.

(iii) Thresholds:

Category of progress assigned: SMALL OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Ecosystem and/or multispecies management plans (including harvest strategies) with pre-defined thresholds have not been developed or are being discussed. We therefore assigned the category of progress – Small or no progress only by the Scientific Committee.

(iv) Responses and management measures:

Category of progress assigned: SMALL 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. Conceptual ecosystem models or multispecies management plans are not available and are not used in decision-making and incorporated 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 category of progress – Small or no progress only by the Scientific Committee.

WCPFC

(i) Operational objectives:

Category of progress 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 protect biodiversity in the marine environment (Article 5f). Therefore the Convention captures the broader impacts of fishing on species dependent on tuna species and biodiversity and promotes ecosystem based approaches to management, but it does not explicitly sets an operational objective to minimize the impacts of fishing on trophic interactions and the structure and functioning of marine food webs (Review Team 2012). Furthermore, 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 2009). We therefore assigned the category of progress – Moderate progress by the Commission.

(ii) Indicators:

Category of progress assigned: SMALL PROGRESS BY COMMISSION

The WCPFC Scientific Committee has focused its effort 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, as requested by the Commission.

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).

In conclusions, several ecosystem and food web models (e.g. SEAPODYM, Ecopath with Ecosim) with interactions of relevant species and potential ecosystem indicators of the WCPO have been developed and discussed by the WCPFC Scientific Committee, but have not been adopted nor considered by Commission. Moreover, ecosystem models and ecosystem indicators are not developed and monitored annually, nor have been linked to pre-established objectives or are used to assist management decisions. We therefore assigned the category of progress – Small progress by the Commission.

(iii) Thresholds:

Category of progress assigned: SMALL OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Ecosystem and/or multispecies management plans (including harvest strategies) with pre-defined thresholds have not been developed or are being discussed. We therefore assigned the category of progress – Small or no progress only by the Scientific Committee.

(iv) Responses and management measures:

Category of progress assigned: SMALL 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. Conceptual ecosystem models or multispecies management plans are not available and are not used in decision-making and incorporated 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 category of progress – Small or no progress only by the scientific committee.

IOTC

(v) Operational objectives:

Category of progress assigned: SMALL OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

The IOTC Convention Agreement does not contain any specific provisions concerning the impact of fisheries on ecosystems to ensure the maintenance of trophic interactions and interdependencies involving relevant species or components of ecosystems, and concerning the impacts of fisheries on the structure and functioning of marine food webs and ecosystem health (IOTC 2009). Although, 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, the Working Party has not defined or stated clear objectives and has not described the main research activities to ensure those tasks are accomplished. Furthermore, the program of work (2015-2019) for the Working Party on Ecosystems and Bycatch does not include any research task to progress on the understanding of the impact of fisheries on trophic interactions involving relevant components of ecosystems or ecosystem properties and structure (IOTC 2014a). In conclusion, IOTC has not formally adopted conceptual or operational objectives to account for the impacts of fisheries on trophic interactions interdependencies of relevant components of ecosystems and maintain the structure and functioning of marine food webs, and 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 category of progress – Small or no progress only by the Scientific Committee.

(vi) Indicators:

Category of progress assigned: SMALL OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Ecosystem or food web models with interactions of relevant species and components of ecosystems and ecosystem indicators have not been requested by Commission or have been developed by IOTC Scientific Committee. Research activities and practices to address the importance of trophic interactions in the development of an ecosystem approach to fishery management have been relatively rare in the IOTC area. Specifically, research activities on species relationships, food web interactions, diet analysis, ecosystem modelling, and development of ecosystem indicators to track ecosystem change or impacts of fishing on ecosystems are very scarce in in the IOTC area (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 or are under discussion. A formal mechanism does not exist to accommodate multispecies and food web interactions and ecosystem modeling into the current management of IOTC target species. We therefore assigned the category of progress – Small or no progress only by the Scientific Committee.

(vii) Thresholds:

Category of progress assigned: SMALL OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

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

(viii) Responses and management measures:

Category of progress assigned: SMALL 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. Conceptual ecosystem models or multispecies management plans are not available and are not used in decision-making and incorporated 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 category of progress – Small or no progress only by the scientific committee.

IATTC

(ix) Operational objectives:

Category of progress assigned: MODERATE PROGRESS BY THE COMMISSION

The IATTC Antigua Convention has several Articles addressing the impacts of fishing on both target stocks and non-target species and associated or dependent species belonging to the same ecosystem (Article VIIa) and calling for the adoption of 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, with a view of maintaining and restoring populations of such species above levels at which their reproduction may become seriously threatened (Article VIIf). Furthermore it 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).

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. Therefore the Convention captures the broader impacts of fishing 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, but it does not explicitly sets clear operational objective to minimize the impacts on trophic and species interactions and the structure and functioning of marine food webs. We therefore assigned the category of progress – moderate progress by the Commission.

(x) Indicators:

Category of progress assigned: SMALL PROGRESS BY THE COMMISSION

The IATTC Science Committee has focused its effort to develop ecosystem indicators to understand the broader community based and ecosystem level consequences of purse seine fisheries, and also 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 other fisheries 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 ecosystem metrics and ecosystem models to understand the broader community based and ecosystem level consequences of fisheries, yet with a central focus on the impacts of purse seine fisheries on the ecosystem. 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). Although developed ecosystem models and ecosystem metrics have not been adopted nor are being considered by the Commission, and. there is little evidence these type of ecosystem considerations are taken into account to assist in management decisions. We therefore assigned the category of progress – Small progress by the Commission.

(xi) Thresholds:

Category of progress assigned: SMALL OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

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

(xii) Responses and management measures:

Category of progress assigned: SMALL 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. Conceptual ecosystem models or multispecies management plans are not available and are not used in decision-making and incorporated 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 category of progress – Small or no progress only by the scientific committee.

3.2.4. Review of elements in Ecological Component 4: Habitats.

ICCAT

(i) Operational objectives:

Category of progress assigned: SMALL PROGRESS BY THE COMMISSION

The ICCAT Convention Agreement does not contain any specific provisions concerning protection of 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. Four 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). 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 bluefin tuna in the Atlantic and Mediterranean 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 task to conduct research and characterize main feeding and reproductive habitat for ICCAT target species.

In conclusion, at least conceptual objectives are 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 category of progress – Small progress by the Commission.

(ii) Indicators:

Category of progress assigned: SMALL PROGRESS BY THE COMMISSION

Habitats of special concern (e.g. reproduction, migration, feeding, hotspots) and/or habitat utilization and preferences for relevant ICCAT species have not been formally investigated and delineated by the Commission or the Scientific Committee, and indicators (associated to pre-established objectives) describing habitat needs and preferences have not been developed, monitored or are being used in management advice. 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 historically relatively scarce in the ICCAT area. However, there are few exceptions or 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. Moreover, ICCAT has developed an international cooperative tagging programme in the Atlantic Ocean and its adjacent seas and is involved in several tagging programmes (e.g. the Atlantic-wide research programme for bluefin tuna -BBYP). These tagging programmes have revealed information 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). These tagging programs are also 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). In addition, there is 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). 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. 2014). Moreover, 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 and 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/or habitat utilization and preferences are under discussion by the Scientific Committee as requested by the Commission for some relevant ICCAT species, and indicators

describing habitat needs are under discussion to provide management advice to the Commission. We therefore assigned the category of progress – Small progress by the Commission.

(iii) Thresholds:

Category of progress assigned: SMALL 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 category of progress – Small or no progress only by the scientific committee.

(iv) Responses and management measures:

Category of progress assigned: SMALL PROGRESS BY THE COMMISSION

The Commission has requested conducting research to identify habitats of special concern for some species of sharks (Recommendations 04-10, 07-06, 09-07, 10-08), tunas (recommendation 08-04, 14-04) and identify the ecological importance of Sargassum for tuna and tuna-like species (Resolutions 05-11, 12-12). 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 not used in decision-making, nor has the Scientific Committee developed formal mechanisms in order to be able to use this type of information in decision-making. Management measures have not been adopted or are being discussed to accommodate knowledge of habitats of special concern and protect them for relevant species. We therefore assigned the category of progress – Small progress by Commission.

WCPFC

(i) Objectives

Category of progress assigned: MODERATE PROGRESS BY THE COMMISSION

The WCPFCs Convention has specific provisions concerning protection of habitats of special concern. Article 6.1 (c) tasks the Members of Commission to "develop data collection and research programmes 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". The Terms of References of the Ecosystem and Bycatch Specialist Working Group also establishes the task of assessing the impacts of fishing on habitats of special concern. Yet the Commission has not formally stated operational objectives for relevant species, nor have formally delineated and identified habitats of special concern for relevant species.

