DOES ICCAT NEED ECOSYSTEM PLANS? A PILOT ECOSYSTEM PLAN FOR THE ATLANTIC TROPICAL ECOREGION

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SUMMARY

The implementation of an Ecosystem Approach Fisheries Management (EAFM) in ICCAT has been slow and patchy, as it lacks a long-term plan, vision and guidance on how to operationalize it. Ecosystem plans are needed to formalize the process of operationalizing the EAFM by identifying and formalizing ecosystem goals and objectives, planning actions based on priorities, measuring performance of the whole fishery system, addressing trade-offs, and incorporating them in fisheries management. The Specific Contract N^0 2 under the Framework Contract - EASME/EMFF/2016/008 provisions of Scientific Advice for Fisheries Beyond EU Waters has developed a pilot ecosystem plan for the tropical ecoregion of the Atlantic Ocean. In this document, we highlight the main potential benefits of developing ecosystem plans in ICCAT. Second, we briefly describe the main core elements developed in the pilot ecosystem plan for the Tropical ecoregion of the Atlantic Ocean. Third, we summarize our main thoughts and lessons learned in the development of this pilot ecosystem plan for one ecoregion within ICCAT. Last, we propose a list of actions, research activities and capacity building activities to foster the development, use and implementation of ecosystem plans in ICCAT.

RÉSUMÉ

La mise en œuvre d'une approche écosystémique de la gestion des pêches (EAFM) à l'ICCAT a été lente et inégale, en raison de l'absence d'un plan à long terme, d'une vision et d'orientations sur la façon de la rendre opérationnelle. Des plans écosystémiques sont nécessaires pour formaliser le processus d'exécution de l'EAFM en identifiant et en formalisant les buts et objectifs écosystémiques, en planifiant les actions en fonction des priorités, en mesurant la performance de l'ensemble du système de pêche, en abordant les compromis et en les incorporant dans la gestion des pêches. Dans le cadre du contrat spécifique nº2 relevant du contrat-cadre EASME/EMFF/2016/008 « Formulation d'avis scientifiques pour la pêche au-delà des eaux de l'UE », un plan écosystémique pilote pour l'écorégion tropicale de l'océan Atlantique a été élaboré. Dans ce document, nous soulignons les principaux avantages potentiels de l'élaboration de plans écosystémiques à l'ICCAT. Deuxièmement, nous décrivons brièvement les principaux éléments essentiels développés dans le plan écosystémique pilote pour l'écorégion tropicale de l'océan Atlantique. Troisièmement, nous résumons nos principales réflexions et enseignements tirés de l'élaboration de ce plan écosystémique pilote pour une écorégion au sein de l'ICCAT. Enfin, nous proposons une liste d'actions, d'activités de recherche et d'activités de renforcement des capacités visant à favoriser l'élaboration, l'utilisation et la mise en œuvre de plans écosystémiques à l'ICCAT.

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RESUMEN

La implementación de una ordenación pesquera basada en el enfoque ecosistémico (EAFM) en ICCAT ha sido lenta e irregular, ya que carece de un plan, una visión y una orientación a largo plazo sobre la forma de ponerla en práctica. Se necesitan planes para el ecosistema a fin de formalizar el proceso de puesta en marcha de la EAFM mediante la identificación y formalización de las metas y objetivos para el ecosistema, la planificación de medidas basada en las prioridades, la medición del desempeño de todo el sistema pesquero, el tratamiento de las soluciones de compromiso y su incorporación en la ordenación pesquera. El «contrato específico Nº2 del Contrato Marco - EASME/EMFF/2016/008 disposiciones de asesoramiento científico para la pesca fuera de las aguas de la UE» ha desarrollado un plan de ecosistema piloto para la ecorregión tropical del océano Atlántico. En este documento, destacamos los principales beneficios potenciales de la elaboración de planes de ecosistemas en ICCAT. En segundo lugar, describimos brevemente los principales elementos básicos desarrollados en el plan de ecosistema piloto para la ecorregión tropical del océano Atlántico. En tercer lugar, resumimos nuestras principales ideas y lecciones aprendidas en el desarrollo de este plan de ecosistema piloto para una ecorregión dentro de ICCAT. Por último, proponemos una lista de acciones, actividades de investigación y actividades de creación de capacidad para fomentar el desarrollo, la utilización y la aplicación de planes de ecosistemas en ICCAT.

KEYWORDS

Ecoregions, ecosystem planning, ecosystem goals, ecosystem trade-offs, ecosystem overview, ecosystem status assessment, ecosystem risk assessment, conceptual ecosystem models

1. Introduction

The implementation of an Ecosystem Approach Fisheries Management (EAFM) in tuna Regional Fisheries Management Organizations (RFMOs) has been patchy, as they lack a long-term plan, vision and guidance on how to operationalize it (Juan-Jordá et al. 2017). The Specific Contract N^0 2 under the Framework Contract - EASME/EMFF/2016/008 *provisions of Scientific Advice for Fisheries Beyond EU Waters*- addresses several scientific challenges and provides solutions to support the implementation of an EAFM through collaboration and consultation with the International Commission for the Conservation of Atlantic Tunas (ICCAT) and the Indian Ocean Tuna Commission (IOTC).

The main purpose of Specific Contract N^0 2 (SC02) is to provide the Directorate-General for Maritime Affairs and Fisheries (DG MARE) with:

- A list of ecosystem indicators (and guidance for associated reference points) to monitor impacts of fisheries targeting highly migratory tuna-and tuna like species. These indicators cover all ecological components of an EAFM, including target species, bycatch and threatened species, foodweb and trophic relationships, and habitats of ecological significance.
- Candidate ecoregions with meaningful ecological boundaries for highly migratory tuna-and tuna like species and its fisheries in the Atlantic and Indian Oceans order to facilitate the operationalization of EAFM in ICCAT and IOTC.
- Two pilot ecosystems plans, using two ecoregions as case studies, one within the ICCAT convention area and one within the IOTC convention area. These ecosystems plans have the main purpose of facilitating the linkage between ecosystem science and fisheries management and formalize the EAFM process.
- Recommendations to better link ecosystem science and fisheries management in order to foster the implementation of an EAFM.

2. Objectives and scope of the present study

Here we present a brief overview of the pilot ecosystem plan developed for the tropical ecoregion in the Atlantic Ocean. The full pilot ecosystem plan can be found in Juan-Jordá et al. (2019a) and the full report of the SC02 project in Juan-Jordá et al. (2019b). First, we highlight the main potential benefits of developing ecosystem plans in ICCAT. Second, we briefly describe the main core elements developed in the pilot ecosystem plan for the tropical ecoregion of the Atlantic Ocean. Third, we summarize our main thoughts and lessons learned in the development of this pilot plan for one ecoregion within ICCAT. Last, we propose a list of actions, research activities and capacity building activities to foster the development, use and implementation of ecosystem plans in ICCAT.

3. The main purpose and benefits of ecosystem plans

Ecosystem plan are based on objectives centered on the ecosystem and not on one individual species or stock targeted in a particular region. Ecosystem plans are used as a tool to identify and formalize ecosystem goals and objectives, plan actions based on priorities, measure performance of the whole fishery system, address trade-offs, and incorporate them in fisheries management (Levin et al. 2018). Therefore, ecosystem plans are documents that formalize the process of operationalizing the EAF in a region. It is important that ecosystem plans are tailored to a well-defined region in order to focus on its priorities and singularities.

There are multiple purposes and benefits in developing an ecosystem plan, which ultimately aims to guide the implementation of an EAFM in a region (NPFMC 2007, Staples et al. 2014, Levin et al. 2018), including:

(1) It creates a transparent process that may help the Commission to set ecosystem goals and management objectives;
(2) It provides a framework for strategic planning to guide and prioritize fishery and ecosystem research, modelling and monitoring needs;
(3) It facilitates the integration of information and knowledge from different fisheries operating in a region and their cumulative impact on the ecosystem;
(4) It provides a framework to document current and best practices in the region as well as the impediments hindering the operationalization of EAFM in the region;
(5) It provides a framework to identify key ecosystem components in the region, their interconnectedness, and their importance for specific management questions;
(6) It helps the Commission to understand the cumulative effects of fisheries and emergent trade-offs between multiple objectives;
(7) It serves as a communication tool to better link ecosystem science and policy and as a dialogue forum for managers, scientist and stakeholders;

The pilot ecosystem plan developed for the Tropical Ecoregion of the Atlantic Ocean seeks to guide and formalize the operationalization of an EAFM in this region and prescribe how fisheries management will be managed from an ecosystem perspective. At this stage, the pilot ecosystem plan developed seeks to create awareness about the need for ecosystem planning, initiate discussion about what elements need to be part of a planning process, and intents to be the foundation for future participatory and consultative ecosystem plans in ICCAT.