Since conceptual objectives have at least formally been stated in Convention Agreement to recognize the importance of protection of habitats of special concern, we therefore assigned the category of progress – Moderate progress by the Commission.

(ii) Indicators:

Category of progress assigned: MODERATE PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

Despite the WCPFC Convention has specific provisions concerning protection of habitats of special concern, habitats of special concern have not been formally investigated and delineated for relevant species, and indicators (associated to pre-established objectives) describing habitat needs and preferences have not been adopted to be used in setting management recommendations and advice and ensure pre-established objectives are met.

Since its creation, the WCPFC 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. The WCPFC has a strong research programme 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, WCPFC, 2014 #6427). 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 WCPFC species of interest to the Commission. Moreover, the WCPFC also conducts a region-wide Tuna Tagging Programme since 2006. The tagging programme collects critical information for the assessment of target tuna species in the WCPO. The tagging programme 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) Finally, habitat research focused on the habitat utilization and preferences of bycatch species has been scarce.

In conclusion, habitats of special concern have not been mapped or delineated for any species of interest to the commission as specified in the Convention mandate, yet for some species habitat utilization and preferences have been investigated or are under investigation by the Scientific Committee. Indicators describing habitat needs and preferences are at the early states of development and are not routinely monitored and used in management advice. We therefore assigned the category of progress – Moderate Progress only by the Scientific Committee.

(iii) Thresholds:

Category of progress assigned: SMALL 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 category of progress – Small or no progress only by the Scientific Committee.

(iv) Responses and management measures:

Category of progress assigned: SMALL 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 and 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 category of progress – Small or no progress only by the Scientific Committee.

IOTC

(i) Operational objectives:

Category of progress assigned: SMALL OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

The IOTC Convention Agreement does not contain any specific provisions concerning the importance of identifying and protecting habitats of special concern for IOTC species. Habitats of special concern have not been formally defined or delineated in the Convention Agreement. 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. Although the importance of conducting habitat research is acknowledged in the research agenda of the ,Scientific Committee, the Scientific Committee has conducted very limited habitat research and 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. We therefore assigned the category of progress – Small or no progress only by the Scientific Committee.

(ii) Indicators

Category of progress assigned: SMALL 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 relevant IOTC species have not been formally investigated and delineated by the Commission and ,Scientific Committee and indicators (associated to pre-established objectives) describing habitat needs and preferences have not been developed, monitored or being used in management advice. 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. However, 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. 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). Habitat research focused on the habitat utilization and preferences of bycatch species has also been very scarce. In conclusion, habitats of special concern and habitat preferences and utilization have not been mapped or delineated for any species of interest to the Commission, and indicators describing habitat needs and preferences have not been developed, nor are under discussion by the Scientific Committee. We therefore assigned the category of progress – Small or no progress only by the Scientific Committee.

(iii) Thresholds:

Category of progress assigned: SMALL 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 category of progress – Small or no progress only by the Scientific Committee.

(iv) Responses and management measures:

Category of progress assigned: SMALL 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 category of progress – Small or no progress only by the Scientific Committee.

IATTC

(i) Objectives

Category of progress assigned: SMALL OR NO PROGRESS ONLY BY THE SCIENTIFIC COMMITTEE

The IATTC Convention Agreement does not contain any specific provisions concerning the importance of identifying and protecting habitats of special concern (e.g. reproduction, migration, feeding, hotspots) for IATTC species, nor is being stated as a research objective in the research activities conducted or research agenda by the IATTC Scientific Committee. Although the IATTC Scientific Committee has conducted assessments on habitat preferences and utilization of tropical tuna species and the effect of environmental changes. We therefore assigned the category of progress – Small or no progress only by the Scientific Committee.

(ii) Indicators

Category of progress 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

adopted to be used in setting management recommendations and advice. Yet some research activities and practices, particularly to identify habitat preferences and utilization, have been conducted for the main target tropical tuna species in support of the implementation of EBFM. Habitat research focused on the habitat utilization and preferences of bycatch species has been scarce in the EPO.

The IATTC 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 programmes since the early fifties (Schaefer et al. 1961). These tagging programmes 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).

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, 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 and are not are not routinely monitored and used in management advice. We therefore assigned the category of progress – Moderate progress only by the scientific committee.

(iii) Thresholds

Category of progress assigned: SMALL 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 category of progress – Small or no progress only by the Scientific Committee.

(iv) Responses and management measures:

Category of progress assigned: SMALL 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 and 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 category of progress – Small or no progress only by the scientific committee.

4. CONCLUSIONS AND FUTURE WORK

The IATTC and the WCPFC are the only tuna RFMOs which Convention Agreements have provisions including core principles and minimum standards making reference to the application of the PA and EBFM in line with UN Fish Stock Agreement, the FAO Compliance Agreement, and FAO Code of Conduct on Responsible Fisheries (Table 3). However, at the first joint tuna RFMO meeting, all the tuna RFMOs agree in one of their commitments to implement the PA and EBFM (Anonymous 2007), and all tuna RFMOs have taken steps to apply EBFM. Yet the extent of their best practices, and ecosystem-related research activities and products differ markedly and occur under different fundamental research and decision-making institutional structures. The current research and management practices under each of the four main ecological components (target species,

bycatch, trophic relationships and habitats) to make operational and assist in the implementation of EBFM also vary greatly among tuna RFMOs.

All tuna RFMOs have made considerable progress within the ecological component of target species (Table 3). Tuna RFMOs have assessed the exploitation status for all their target species (principal market tunas and swordfish), and stock status indicators are routinely developed and monitored for these assessed species. The WCPFC and IATTC has also made considerable headway defining and testing the consequences of adopting different target and limit reference points for target species and to lesser extent IOTC and ICCAT. Currently, the WCPFC, IATTC and IOTC has adopted limit reference points for their principal tuna stocks, yet harvest control rules for these stocks with clear pre-define objectives and management actions with timelines have not been adopted yet. In contrast ICCAT and IOTC are currently defining and testing limit reference point and harvest control rules for various stocks; north Atlantic albacore and swordfish in ICCAT and skipjack and albacore in IOTC, but have not adopted them yet. The recent establishment of the Management Objective Workshops in the WCPFC, the Working Group to Enhance Dialogue Between Fisheries Scientists and Managers in ICCAT (Recommendation 14/13) and IOTC (Resolution 14/03) are three important initiatives to assist in the progress of developing target and limit reference points and harvest control rules with pre-established objectives and management responses.

All tuna RFMOs have made moderate progress within the ecological component of bycatch (Table 3). The ICCAT and IOTC Conventions do not make explicit provisions concerning the impact of fisheries on non-target species and minimization of impacts, and the IATTC and WCPFC Conventions have explicit provisions requiring the minimization of the impacts of fisheries on bycatch species. Yet none of them has formally adopted species-specific or taxonomic-specific operational objectives to actually measure whether meaningful reductions in the impacts of fishing are actually occurring. In all the tuna RFMOs the status of non-target species is in most cases unknown or relatively poorly known and very few quantitative stock assessments exist for non-target species. ICCAT, WCPFC and IATTC have carried out fishery stock assessments for several sharks stocks and all tuna RFMOs have carried out fishery stock assessment for some billfish stocks. For these assessed species and stocks, indicators of stock status have been developed and are regularly monitored. IATTC also assesses regularly the status of several species of dolphins that are impacted by their tuna purse seine fisheries. For the rest of taxonomic groups of bycatch species, the paucity of basic information on fisheries statistics and on the biology of the non-target species hinders many of the efforts to comprehensively evaluate the impact of fisheries on by-catch species and the development of indicators of stock status. In the three tuna RFMOs, the development of qualitative and quantitative Ecological Risk Assessments for incidentally caught species of sharks, seabirds, sea turtles, marine mammals and other finfishes have been critical to set priorities and take management action following the precautionary approach in the absence of quality stock assessments for bycatch species. Moreover, all tuna RFMOs have adopted management measures to mitigate the effects of fishing on by-catch species including sensitive species. Yet, these management measures have not been generally linked to pre-agreed operational objectives and associated indicators, and are not activated when predefined thresholds are exceeded. The only exception is the IATTC management measure that limits the incidental mortality rates of dolphins in large purse-seine tuna fisheries. Most of the management measures adopted by the tuna RFMOs focus in applying the precautionary approach to minimize fishing impacts on non-target species and focus less in strictly applying EBFM. Most of the management measures focus on minimizing fishing impacts on sharks, seabirds and sea turtles and focus on requiring the reporting of fisheries data, the use of mitigation measures and safe handling and release practices, as well as the prohibition of retaining onboard various shark species (Clarke et al. 2014a). But none have measures with specific catch and mortality limits to reduce fishing interactions to specific targets, with the exception of the mortality limits for dolphins adopted by IATTC. None of the tuna RFMOs have measures requiring the use of mitigation measures to reduce other non-tuna bycatch fish species. An evaluation of the efficacy and effectiveness of management measures have not been attempted yet in any of the tuna RFMOs.