4. The core elements of pilot ecosystem plan

The geographic area of the ecosystem plan covers the tropical ecoregion of the Atlantic Ocean (**Figure 1**). Seven potential ecoregions within the convention area of ICCAT were proposed in the project *EASME/EMFF/2016/008 SC02 Selecting ecosystem indicators for fisheries targeting highly migratory species* (Juan-Jordá et al. 2019b). These ecoregions aim to guide ecosystem planning, research assessment and management at the regional level. The boundaries of the ecoregions rest on three pillars of information: the existing knowledge of biogeographic classifications of the pelagic environment, the spatial dynamics of tuna and tuna-like species and communities they form, and the spatial distributions of the main fishing fleets targeting them (for more details on the delineation of ecoregions see Task 3 of final project report). Each ecoregion is characterized by greater similarity in biogeographic and oceanographic characteristics, in tuna and billfish communities and the type of fishing fleets exploiting them. The proposed ecoregions aim to focus fisheries management on a specified place and on priority issues facing the most challenging needs for each region.

The pilot ecosystem plan for the Tropical Ecoregion of the Atlantic Ocean is composed of five core elements (**Figure 2**). These five core elements were considered to be the first steps towards the development of a formal ecosystem plan in the Tropical Ecoregion. At present, the current state and formulation of elements included in the ecosystem plan should be seen as preliminary as they need to be openly discussed with the SCRS and eventually with the Commission. Furthermore, the elements developed under this plan should not be considered as a complete list. Future revisions of this pilot ecosystem plan foresee to include additional elements.

Next, we briefly described each of core elements developed in this pilot plan.

4.1. Strategic vision, goals and objectives

An ecosystem plan needs a vision, goals, and objectives. A vision in line with the EAFM should be a long-term statement of the aspirations of the Commission of what the future would look like if management is successful accounting for ecosystem considerations (Staples et al. 2014). Ideally a strategic vision and high-level goals should be agreed by the Commission. ICCAT has not yet adopted ecosystem plans with formal ecosystem goals and objectives. Therefore, this pilot ecosystem plan included examples of vision statements and high level objectives from other organizations which can be used to guide the Commission when developing its own. A vision statement should encapsulate key principles of the ecosystem approach such as the sustainable use of fish resources, the conservation of biodiversity and the maintenance of resilient and productive ecosystems, and the provision of economic, social and employment benefits to stakeholders.

An example of a vision statement:

The North Pacific Fisheries Management Council in the USA adopted in 2014 an ecosystem policy that expressed the Council aspiration to continue moving towards implementing the ecosystem approach to fisheries management. The policy included a value statement, vision statement, implementation strategy and ecosystem goals. Its ecosystem vision articulates:

> **Vision statement**
> *"The Council envisions sustainable fisheries that provide benefits for harvesters, processors, recreational and subsistence users, and fishing communities, which (1) are maintained by healthy, productive, biodiverse, resilient marine ecosystems that support a range of services; (2) support robust populations of marine species at all trophic levels, including marine mammals and seabirds; and (3) are managed using a precautionary, transparent, and inclusive process that allows for analyses of trade-offs, accounts for changing conditions, and mitigates threats."*

4.2. Ecosystem overview -understanding the tropical ecosystem in the atlantic ocean

An ecosystem overview for the tropical ecoregion was developed as a core element of the ecosystem plan. The ecosystem overview integrates and synthesizes the existing knowledge of the main pressures and drivers that contribute to the state, and changes in the state, of the different ecosystem components in the ecoregion. The ecosystem overview also facilitated the identification of how the different ecosystem components interact and relate to each other, raising up those emergent issues that need to be monitored in the ecoregion and those research gaps that need to be addressed to have a complete view of the system. At the end, the ecosystem overview is just a tool that allows the synthesis and integration of all relevant and available ecosystem information of the tropical ecoregion, so it can be better communicated to the SCRS and the Commission.

The development of the ecosystem overview required the prior identification of the main pressures impacting the state of the marine ecosystem in the tropical ecoregion, and identification of what ecosystem components were being affected and impacted by these pressures in the region (**Figure 3**).

For practical reasons, the ecosystem overview synthesized and integrated of all relevant and available ecosystem information by dividing the pressure and state components of the ecosystem into the following sections (**Figure 4**):

- **Manageable pressures:** The ecosystem overview describes the main pressures that can be controlled by ICCAT management (fishing and dumping of marine debris). The overview examines the main fisheries, gear and fleets operating in the tropical ecoregion, as well as the main species being caught by these fisheries. It also summarizes the state of knowledge about the dumping of marine debris by ICCAT fisheries in this region.