IATTC and WCPFC have made moderate progress and ICCAT and IOTC little progress within the ecological component of ecosystem properties and trophic relationships (Table 3). While the IATTC and WCPFC Conventions attempt to capture the broader impacts of fishing on species dependent on tuna species and biodiversity, the ICCAT and IOTC Conventions do not contain any specific provisions concerning the impact of fisheries on species dependent on tuna species and on trophic interactions that might change the structure and functioning of marine food webs. All tuna RFMOs recognize the value of research activities on food web interactions, diet analysis, ecosystem modeling, and development of indicators to track ecosystem change or impacts of fishing on ecosystems. Yet only IATTC and the WCPFC have made progress on developing several ecosystems and food web models (primarily SEAPODYM, and EwE). These ecosystem models have been used to develop multispecies and ecosystem indicators and also to investigate the spatial population dynamics of tunas

under the influence of both fishing and climate and environmental effects. Although ecosystem models and derived ecosystem indicators are available in the WCPFC and IATTC, they are not monitored and reported regularly, or used to provide management advice on trophic relationships and minimize the impact on the structure and functioning of marine ecosystems. None of the tuna RFMOs have formal mechanisms to accommodate multispecies and food web interactions and ecosystem modeling into the current management of target species or bycatch species and associated ecosystems.

Despite the recognition that identifying and protecting habitats of special concern is central to the sustainable management of species and biodiversity in ecosystems (Lodge et al. 2007), the development of practices, research activities and adoption of management measures to address the importance of habitats of special concern and habitat preferences and utilization for their protection have been the most underdeveloped ecological component to assist in the implementation of EBFM in all the tuna RFMOs. Most of the habitat work has focused in using oceanographic information to improve single species stock assessments and understand habitat preferences and habitat utilization for target species. The WCPFC is the only tuna RFMO that has a Convention Agreement with specific provisions concerning protection of habitats of special concern. ICCAT is also the only tuna RFMO that has adopted several management measures acknowledging and encouraging member states to conduct habitat research to identify shark nursery areas and spawning grounds for bluefin tuna to protect habitats of special concern and investigate the ecological importance of the Sargassum Sea for tuna and tuna-like species. At the end, none of the tuna RFMOs have mapped or protected any habitats of special concern for relevant or sensitive species. All tuna RFMOs need to define clear operational objectives to address the importance of habitats of special concerns and habitat utilization and set a habitat research agenda in a multi species context in order to progress towards EBFM.

All tuna RFMOs share similar challenges. One challenge consist in dealing with the widespread paucity and lack of basic data including standardize fisheries statistics, basic biology of the non-target species, food web dynamics and ecosystem processes, all of which hinders many of the efforts to holistically evaluate the impact of fisheries on the different components of ecosystems and progress towards EBFM. The second challenge consists in developing formal mechanisms to better integrate ecosystem considerations into management advice and management decisions. A global joint tuna RFMO effort and discussion to prepare a step-wise operational EBFM framework and plan might facilitate venues of cooperation across all the tuna RFMOs. Such an initiative could assist and speed up the implementation of good practices not only to manage sustainably the target tuna species but also minimize impacts of fisheries on other components of the ecosystems in order to manage them sustainably.

In this study, we presented a framework of a Conceptual Ecological Model for a role model tuna RFMO and an objective criteria to evaluate the progress of tuna RFMOs in applying EBFM against the idealized role model RFMO. We used this framework and criteria to evaluate progress of ICCAT, WCPFC, IOTC and IATTC in applying and implementing EBFM to manage tuna and tuna-like species and associated ecosystems. Tuna RFMOs might be at the early stages of implementing EBFM, still its implementation should be seen as a step-wise process which should be supported with the best ecosystem science as a tool and pathway to advance towards its full implementation. We are currently expanding this review to include all the five tuna RFMOs so a baseline of progress in implementing EBFM can be established. While we specifically focused on reviewing the progress on developing and implementing the ecological component, rather than the socio-economic and governance components of an EBFM approach, these components should also be reviewed and accounted for when developing a full operational EBFM plan.

5. REFERENCES

Allain, V. 2005. Ecopath model of the pelagic ecosystem of Western and Central Pacific Ocean. 1st Meeting of the Scientific Committee of the Western and Central Pacific Fisheries Commission, WCPFC-SC1 EB WP-10.

Allain, V., S. P. Griffiths, J. Polovina, and S. Nicol. 2012. WCPO ecosystem indicators trends and results from ecopath simulations. Western and Central Pacific Fisheries Commission. Scientific Committee Eight Regular Session. Busan, Republic of Korea, 7-15 August 2012. WCPFC-SC8-2012/EB-IP-11.

Anonymous. 2007. Report of the Joint Meeting of Tuna RFMOs, January 22-26, 2007, Kobe, Japan.

Arrizabalaga, H., P. de Bruyn, G. A. Diaz, H. Murua, P. Chavance, A. Delgado de Molina, D. Gaertner, J. Ariz, J. Ruiz, and L. T. Kell. 2011. Productivity and susceptibility analysis for species caught in Atlantic tuna fisheries. Aquat Living Resour 24:1-12.

Arrizabalaga, H., D. Florence, K. Laurence, M. Gorka, L. Ibaibarriaga, G. Chust, X. Irigoien, J. Santiago, H. Murua, I. Fraile, M. Chifflet, N. Goikoetxea, Y. Sagarminaga, O. Aumont, L. Bopp, M. Herrera, J. M. Fromentin, and S. Bonhomeau. 2014. Global habitat preferences of commercially valuable tuna. Deep-Sea Research II http://dx.doi.org/10.1016/j.dsr2.2014.07.001i.

Australia. 2014. Draft conservation and management measure on establishing a harvest strategy for key tuna species in the WCPO. Western and Central Pacific Fisheries Commission, Scientific Committee Tenth Regular Session, Majuro, Republic of the Marshall Islands, 6-14 August 2014. WCPFC-SC10-2014/ MI-WP-08.

Bell, J. D., A. Ganachaud, P. C. Gehrke, S. P. Griffiths, A. J. Hobday, O. Hoegh-guldberg, J. E. Johnson, R. L. Borgne, P. Lehodey, J. M. Lough, R. J. Matear, T. D. Pickering, M. S. Pratchett, A. S. Gupta, and I. Senina. 2013. Mixed responses of tropical Pacific fisheries and aquaculture to climate change. Nature Climate Change DOI: 10.1038/NCLIMATE1838.

Block, B. A., H. Dewar, S. B. Blackwell, T. D. Williams, E. D. Prince, C. J. Farwell, A. Boustany, S. L. Teo, A. Seitz, A. Walli, and D. Fudge. 2001. Migratory movements, depth preferences, and thermal biology of Atlantic bluefin tuna. Science 293:1310-1314.

Caillot, S., B. Leroy, C. Sanchez, D. Kolody, S. Nicol, J. Hampton, A. Lewis, T. Usu, B. Kumasi, and L. Kumoru. 2012. Pacific tuna tagging and PNG tagging project progress report and workplan for 2012-2013. Western and Central Pacific Fisheries Commission, Scientific Committee eight regular session, Busan, Korea, 07-15 August, 2012, WCPFC-SC8-2012/RP-PTTP-02.

Cartwright, I., J. Ianelli, and R. Allen. 2013. Report of the Expert Working Group. Management objectives, performance indicators and reference points. Scientific Committee Ninth Regular Session, 6-14 August 2013. Pohnpei, Federated States of Micronesia. WCPFC-SC9-2013/ MI-WP-05.

Clarke, S., M. Sato, C. Small, B. Sullivan, Y. Inoue, and D. Ochi. 2014a. Bycatch in Longline Fisheries for Tuna and Tuna-like Species: a Global Review of Status and Mitigation Measures. Western and Central Pacific Fisheries Commission, Scientific Committee Tenth Regular Session, Majuro, Republic of the Marshall Islands, 6-14 August 2014. WCPFC-SC10-2014/ EB-IP-04.