- **Unmanageable pressures:** The ecosystem overview describes the main pressures that cannot be controlled by ICCAT (changing oceanographic/environmental conditions and climate). It describes the main oceanographic features of the tropical ecoregion and the state of knowledge of climate change impact on ICCAT fisheries in the region.

- **State of retained species**: It describes the state of the main commercial fish species, tunas, billfishes and sharks as well as the small tunas and other bony fish species caught and being retained by ICCAT fisheries because of their commercial value. Each fishery preferentially targets and retains a set of species but may also catch other fish species, that although not primarily targeted, are also retained for commercial reasons.

- **State of non-retained species:** It describes the state of the main species (fish and non-fish species) incidentally caught by ICCAT fisheries and non-retained either because of their low commercial value or the non-retention measures in place. Non-retained species include bony fishes, sharks, sea turtles, seabirds, and marine mammals.

- **State of foodweb and biodiversity:** It describes the state of knowledge of the main trophic relationships and the potential impacts of the fishing activity on the structure and functioning of the marine ecosystem in the tropical ecoregion.

- **State of habitats of ecological significance:** It describes the state of knowledge on habitats of ecological significance (e.g. spawning grounds, migration corridors, productive areas for feeding) for the species interacting with ICCAT fisheries and how these fisheries might be impacting them.

- **State of productivity:** It describes the state of productivity and main spatio-temporal patterns of the region and its link to fisheries productivity.

The full ecosystem overview can be found in Juan-Jordá et al. (2019a), yet, some of the main highlights are summarized below.

- **Manageable pressures -** The selective extraction of species by fishing is the primary manageable pressures by ICCAT having an effect on the state of the ecosystem. The ICCAT Commission does monitor the extent of fishing pressure and effort to support the design of sound management strategies to manage principally their main targeted species (principal market tunas, billfishes and some sharks), and to a limited extent to design management strategies that minimize and avoid undesired impacts on bycatch species, foodwebs and the broader the ecosystem. Despite the Commissions effort to monitor fishing effort, there have been limited resources and capacity to map the spatio-temporal patterns of fishing activity and fishing pressure across all the fleets and by area at relevant spatial scales. This limits the potential of defining area-based plans to minimize regional impacts of fishing on main target species, on vulnerable taxa (e.g. avoid localized depletions), and habitats of ecological significance. Additionally, the production and dumping of marine debris derived from fishing activities is another manageable pressure by ICCAT which can have an effect on the state of the ecosystem. There have also been limited resources and capacity to monitor and minimize the extent and magnitude of marine debris produced by ICCAT fisheries.

- **Unmanageable pressures -** Changes in the environment and climate are the main pressures non-susceptible to ICCAT management. The ICCAT Commissions are not monitoring or accounting for the effects of the environment and climate on ICCAT fisheries and species, with some few exceptions.

- **State of retained species -** 23 of the 28 species under the ICCAT mandate are found in the tropical ecoregion. The exploitation state for 11 species (19 stocks) is known, mostly covering principal market tunas (and few billfish and shark species), which are the main targeted and retained species by ICCAT fisheries in the region. However, around 181 fish species are known to interact with some degree with ICCAT fisheries. The extent of the interactions is poorly known and monitored for most of them.

- **State of non-retained species -** The extent of the interactions between ICCAT fisheries and the large majority of non-retained species including sharks, marine turtles, seabirds and marine mammals are poorly known and monitored in the region. Ecological risk assessments conducted for the different taxonomic groups and gears have been determinant to prioritize work and identify those species most at risk by each fishing gear in the region. There are a number of fish and non-fish species interacting with ICCAT fisheries that have been categorized as threatened by the IUCN Red List and are currently listed in CITES.

- **State of foodweb and biodiversity -**The cumulative impacts of ICCAT fisheries on the structure and function of the foodweb in the Tropical ecoregion also remain poorly monitored and understood.

- **State of habitats of ecological significance -** Habitat of ecological significance, which might include areas used by species for spawning grounds and migration corridors, productive areas for feeding, or areas of high biodiversity where multiple species aggregate in a particular time, are also poorly monitored and understood in the tropical ecoregion.

4.3. Conceptual ecosystem models – undestanding the key ecological interactions in the tropical atlantic ecosystem

While the ecosystem overview facilitated the integration of relevant knowledge and research for the tropical ecoregion, it does not connect well how the different ecosystem components interact and relate to each other. It is pivotal the ecosystem plan identifies well the key interactions between the different ecosystem components to ensure a more holistic and integrative view of how the different pressures may be affecting species and the structure and functions of the ecosystem they rely. Therefore, several conceptual models of the ecosystem were developed at different scales of detail (at the ecosystem and fishery level) to assist in the identification and the visualization of those relevant ecosystem components and their interconnection in the region. The conceptual models allowed to identify a manageable number of issues that may require monitoring or need to be researched separately or jointly, and ensured that no critical components are missed.

All the developed conceptual models of the ecosystem can be found in Juan-Jordá et al. (2019a), yet, one conceptual model is shown below to illustrate an example (**Figure 5**). This multifishery conceptual model illustrates the main fisheries operating in the Tropical Atlantic ecoregion and their interactions with different species and taxonomic groups.

The ecosystem overview and the conceptual ecosystem models allowed the identification all the relevant ecosystem interactions that ICCAT should be monitoring in the tropical ecoregion to avoid undesired ecosystem states (**Figure 6**). Monitoring the key interactions with different pressure and state indicators would allow to provide feedback to the Commission about the state of each interactions, as well as identify the research and data gaps than hinders the monitoring of specific interactions. Ecosystem indicators as well as management objectives are needed to monitor key interactions as well as to determine how a well an interaction is managed in relation to management objectives.

At this stage, the ecological interactions identified in the tropical ecoregion should be treated as equally relevant to monitor changes in the ecosystem and avoid undesired ecosystem states. However, some interactions might be more relevant than others, either because they are more prevalent and have a higher probability to occur or because their level of impact might be relatively higher which might be imposing a high cost to the fishery or the ecosystem. Therefore, it is not only important to identify the existing ecological interactions, but also their importance to assess their relative risks (NPFMC 2007). In the future, an ecosystem risk assessment should be conducted to determine the degree of importance of each interaction to the Commission. At a glance, an ecosystem risk assessment aims to quantify the strength of each interaction, its risk, based on two sources of information, their probability of occurrence as well as the level of impact to the current ecosystem state. Defining these interactions and their relative importance and risk in the system, can provide the Commission with a tool to prioritize potential issues, make choices between different risks and trade-offs or take actions to avoid unwanted risk through appropriate management actions (NPFMC 2007).

4.4. Skeleton of an indicator based assessment for monitoring ecosystem interactions

For each ecosystem interaction illustrated in **Figure 6**, the ecosystem plan elaborated the following elements:

- A **description of the interaction and the potential risks** of not monitoring the interaction.
- A proposal of several **potential management objectives** to track the state of the interaction.
- A **list of ecosystem indicators** to assess the state of the interaction. The ecosystem indicators proposed under each ecosystem interaction have two main purposes under this pilot ecosystem plan: (1) to help assess the state of the ecosystem components and their relevant interactions, and (2) to assess how well a fishery is managed in relation to objectives. The proposed indicators were divided into three categories depending on the on-going work in ICCAT and data availability to estimate them: (1) Indicators currently estimated and/or monitored in ICCAT; (2) Indicators for which data is potentially available (or partially available), but are not currently estimated and/or monitored by ICCAT; (3) Indicators for which data is not currently and readily available for their estimation, but are included to guide future data collection and research efforts. Notice that the pilot plan merely proposes a list of candidate indicators and does not go through the process of estimating them.

- A snapshot of **potential data sources, data gaps and research needs** to support the future development of the indicators.
- A **synopsis of what the Commission is doing** to monitor (and potentially address the potential risks) each interaction. It also identifies actions that the Commission may need to initiate in order to monitor and address the potential risks associated with the interactions.

The proposed management objectives, ecosystem indicators and synopsis of what the Commission is doing to address each interaction intend to be an interim step towards developing a comprehensive regionalized ecosystem status assessments at the ecoregion level. Ecosystem status assessments aim to provide an integrated overview of the health and status of the ecosystem in a given region. Ecosystem status assessments can be a powerful tool to inform fisheries and marine resource decision making and advice for several reasons: (1) they can provide early signals of the impacts of pressures (fishing, climate) on ecosystem components that might warrant management interventions; (2) they can spur new understanding of the connections between ecosystem components by bringing together the results from a blend of data observations, data analysis, models and indicators; (3) they can bring ecosystem indicators and research efforts that are not easily incorporated into single species stock assessments to the attention of managers, and (4) they can provide evidence on the efficacy of past management measures (Zador et al. 2017).