Clarke, S., M. Sato, C. Small, B. Sullivan, Y. Inoue, and D. Ochi. 2014b. Bycatch in longline fisheries for tuna and tuna-like species: a global review of status and mitigation measures. FAO Fisheries and Aquaculture Technical Paper No. 588. Rome, FAO. 199 pp.

Collette, B. B., K. E. Carpenter, B. A. Polidoro, M. J. Juan-Jordá, A. Boustany, D. J. Die, C. Elfes, W. Fox, J. Graves, L. R. Harrison, R. McManus, C. V. Minte-Vera, R. Nelson, V. Restrepo, J. Schratwieser, C.-L. Sun, A. Amorim, M. B. Brick Peres, C. Canales, G. Cardenas, S.-K. Chang, W.-C. Chiang, N. de Oliveira Leite Jr., H. Harwell, R. Lessa, F. L. Fredou, H. A. Oxenford, R. Serra, K.-T. Shao, R. Sumaila, S.-P. Wang, R. Watson, and E. Yáñez. 2011. High value and long life - Double jeopardy for tunas and billfishes. Science 333:291-292.

Fonteneau, A., and J. P. Hallier. 2015. Fifty years of dart tag recoveries for tropical tuna: A global comparison of results for the western Pacific, eastern Pacific, Atlantic, and Indian Oceans. Fish Res 163:7-22.

Galuardi, B., and M. Lutcavage. 2012. Dispersal Routes and Habitat Utilization of Juvenile Atlantic Bluefin Tuna, Thunnus thynnus, Tracked with Mini PSAT and Archival Tags. . PLoS ONE 7:e37829. doi:37810.31371/journal.pone.0037829.

Gilman, E., K. Passfield, and K. Nakamura. 2014. Performance of regional fisheries management organizations: ecosystem-based governance of bycatch and discards. . Fish Fish 15:327–351.

Hall, M., and M. Roman. 2013. Bycatch and non-tuna catch in the tropical tuna purse seine fisheries of the world. FAO Fisheries and Aquaculture Technical Paper No. 568. Rome, FAO. 249pp.

Harley, S., J. Rice, and P. Williams. 2013. A progress report on the Shark Research Plan. Western and Central Pacific Fisheries Commission, Scientific Committee Ninth Regular Session, Pohnpei, Federated States of Micronesia, 6-14 August 2013. WCPFC-SC9-2013/EB-WP-06.

Harley, S., and P. Williams. 2013. A compendium of fisheries indicators for bigeye, skipjack, yellowfin, and south Pacific albacore tunas. Western and Central Pacific Fisheries Commission. Scientific Committee Ninth Regular Session, 6-14 August 2013. Pohnpei, Federated States of Micronesia. WCPFC-SC9-2013/SA-WP-06.

IATTC. 2003. Inter-American Tropical Tuna Commission Convention for the Strengthening of the Inter-American Tropical Tuna Commission. Established by the 1949 Convention between the United States of America and the Republic of Costa Rica ("Antigua Convention"). Inter-American Tropical Tuna Commission, La Jolla, USA.

IATTC. 2014. Stock status indicators for silky sharks in the eastern Pacific Ocean. Inter-American Tropical Tuna Commission, Scientific Advisory Committee, Fifth Meeting. La Jolla, California (USA, 12-16 May). Document Sac-05-11a.

IATTC. 2015a. Current and planned activities of the IATTC staff. Document SAC-06-10a. Inter-American Tropical Tuna Commission. Scientific Advisory Committee. Sixth meeting, La Jolla, California, USA, 11-15 May 2015.

IATTC. 2015b. Ecosystem Considerations. Inter-American Tropical Tuna Commission, Scientific Advisory Committee, Sixth Meeting. La Jolla, California (USA, 11-15 May 2015. Document Sac-06-09.

IATTC. 2015c. Recommendations by the staff for conservation measures in the eastern Pacific Ocean, 2015. Inter-American Tropical Tuna Commission, Scientific Advisory Committee, Sixth Meeting, La Jolla, California, USA, 11-15 May 2015. Document SAC-06-11 (REV).

ICCAT. 2005. Terms of reference for a Sub-committee on Ecosystems. Standing Committee on Research and Statistics, International Commission for the Conservation of Atlantic Tunas, Madrid, Spain.

ICCAT. 2007. Basic Texts, 5th revision. International Convention for the Conservation of Atlantic Tunas, Madrid.

ICCAT. 2009a. Report of the 2009 Inter-Sessional Meeting of the SCRS Sub-Committee on Ecosystems (Recife, Brazil, June 8 to 12, 2009). International Commission for the Conservation of Atlantic Tunas, Madrid.

ICCAT. 2009b. Report of the Independent Performance Review of ICCAT. International Commission for the Conservation of Atlantic Tunas, Madrid.

ICCAT. 2013. 2013 Inter-sessional meeting of the sharks species group (Mindelo, Cape Verde, April 8 to 12, 2013). International Commission for the Conservation of Atlantic tunas, Madrid.

ICCAT. 2014. Second meeting of the working group on convention amendment, Barcelona, Spain -19-21 May 2014. International Commission for the Conservation of Atlantic Tunas, Madrid.

ICCAT. 2015a. 2015 Inter-sessional meeting of the sub-committee on ecosystems (Madrid, Spain,8-12 June 2015). International Commission for the Conservation of Atlantic Tunas, Madrid.

ICCAT. 2015b. Report for biennial period, 2014-15. Part I (2014) - Vol.2 -SCRS, International Commission for the Conservation of Atlantic Tunas, Madrid, Spain.

IOTC. 2007. Report of the third session of the IOTC Working Party on Ecosystems and Bycatch (previously the Working Party on Bycatch). Seychelles, 11-13 July 2007. Indian Ocean Tuna Commission. IOTC-2007-WPEB-R[E].

IOTC. 2009. Report of the IOTC Performance Review Panel: January 2009. Indian Ocean Tuna Commission, Mahé, Seychelles.

IOTC. 2014a. Program of work (2015-2019) for the Working Party on Ecosystems and Bycatch. Indian Ocean Tuna Commission.

IOTC. 2014b. Status of seabirds in the Indian Ocean. Draft Executive Summary: Seabirds. IOTC-2014-SC17-ES25 Rev_1.

IOTC. 2015. Report of the 5th session of the IOTC working party on neritic tunas. Zanzibar, Tanzania, 26-29 May 2015. Indian Ocean Tuna Commission. IOTC-2015-WPNT05-R[E].

IOTC-SC17. 2014. Report of the Seventeenth Session of the IOTC Scientific Committee. Seychelles, 8–12 December 2014. IOTC–2014–SC17–R[E]: 357 pp.

IOTC–WPEB06. 2010. Report of the Sixth Session of the IOTC Working Party on Ecosystems and Bycatch. Victoria, Seychelles, 27-30 October 2010. IOTC–2010–WPEB–R[E]: 38 pp.

IOTC–WPEB07. 2011. Report of the Seventh Session of the IOTC Working Party on Ecosystems and Bycatch. Lankanfinolhu, North Malé Atoll, Republic of Maldives, 24–27 October 2011. IOTC–2011–WPEB07–R[E]: 99 pp.

IOTC–WPEB08. 2012. Report of the Eighth Session of the IOTC Working Party on Ecosystems and Bycatch. Cape Town, South Africa, 17–19 September, 2012. IOTC–2012–WPEB08–R[E]: 77 pp.

IOTC–WPEB09. 2013. Report of the Ninth Session of the IOTC Working Party on Ecosystems and Bycatch. La Réunion, France, 12–16 September, 2013. IOTC– 2013–WPEB09–R[E]: 98 pp.

Kelble, C. R., D. K. Loomis, S. Lovelace, W. K. Nuttle, P. B. Ortner, P. Fletcher, G. S. Cook, J. J. Lorenz, and J. N. Boyer. 2013. The EBM-DPSER Conceptual Model: Integrating Ecosystem Services into the DPSIR Framework. PLoS ONE 8:e70766. doi:70710.71371/journal.pone.0070766.

Kirby, D. 2006. Ecological Risk Assessment for Species Caught in WCPO Tuna Fisheries: Inherent Risk as Determined by Productivity-Susceptibility Analysis. WCPFC-SC2-2006/EB WP-1. Western and Central Pacific Fisheries Commission, Palikir, FSM.