The aforementioned elements (objectives, indicators, data sources, risks for the Commission) have been fully developed for each of the ecosystem interactions identified (**Figure 6**) and can be found in Juan-Jordá et al. (2019a). The work developed for one of the ecosystem interactions is shown below to illustrate one example.

INTERACTION I - Impact of purse seine associated to FADs on vulnerable taxa

Description
In order to monitor and reduce the impacts of purse fisheries associated to Fish Aggregating Devices (FAD) on vulnerable taxa, it is important to distinguish between interactions and mortality rates. Some purse seine fisheries employ post-capture mitigation measures as they attempt to decrease the mortality rates of the species (Hall and Roman 2013). Purse fisheries setting on FADs interact with a wide range of taxa that is non-retained which is discarded or released back into the sea dead or alive (bony fish, sharks, rays, sea turtles and marine mammals) (Amande et al. 2008). On general terms the cumulative magnitude and regional extent of purse seine interaction (across all the fleets) with the different taxa (bony fish, sharks, rays, sea turtles and marine mammals) and post-mortalities is poorly known in the Tropical ecoregion. There are some exceptions since some national fleets monitor and report their level of interactions with vulnerable taxa (see Ecosystem Overview). In some fleets, the observer coverage is relatively high (~50-60% coverage) and therefore the spatial and temporal scale of the reporting is of relatively good quality.

Purse seiners pose negligible threats to turtles relative to longlines, however they are still captured in purse seiners setting on FADs (Amandé et al. 2010). While sea turtles are caught in small numbers by purse seiners and they can be release alive relatively easily, if entangle in the FADs and not released they may die (Hall and Roman 2013). While the total number of sea turtles interactions with purse seine gear have not been estimated and it is not known in the ICCAT convention area, the number of interactions and bycatch rates of sea turtles of purse seiners is known for some fleets (Amandé et al. 2010). The EU purse seine fishery, which operates entirely in the Tropical Ecoregion, reported that the green and loggerhead turtles had the largest number of interactions with purse seiners setting on FADs between 2003-2007. A more recent study estimated that the European Spanish and France purse seine fishery operating in the Atlantic Ocean incidentally caught annually 218 (standard deviation 150) individuals between 1995 and 2011, with more than 75% release alive (Bourjea et al. 2014). This study also showed that the number of by-caught turtles per observed set is very similar in both purse seine fishing modes, nets setting on free schools and FADs. For sharks and rays, the silky shark and the giant manta ray (*Mobula birostris*) was the one with the largest number of interactions with purse seine associated to FADs (Amandé et al. 2010). The EU purse seine tuna fishery setting on FADs operating in the eastern tropical Atlantic has reported zero interactions with marine mammals (Amandé et al. 2010). Longline fisheries also interact with marine mammals, but the extent of the interactions is poorly documented. Overall, the magnitude and regional extent of these mammal interactions with the different gears and post-mortalities is poorly known.

What is the risk of not monitoring this interaction?

The abundance of species most vulnerable to ICCAT fisheries, those being highly susceptible to being caught by ICCAT fisheries and well as having low intrinsic productivity values, might decline to low levels jeopardizing their reproductive capacity if not properly monitored.

Management objectives

-Minimize and reduce the number of interactions of fishing on non- retained vulnerable taxa
-Increase the post-release survival of non-retained vulnerable species
-Monitor and prevent overfishing of non- retained vulnerable species
-Protect species most-at-risk

Candidate Indicators to evaluate whether objectives are met:

Priority species to develop the indicators:
Bony fish – There are not non-retention measures in place for any species
Sharks – Silky shark (*Carcharhinus falciformis) and Oceanic whitetip shark*
Rays **-** Giant manta ray (*Mobula birostris*)
Sea turtles - Green and loggerhead turtles
Marine mammals – Priority species unknown. Ecological risk assessments have not been conducted for any gear.
Seabirds – Negligible impacts on seabirds

Indicators which are currently estimated and/or monitored in ICCAT	**Indicators currently not monitored in ICCAT for which data are potentially available**	**Indicators currently not monitored in ICCAT for which data are not available**
• Number of interactions for some fleets with limited spatial and temporal coverage • Number of bycatch vulnerable species release dead and alive for some fleets with limited spatial and temporal coverage • Post release mortality for some species and fleets	• Bycatch per unit effort • Frequency of bycatch and total number of interactions of bycatch species • Discard survival of bycatch species (total number of individuals killed per fleet) • Population level mortality of bycatch species • For fish and sharks -Single species size based indicators (mean length, 95th percentile of the length distribution, Proportion of fish larger than the mean size of first sexual maturation) • For fish and sharks - Distributional range (including extent, center of gravity, pattern within range and pattern along environmental gradients) • For fish and sharks -Single species biomass/abundance/catch rate indicators • For fish and sharks -Single species catch	• For sea turtles, marine mammals - Biomass/abundance of species • Population genetic structure • For sea turtles, marine mammals -Distributional range (including extent, center of gravity, pattern within range and pattern along environmental gradients) •

Data sources, data gaps and research needs

The catch statistics (Task I and Task II) for the non-retained bony fishes, sharks and rays are of low quality due to the large underreporting by CPCs. The quantity of fish non-retained, and therefore discarded at sea, dead or alive, is generally poorly monitored, as this is poorly or non-reported in logbooks. Yet, these data are collected by some fleets via logbooks or as part of the observer programs.

Data collected by the National observers programs still remains the main source of information to develop most of the indicators proposed above. Similar to the measures of impacts derived from longliners, the most important indicators to measure impacts of purse seiners on vulnerable taxa should be bycatch rates (i.e. number of individuals killed per a given unit effort) and total number of individuals killed per fleet and it important that both of these indicators should be used together as an overall indicator to monitor bycatch trends over time.

The estimation of these indicators still depends on the observer data collected in the National observer programs of each CPC, and while some CPCs collect and report these measures to ICCAT, the majority do not report it, and if reported, the spatial and temporal extent of the data is too fragmented and too coarse to compute reliable indicators that can be used to provide management advise. There are some exceptions since some national fleets monitor and report their level of interactions with vulnerable taxa (see section 3).

For purse seiners, while the minimum level of observer coverage is 5%, some countries are not achieving these levels while others have 100% observer coverage (ICCAT 2012). The use of electronic monitoring systems to increase the observer coverage in large scale purse fisheries should be further encouraged as well as supporting the development of electronic monitoring and electronic reporting standards to ensure data collected by different members can be collated and used in a sound manner (ICCAT 2018).

Recommendation for indicator development

- Bycatch rates (total number of interactions per unit effort or production of target species) as well as bycatch mortality rates (i.e. number of individuals death per a given unit effort or production of target species)
- Total number of individuals dead per fleet
- Total number of release alive
- Post release mortality for different species

Relevance and implications for management

(a) How is the commission addressing the risk now?

- CPCs have to collect, monitor and report to the Secretariat the level of interactions and mortality rates of vulnerable taxa, yet the reporting level is low.
- The minimum level of observer coverage is 5%, whole some countries are not achieving this levels, others have 100 observer coverage.
- It has a requirement for purse seiners for using non-entangling and biodegradable FADs to minimize impacts on vulnerable taxa.
- It has adopted a measure to prohibit the discards of target tunas in tropical tuna purse seine fisheries (Rec 17-01), which can help improve the reliability of catch statistics for the main target tunas as well as improve regional food security.
- Encourages further research and testing of more efficient mitigation methods to reduce the impacts of fisheries (e.g. shark deterrent measures).

(b) What other actions might the Commission put in place to address and mitigate the risk?

- Ensure requirements for non-entangling and biodegradable FADs are being met by CPCs to reduce impacts on vulnerable taxa.
- While it has adopted a measure to prohibit the discards of target tunas in tropical tuna purse seine fisheries, which can help improve the reliability of catch statistics for the main target tunas and regional food security, the expansion of this measure to other bonyfish species should be investigated.
- Encourage and fund collaborative efforts involving relevant CPCs to quantify the cumulative impacts including total number of interactions, discard rates and mortality rates of vulnerable taxa based on information collected in the observer programs of their fleets
- To make mandatory the progressive increase of observer coverage to 100% including human and EMS for all year round to improve the reliability of the data collected in these programs.
- Encourage the use of electronic monitoring systems to increase the observer coverage and the development of electronic monitoring and electronic reporting standards to ensure data collected by different members can be collated and used in a sound manner.
- Require the monitoring of the number of interactions with marine mammals in the ST09forms
- Explore the utility of the data collected from observer programs to estimate alternative indicators such as the distributional range of the species
- Test and develop emergent mitigation methods to reduce impacts of fisheries (e.g. shark deterrent measures)

4.5. A strategy for communication and producing ecosystem advice

The process of operationalizing an EAFM requires at least three major steps: ecosystem planning, the development of ecosystem assessments, and linking ecosystem knowledge to fisheries management (**Figure 7**). This ecosystem plan also proposes a series of steps and how they could be connected to better link ecosystem science and fisheries management advice.