Kirby, D., and A. Hobday. 2007. Ecological Risk Assessment for the Effects of Fishing in the Western and Central Pacific Ocean: Productivity Susceptibility -Analysis. Third Scientific Committee Meeting of the Western and Central Pacific Fisheries Commission, Honolulu, USA, 13-24 August 2007. WCPFC-SC3-EB SWG/WP-1. Western and Central Pacific Fisheries Commission, Palikir, FSM.

Lefort, S., O. Aumont, L. Bopp, T. Arsouze, M. Gehlen, and O. Maury. 2014. Spatial and body-size dependent response of marine pelagic communities to projected global climate change. Global Change Biology doi:10.1111/gcb.12679.

Lehodey, P., I. Senina, A. C. Dragon, and H. Arrizabalaga. 2014a. Spatially explicit estimates of stock size, structure and biomass of North Atlantic albacore tuna (Thunnus alalunga). Earth System Science Data 7:169-195.

Lehodey, P., I. Senina, O. Titaud, B. Calmettes, A. Conchon, A. Dragon, S. Nicol, S. Caillot, J. Hampton, and P. Williams. 2014b. Project 62: SEAPODYM applications in WCPO. Western and Central Pacific Fisheries Commission, Scientific Committee Tenth Regular Session, Majuro, Republic of the Marshall Islands, 6-14 August 2014. WCPFC-SC10-2014/EB-WP-02.

Lehodey, P., I. Senina, O. Titaud, B. Calmettes, S. Nicol, J. Hampton, S. Caillot, and P. Williams. 2013. Project 62: SEAPODYM applications in WCPO. Western and Central Pacific Fisheries Commission, Scientific Committee Ninth Regular Session, Pohnpei, Federated States of Micronesia, 6-14 August 2013. WCPFC-SC9-2012/EB-WP-03 Rev 1.

Levin, P., M. Fogarty, S. Murawski, and D. Fluharty. 2009a. Integrated ecosystem assessments. Public Library of Science Biology Journal 7:1-6.

Levin, P. S., M. J. Fogarty, S. Murawski, and D. L. Fluharty. 2009b. Integrated Ecosystem Assessments: Developing the Scientific Basis for Ecosystem-Based Management. PLoS Biology 7:23-28.

Lodge, M. W., D. Anderson, T. Lobach, G. Munro, K. Sainsbury, and A. Willock. 2007. Recommended best practices for regional fisheries management organizations. Report of an independent panel to develop a model for improved governance by Regional Fisheries Management Organizations. The Royal Institute of International Affairs, Chatham House.

Lucena Frédou, F., L. T. Kell, T. Fredou, D. Gaertner, M. Potier, P. Bach, P. Travassos, F. Hazin, and F. Menard. 2015. Estimating vulnerability of teleosts caught by the tuna longline fleet in South Atlantic and Indian Oceans. SCRS/2015/103.

Luckhurst, B. E. 2014a. Elements of the ecology and movement patterns of highly migratory fish species of interest to ICCAT in the Sargasso Sea. Collect. Vol. Sci. Pap. ICCAT 70 (5): 2183 - 2206.

Luckhurst, B. E. 2014b. A preliminary food web of the pelagic environment of the Sargasso Sea with a focus on the fish species of interest to ICCAT. SCRS/ 2014/120. International Commission for the Conservation of Atlantic Tunas, Madrid.

Luckhurst, B. E., and F. Arocha. 2015. Evidence of spawning in the Sargasso Sea of fish species managed by ICCAT -albacore tuna, swordfish and white marlin. SCRS/2015/111. International Commisssion for the Conservation of Atlantic Tuna, Madrid.

Maunder, M., and R. B. Deriso. 2014. Proposal for biomass and fishing mortality limit reference points based on reduction in recruitment. IATTC Stock Assessment Report 15: 193-206.

Maunder, M., J. F. Zhu, and A. Aires-da-Silva. 2015. Preliminary management strategy evaluation to evaluate the IATTC interim reference points and proposed harvest control rule. Inter-American Tropical Tuna Commission, Scientific Advisory Cimittee, Sixth Meeting, La Jolla, California, USA, 11-15 May 2015, Document SAC-06-10b.

Meltzer, E. 2009. The quest for sustainable international fisheries : regional efforts to implement the 1995 United Nations Fish Stock Agreement : an overview for the May 2006 review conference. NRC Research Press, Ottawa.

Millennium Ecosystem Assessment. 2005. Ecosystems and Human Well-being: Biodiversity Synthesis. Page 86. World Resources Institute, Washington, DC.

Murua, H., H. Arrizabalaga, J. J. Hsiang-Wen Huang, E. Romanov, P. Bach, P. de Bruyn, P. Chavance, A. Delgado de Molina, R. Pianet, J. Ariz, and J. Ruiz. 2009. Ecological Risk Assessment (ERA) for species caught in fisheries managed by the Indian Ocean Tuna Commission (IOTC): a first attempt. Indian Ocean Tuna Commission. IOTC-2009-WPEB-20.

Murua, H., R. Coelho, M. N. Santos, H. Arrizabalaga, K. Yokawa, E. Romanov, J. F. Zhu, Z. G. Kim, P. Bach, P. Chavance, A. Delgado de Molina, and J. Ruiz. 2012. Preliminary Ecological Risk Assessment (ERA) for shark species caught in fisheries managed by the Indian Ocean Tuna Commission (IOTC). IOTC-2012--nº XX revision 1:1-26.

Nel, R., R. M. Wanless, A. Angel, B. Mellet, and L. Harris. 2013. Ecological risk assessment and productivity/susceptibility analysis of sea turtles overlapping with fisheries in the IOTC region. Unpublished report to IOTC and IOSEA marine turtle MoU.

Palumbi, S., P. Sandifer, J. Allan, M. Beck, D. Fautin, M. Fogarty, B. Halpern, L. Incze, J. Leong, E. Norse, J. Stachowicz, and D. Wall. 2009. Managing for ocean biodiversity to sustain marine ecosystem services. Frontiers in Ecology and the Environment 7:204–211.

Pikitch, E. K., C. Santora, E. A. Babcock, A. Bakun, R. Bonfil, D. O. Conover, P. Dayton, P. Doukakis, D. Fluharty, B. Heneman, E. D. Houde, J. Link, P. A. Livingston, M. Mangel, M. K. McAllister, J. Pope, and K. J. Sainsbury. 2004. Ecosystem-based fishery management. Science 305:346–347.

Review Team. 2012. Review of the performance of the WCPFC. Commission Eight Regular Session. Tumon, Guam, USA, 26-30 March 2012, Western and Central Pacific Fisheries Commission. WCPFC-2011/12.

Rogers, A. D., U. R. Sumalia, S. S. Hussain, and C. Baulcomb. 2014. The high sea and us. Understanding the value of high-seas ecosystems. Global Ocean Commission.

Rosenberg, A. A., and K. McLeod. 2005. Implementing ecosystem-based management approaches to management for the conservation of ecosystem services. Mar Ecol Prog Ser 300:241-296.

Schaefer, K. M., and D. W. Fuller. 2005. Conventional and archival tagging of bigeye tuna (Thunnus obesus) in the eastern equatorial Pacific Ocean. . Collective Volume of Scientific Papers - ICCAT 57:67–84.

Schaefer, K. M., and D. W. Fuller. 2006. Estimates of age and growth of bigeye tuna (Thunnus obesus) in the eastern Pacific Ocean based on otolith increments and tagging data. . Inter-Am Trop Tuna Comm Bull 23:1-59.

Schaefer, K. M., and D. W. Fuller. 2009. Horizontal movements of bigeye tuna (Thunnus obesus) in the eastern Pacific Ocean, as determined from conventional and archival tagging experiments initiated during 2000–2005. Inter-Am Trop Tuna Comm Bull 24:189–248.

Schaefer, K. M., and D. W. Fuller. 2010. Vertical movements, behavior, and habitat of big- eye tuna (Thunnus obesus) in the equatorial eastern Pacific Ocean, ascertained from archival tag data. Marine Biology 157:2625–2642.

Schaefer, M. B., B. M. Chatwin, and G. C. Broadhead. 1961. Tagging and recovery of tropical tunas, 1955–1959. . Inter-Am Trop Tuna Comm Bull 5:341–455.

Schirripa, M., P. Lehodey, E. Prince, and J. Luo. 2011. Habitat modeling of Atlantic blue marlin with SEAPODYM and satellite tags. Collective Volume of Scientific Papers - ICCAT 66:1735-1737.

Sibert, J. 2005. Ecosystem Boundaries and Indicators: Getting started with the ecosystem approach. Western and Central Pacific Fisheries Commission. 1st meeting of the scientific committee of the western and central pacific fisheries commission WCPFC-SC1 Boumea, New Caledonia, 8-19 August 2005. WCPFC-SC1 EB WP-6.

Small, C. J. 2005. Regional Fisheries Management Organizations: their duties and performance in reducing bycatch of albatrosses and other species. Cambridge, UK: BirdLife International.

SPC, Oceanic Fisheries Programme (OFP), and the Parties to the Nauru Agreement (PNA). 2014. Assessing a candidate target reference point for skipjack tuna consistent with PNA management objectives. Western and Central Pacific Fisheries Commission, Scientific Committee Tenth Regular Session, Majuro, Republic of the Marshall Islands, 6-14 August 2014. WCPFC-SC10-2014/MI-WP-09.

Tallis, H., P. S. Levin, M. Ruckelshaus, S. E. Lester, K. L. McLeod, D. L. Fluharty, and B. J. Halpern. 2010. The many faces of ecosystem-based management: Making the process work today in real places. Mar Policy 34:340-348.

Tuck, G. N., R. A. Phillips, C. Small, R. B. Thomson, N. L. Klaer, F. Taylor, R. M. Wanless, and H. Arrizabalaga. 2011. An assessment of seabird–fishery interactions in the Atlantic Ocean. ICES J Mar Sci 68:1628-1637.

WCPFC. 2000. Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean. Western and Central Pacific Fisheries Commission, Palikir, Federated States of Micronesia.

WCPFC. 2007. Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean, fourth regular session, Tumon, Guam, USA, 2–7 December 2007. Summary Report. 147 p.

WCPFC. 2009. Terms of reference for the specialist working groups. Scientific Committee Specialist Working Group. Western and Central Pacific Fisheries Commission.

WCPFC. 2011. Strategic research plan of the scientific committee 2012-2016 (Adopted by SC7). Scientific Committee Seventh Regular Session. Pohnpei, Federated States of Micronesia, 9-17 August 2011. Western and Central Pacific Fisheries Commission.

WCPFC. 2013. Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean. Scientific Committee. Ninth regular session, Pohnpei, Federated States of Micronesia, 6-14 August 2013 : summary report, 224 p.

WCPFC. 2014. Commission for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean, Eleventh Regular Session, Apia, Samoa, 1-5 December 2014, Summary Report, 306 p.

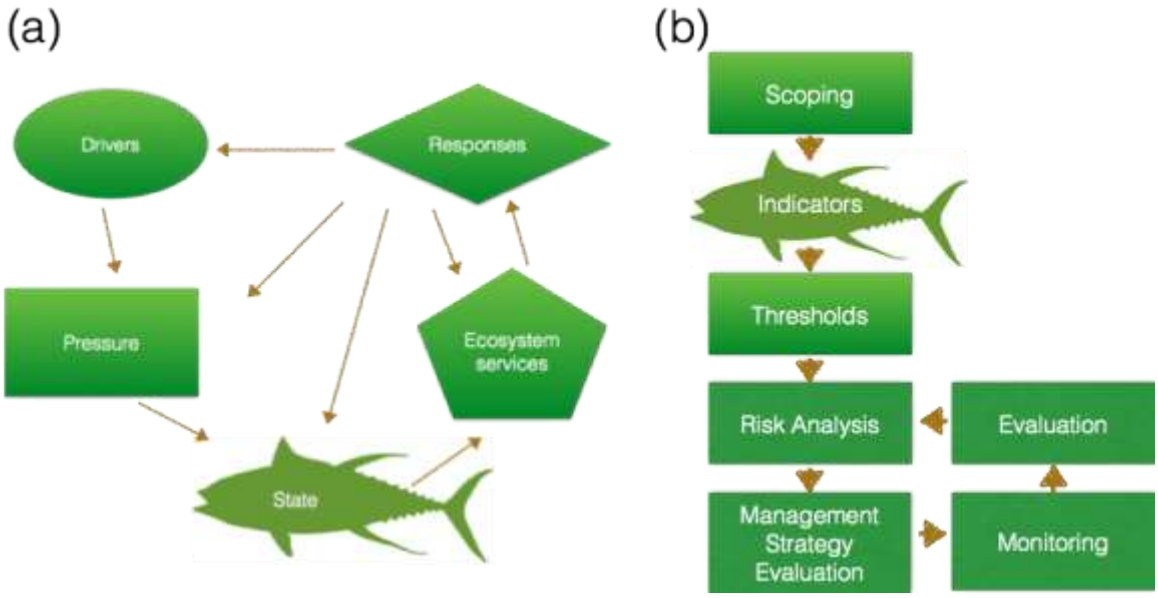

Figure 1. Frameworks to make the implementation of EBFM more operational. (a) Driver-Pressure-State-Ecosystem services-Response (DPSER) framework (based on Kelble et al 2013). (b) The Integrated Ecosystem Assessment (IEA) framework (Based on Levin et al 2009; Tallis et al 2010).

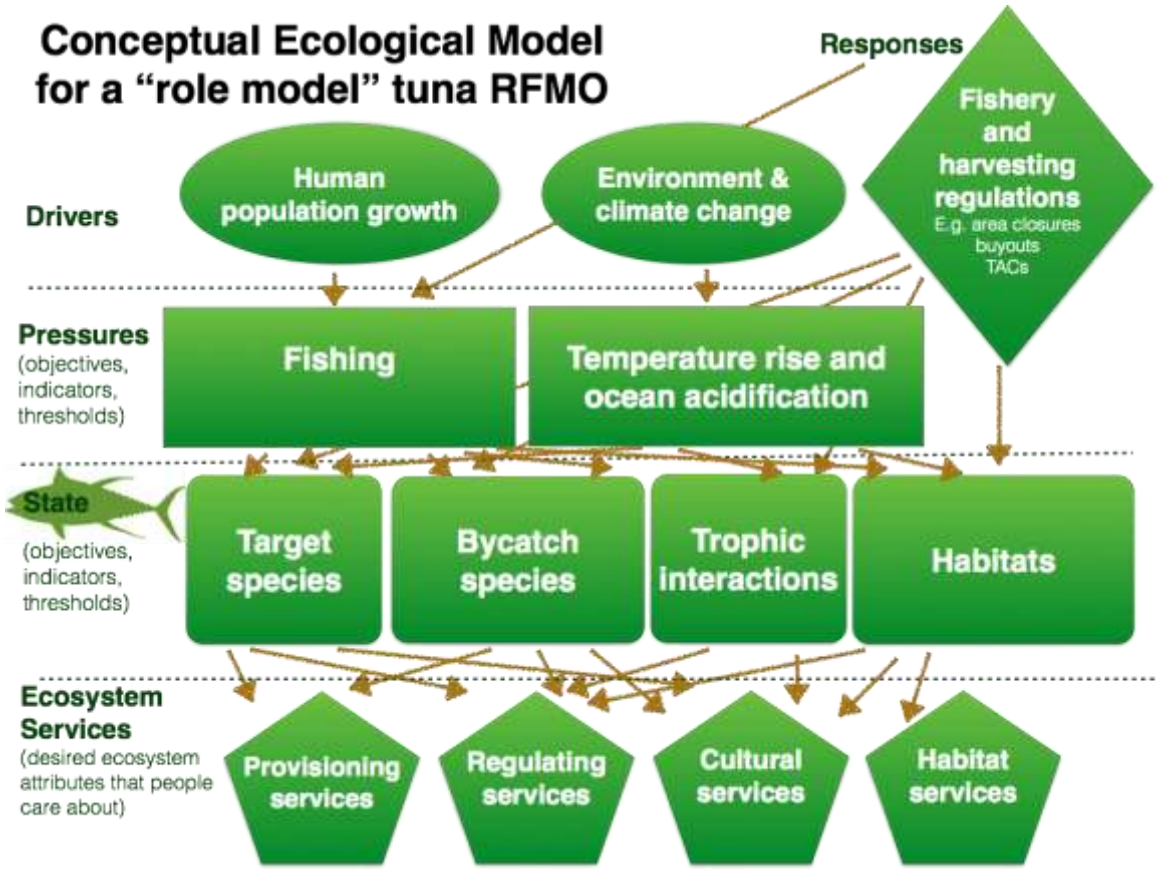

Figure 2. Conceptual Ecological Model for a "role model" tuna RFMO based on the DPSER and IEA frameworks.

Table 1. Towards developing a Conceptual Ecological Model based on the IEA and DPSER frameworks for a "role model" t-RFMO. The Ecological Conceptual Model for our "role model" t-RFMO is based on the best conservation and management practices of RFMOs for addressing EBFM. These best practices were identified in a review of almost 20 RFMOs in addressing ecosystem based fisheries management and the precautionary approach (Lodge et al. 2007).
In this table, we define what would be the main elements and ecological components of a role model RFMO in addressing EBFM, including (1) the overall overarching objective of a "role model" RFMO and supporting main elements and (2) the four ecological components supporting the full implementation of ecosystem based fisheries management. 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 T-RFMO

Overarching objective: The main goal of ecosystem based management (EBM) 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, structure and elements
A role model t-RFMO formally recognizes in its Convention Agreement the main principles of PA and EBFM set 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	Conceptual and 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 Bmsy or Bo -Fishing mortality rate trends relative to Fmsy -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	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	Conceptual and operational objectives have been formally stated in Convention Agreement - for all species or main taxonomic groups E.g. Maintain sustainable populations of bycatch species by reducing and mitigating the impacts of fishing	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. of species-level indicators: -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 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	Conceptual and operational objectives have been formally stated in Convention Agreement for relevant species and components of ecosystems. E.g. Maintain viable trophic interactions and	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	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	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

	interdependencies involving species that are affected by fishing	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	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	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: Habitat	Conceptual and operational objectives have been formally stated in Convention Agreement to recognize the importance of protection of habitats of special concern. E.g. Support and protect the maintenance of habitats of special concern	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. 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 -Habitat shifts and range contractions -Habitat suitability index -Habitat size (e.g. O2 minimum zones)	Minimum habitat needs and requirements have been identified and adopted for all relevant species with habitats of special concern E.g. -Minimum habitat needs for population viability	Knowledge of habitats of special concern for all relevant species is used in decision-making. Management measures (binding) 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 t-RFMO)	FP - by C
Moderate progress by the Commission	MP - by C
Small progress by the Commission	SP - by C
Full progress only by Scientific Committee	FP- only by SC
Moderate progress only by the Scientific Committee	MP- only by SC
Small 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 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. The group oversees and coordinates all relevant 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, 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 EBFM plan covers all relevant ecological elements of the ecosystem (target species, bycatch species, trophic interactions and habitats) as well as all relevant human and institutional elements to fully implement EBFM.
MP - by C	An operational EBFM plan has been adopted by the Commission. The EBFM only covers some of the relevant ecological, human and institutional elements to fully implement EBFM and the plan might not have clearly establishes a priori operational objectives, associated indicators and thresholds and response management actions to ensure the objectives are met.
SP - by C	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 (yet less comprehensive than a EBFM plan). An operational 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 SC
MP- only by SC	Fisheries Management Plans or Science Strategic Plans have been developed by the SC that include some management or research actions related to ecosystems (yet less comprehensive than a EBFM plan). An EBFM plant might be under development by the SC
SP or NP -only by SC	An EBFM plan has not been developed and not being discussed
4. Does it exist a long-term data collection and monitoring programme to support the implementation of EBFM?	
FP - by C	A standardized regional data collection and monitoring programme relative to EBFM coordinated by the RFMO secretariat exist
MP - by C	A standardized regional data collection and monitoring programme coordinated by RFMO secretariat exists, but not necessarily in support of implementing EBFM. The regional monitoring programme coordinated by RFMO secretariat exist at least for some fishing fleets and was design to support the conservation and management of stocks covered by the RFMO and associated ecosystems, not necessarily to fully implement EBFM.

SP - by C	A standardized regional data collection and monitoring programme relevant to EBFM or fisheries management does not exist. Instead multiple national data collection and monitoring programmes exist conducted by individual member countries for certain fishing gears and fleets as requested by the Commission. Data from the monitoring programmes 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 RFMO and SC is unable or partially able to use the national data collection programmes to conduct regional assessments relevant to bycatch and ecosystem issues.
FP- only by SC	A standardized regional data collection and monitoring programme in support of EBFM has been developed by the SC, yet not adopted by Commission.
MP- only by SC	A standardized regional data collection and monitoring programme in support of EBFM is under development by the SC, yet not adopted by Commission.
SP or NP -only by SC	A standardized regional data collection and monitoring programme 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 for target species?	
FP - by C	Conceptual and operational objectives have been formally stated in Convention Agreement -objectives are species-specific.
MP - by C	At least conceptual objectives are formally stated in Convention Agreement. Conceptual and operational objectives might be formally recognized in adopted management measures or species-specific operational objectives are being discussed by the Commission.
SP - by C	At least conceptual objectives are formally stated in adopted management measures.
FP- only by SC	Objectives are formally contemplated in Science Research Plans or SC reports.
MP- only by SC	Adhoc consideration of objectives in SC reports.
SP or NP -only by SC	Not under discussion.
Indicators 6. Have target species been evaluated, 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 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 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 objectives) and may not be routinely developed and monitored -for some species.
FP- only by SC	Fisheries stock assessments are regularly conducted for all species; A series of indicators of stock status (associated to 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 of species.
SP or NP -only by SC	Fisheries stock assessments and indicators of stock status under discussion or not discussed.
Thresholds 7. Have thresholds, including target and limit reference points, been defined, developed and linked to associated objectives and indicators?	
FP - by C	Species-specific limit and target reference points (associated to pre-defined objectives and indicators) have been developed and adopted -for all species.
MP - by C	General-species limit and/or target reference points (associated to pre-defined objectives and indicators) have been developed and adopted -for some species. Species-specific reference points are under development for some species.
SP - by C	Limit and/or target reference points are being discussed to be adopted by the Commission.
FP- only by SC	General-species limit and/or target reference points have been developed by the SC for all species. Species-specific reference points are under development and being tested for some species.
MP- only by SC	Limit and/or target reference points have been developed for some species and under development and under discussion for others.
SP or NP -only by SC	Limit and/or target reference points 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 thresholds?	
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 or are under discussion by Commission. Management measures have been adopted (mostly binding) for majority of target species to ensure management objectives are achieved.
SP - by C	Harvest control rules have not been adopted or are under development or discussion by the Commission. Relative few management measures have been adopted (some binding, some non-binding) 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 under development 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 for 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. Operational objectives might have been adopted for some species or taxonomic groups or may be under discussion.
SP - by C	At least conceptual objectives are formally stated in adopted management measures.
FP- only by SC	Objectives are formally contemplated in Science Research Plans or SC reports.
MP- only by SC	Adhoc consideration of objectives in SC 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	Assessments of status are conducted routinely for all vulnerable species as requested by the Commission; A series of indicators of species status (associated to objectives) have been adopted and are routinely developed and monitored -for all vulnerable species and all relevant fisheries.
MP - by C	Assessments of status are conducted routinely for some vulnerable species as requested by the Commission; A series of indicators of species status (associated to 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 usually 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)
SP - by C	Assessments of status and development of indicators have been requested by Commission. A series of simple indicators of stock status (or proxies or indirect indicators of stock status) have been developed for few vulnerable species, but those indicators are not routinely developed and monitored over time. The developed indicators are usually proxies or indirect indicators of stock status, that 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	Species-specific or taxo-specific assessments of status or risk-based impact assessments of the effects of fishing have been conducted for all vulnerable species. The relative vulnerability of species to fishing has been identified. Species assessments are routinely conducted and a series of indicators of stock status (associated to objectives) have been developed and are being monitored -for all or most vulnerable species caught in all relevant fisheries.

MP- only by SC	Species-specific or taxo-specific assessments of status or risk-based impact assessments of the effects of fishing have been conducted for some vulnerable species. The relative vulnerability of species to fishing has been identified for most species. Species assessments are routinely conducted and a series of indicators of stock status (associated to objectives) have been developed or are being developed, but are not being monitored -for some vulnerable species caught in some (but not all) fisheries.
SP or NP -only by SC	Risk-based impact assessments (at least level 1 and 2 ecological risk assessments) have been conducted or are being developed for some vulnerable species, or not developed yet. The development of indicators of stock status are under discussion or not discussed
Thresholds 11. Have thresholds, including target and limit reference points, have been defined, developed and linked to associate indicators?	
FP - by C	Species-specific limit and target reference points (associated to pre-defined objectives and indicators) have been developed and adopted - for most vulnerable species and all relevant fisheries.
MP - by C	At least general-species limit or target reference points (associated to pre-defined objectives and indicators) have been developed and adopted - for some vulnerable species and relevant fisheries. Species-specific limit reference points might be under development for some species.
SP - by C	Limit and/or target reference points are being discussed to be adopted by the Commission or limit and/or target reference points are being developed for some species as requested 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	General-species limit and/or target reference points have been developed by the SC for majority of vulnerable species. Species-specific reference points might be under development and being tested for some vulnerable species.
MP- only by SC	Limit and/or target reference points have been developed for some vulnerable species and are under development and under discussion for others.
SP or NP -only by SC	Limit and/or target reference points are under discussion or not being discussed.
Management responses and measures 12. Have conservation and management measures been put in place and linked to pre-established management objectives, indicators and thresholds?	
FP - by C	Management measures (mostly binding) associated with pre-established management objectives, indicators and thresholds have been adopted that include limits to be avoided in order to reduce impacts of fisheries on by catch species and achieve management objectives -for all or majority of vulnerable species.
MP - by C	Management measures (mostly binding) associated with pre-established management objectives, indicators and thresholds have been adopted that include limits to be avoided 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) 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 in order to reduce impacts of fisheries on by catch have been developed and 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 to be avoided) are being developed and being tested for some vulnerable species.
SP or NP -only by SC	Management measures to minimize impacts of fisheries 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 for ecosystem properties and trophic relationships?	
FP - by C	Conceptual and operational objectives have been formally stated in Convention Agreement for relevant species and components of ecosystems.
MP - by C	At least conceptual objectives are formally stated in Convention Agreement for relevant species and components of ecosystems.
SP - by C	At least conceptual objectives are formally stated in adopted management measures for relevant species and components of ecosystems.
FP- only by SC	Objectives are formally contemplated in Science Research Plans or SC reports for relevant species and components of ecosystems.
MP- only by SC	Adhoc consideration of objectives in SC reports.
SP or NP -only by SC	Not under discussion
Indicators 14. Have food web models with interactions of relevant species 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 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 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 or under discussion by the Commission. Empirically- based and/or model-based ecosystem indicators (not associated to 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 objectives) have been developed and are being monitored for all relevant components and species of ecosystem.
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. Empirically- based and/or model-based ecosystem indicators (not associated to objectives) have been developed for some relevant components of ecosystems and are under development for others, but not 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. Empirically- based and/or model-based ecosystem indicators are being developed or under discussion, or not discussed.
Thresholds 15. Have ecosystem and/or multispecies management plans (including harvest strategies) been developed with pre-defined thresholds and used for management advice?	
FP - by C	Ecosystem and/or multispecies management plans (including harvest strategies) with pre-defined thresholds (associated to pre-established objectives and indicators) 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.
MP - by C	Ecosystem and/or multispecies management plans (including harvest strategies) with pre-defined thresholds (associated to pre-established objectives and indicators) have been developed and adopted for some relevant species and component 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 thresholds (associated to pre-established objectives and indicators) 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 thresholds (associated to pre-established objectives and indicators) have been developed for all relevant species and component of ecosystems. It is used to provide management advice.
MP- only by SC	Ecosystem and/or multispecies management plans (including harvest strategies) with pre-defined thresholds (associated to pre-established objectives and indicators) have been developed for some relevant species and component of ecosystems. It 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 thresholds are under discussion for some relevant components of ecosystems or 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 and their use evaluated in decision-making and incorporated in management measures (e.g. multispecies harvest control rules, time-area closures). Management measures (mostly binding) have been adopted to accommodate multispecies and food web interactions in all relevant components of ecosystems into the current management of target and bycatch species and associated ecosystems.
MP - by C	One or more conceptual ecosystem/foodweb models and multispecies management plans have been developed and their use evaluated in decision-making and incorporated in management measures (e.g. multispecies harvest control rules, time-area closures). Management measures (binding or non binding) have been adopted to accommodate multispecies and food web interactions for some relevant components of ecosystems into the current management of target species and bycatch species and associated ecosystems.
SP - by C	Ecosystem/foodweb models and multispecies management plans have been requested by the Commission, or multispecies management plans are being discussed by the Commission to accommodate multispecies and food web interactions and ecosystem modeling into the current management of target species and bycatch species and associated ecosystems.
FP- only by SC	Ecosystem/food web models and multispecies management plans/scenarios developed and tested but not systematically in used in decision making or incorporated in management measures.
MP- only by SC	Ecosystem/food web models and multispecies management plans/scenarios are being developed for some relevant components and species of ecosystems to be used in decision making or incorporated in management measures.
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 not being discussed.
ECOLOGICAL COMPONENT 4: HABITAT	
Objectives 17. Have conceptual and operational objectives been formally stated to protect habitats of special concern?	
FP - by C	Conceptual and operational objectives have been formally stated in Convention Agreement to recognize the importance of protection of habitats of special concern.
MP - by C	At least conceptual objectives are formally stated in Convention Agreement to recognize the importance of protection of habitats of special concern.
SP - by C	At least conceptual objectives are formally stated in adopted management measures to recognize the importance of protection of some habitats of special concern or is under discussion by the Commission.
FP- only by SC	Objectives are formally contemplated in Science Research Plans or SC reports that recognize the importance of protection of habitats of special concern.
MP- only by SC	Adhoc consideration of objectives in SC reports that recognize the importance of protection of habitats of special concern.
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	As requested by the Commission, 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. Indicators (associated to objectives) describing habitat needs and preferences have been adopted, developed and are routinely monitored and used in management advice.
MP - by C	As requested by the Commission, 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. Indicators (associated to objectives) describing habitat needs and preferences have been adopted and developed, but are not routinely monitored and used in management advice.
SP - by C	As requested by the Commission, 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. Indicators (not associated to objectives) describing habitat needs and preferences have been developed (or under development), but are not routinely monitored and or used in management advice.
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 in 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 and used in 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 not being discussed.
Thresholds 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 and incorporated in management measures to ensure pre-established objectives are met?

FP - by C	Knowledge of habitats of special concern for all relevant species 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	Knowledge of habitats of special concern for some relevant species 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. Knowledge of habitat of special concern not used in decision-making and not incorporated in management measures. Management measures are under discussion to accommodate knowledge of habitats of special concern for some relevant species.
FP- only by SC	Knowledge of habitats of special concern exist for all relevant species and the SC 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	Knowledge of habitats of special concern exist for some relevant species and the SC 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	Knowledge of habitats of special concern for some relevant species is under discussion to be used potentially in decision-making or not being discussed. Mechanisms to incorporate this type of information into decision-making are not under discussion or not being discussed.

Table 3 Progress of tuna RFMOs in applying EBFM

CATEGORIES OF PROGRESS	
Full progress by the Commission (role model tuna RFMO)	FP - by C
Moderate progress by the Commission	MP - by C
Small progress by the Commission	SP - by C
Full progress only by Scientific Committee	FP- only by SC
Moderate progress only by the Scientific Committee	MP- only by SC
Small 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**	**WCPFC**	**IOTC**	**IATTC**
1. Reference to EBFM and PA				
2. Lead entity exist to advance progress of EBFM and ecosystem science				
3. EBFM plan exist				
4. Long-term data collection programme exists to support the implementation of EBFM				

REVIEW OF MAIN ECOLOGICAL COMPONENTS IN SUPPORT OF EBFM

Ecological component 1: Target species	**ICCAT**	**WCPFC**	**IOTC**	**IATTC**
5. Objectives				
6. Indicators				
7. Thresholds				
8. Measures				
Ecological component 2: Bycatch species				
9. Objectives				
10. Indicators – billfishes				
10. Indicators – sharks				
10. Indicators – seabirds				
10. Indicators - sea turtles				
10. Indicators - marine mammals				
10. Indicators -other finfish				
11. Thresholds – billfishes				
11. Thresholds – sharks				
11. Thresholds – seabirds				
11. Thresholds - sea turtles				
11. Thresholds - marine mammals				
11. Thresholds - other finfish				
12. Measures – billfishes				
12. Measures – sharks				
12. Measures – seabirds				
12. Measures - sea turtles				
12. Measures - marine mammals				
12. Measures - other finfish				
Ecological component 3: Ecosystem properties and trophic relationships				
13. Objectives				
14. Indicators				
15. Thresholds				
16. Measures				
Ecological component 4: Habitat				
17. Objectives				
18. Indicators				
19. Thresholds				
20. Measures				