5. Overall thoughts and lessons learned in the development of this pilot plan

- At this stage, this pilot ecosystem plan seeks to create awareness about the need for ecosystem planning, initiate discussion about what elements need to be part of a planning process, and intents to be the foundation for future participatory and consultative ecosystem plans in the ICCAT.

- The five core elements developed in the pilot ecosystem plan should be considered to be the first steps towards the development of a formal ecosystem plan of the Atlantic tropical ecoregion. At present, the current state and formulation of elements included in the ecosystem plan should be seen as preliminary as this is a pilot study that needs to be openly discussed with the SCRS and Commission. Furthermore, the elements developed under this plan should not be considered as a complete list. Future revisions of this pilot ecosystem plan could also envision to include additional elements. For example, it could include a section with management actions needed to meet each specific objective, a section on skills and capabilities to support the implementation of the plan, as well as identify continuous financial support for ensure its implementation, to name a few (see recommendations section).

- While the pilot ecosystem plan has focused on a region (the tropical ecoregion) with well-defined geographic boundaries, these boundaries should be relaxed when developing ecosystem analyses and assessments to allow understanding of the external pressures, impacts and ecosystem processes governing in the region. The geographical boundaries of the ecoregion should guide the ecosystem planning and assessment of the region but not be used as rigid boundaries. By regionalizing the ecosystem plans, the ecosystem-level management advice will focus on the most pressing and challenging needs of each ecoregion.

- Ecosystem plans should be driven by objectives centered on the ecosystem, and not on individual species or stocks. ICCAT has not developed and adopted their own ecosystem policy which should include a well-defined ecosystem vision statement, ecosystem goals and an implementation strategy to achieve them. The pilot plans include examples of ecosystem vision statements adopted by other organizations and programs and highlight their commonalities to guide the Commission on what key principles should be included when developing its own.

- The ecosystem overview developed for the tropical ecoregion have facilitated the synthesis and integration of all relevant and available ecosystem information of this region, so it can be better communicated to the Commission. It is important to highlight that each ecoregion identified in the ICCAT convention area would be characterized by unique biogeographic and oceanographic characteristics, characterized by different tuna and billfish communities and different type of fishing fleets exploiting them. The bycatch species and the extent of the impacts of fisheries on bycatch species would also be expected to differ by regions.

- The conceptual ecosystem models developed for the tropical ecoregion allowed the identification of 14 relevant ecological interactions to be monitored by ICCAT to ensure the sustainable management of all its fisheries and avoid undesired changes of ecosystem state. It is anticipated that many of the broad ecosystem interactions identified will be very similar in other ecoregions, however the type of fisheries operating in each ecoregion and species targeted will be different with different expected impacts on the ecosystems.

- All the ecological interactions identified in the tropical ecoregion are treated at this stage as equally important to monitor changes in the state of the ecosystem and avoid undesired ecosystem states. However, some interactions might be more relevant than others, either because they are more prevalent and have a higher probability to occur or because their level of impact might be relatively higher which might be imposing a high cost to the fishery or the ecosystem. It is also expected that the relative importance of these interactions will also differ by ecoregion. In the future, regional level ecosystem risk assessment should be conducted to determine the degree of importance of each interaction to the Commission, so the

Commission can prioritize research, management actions and make choices between different risks at the ecoregion level. Regulatory and socio-economic interactions should also be identified in future revised ecosystem plans so they can be accounted in the ecosystem risk assessments.

- Some lessons were also learned in the process of proposing management objectives and candidate indicators for each of the interactions identified.
    - ICCAT only routinely monitors a small number of the proposed ecosystem indicators. However, many ecosystem indicators could potentially be developed in the short term using the data available in ICCAT, using the data collected by the observer programs, and using external data sources. Ecosystem indicators, for which data are not currently and readily available for their estimation, are still included in the proposal, to guide future data collection and research efforts.

    - Currently the catch, effort and size data with explicit spatial information is only available for a small number of ICCAT species, which hampers the regional development of many of the ecosystem indicators proposed.

    - Many of the proposed indicators rely on data collected by the national observer programs and on the level of coverage of these programs. The data derived from these programs are currently underexploited for the development of ecosystem indicators. This is due in part because the observer data held by the ICCAT Secretariat at their current state are of no use to develop any of the ecosystem indicators proposed in this project. These is because the spatial and temporal coverage, the aggregation levels, and quantity of the data received by the ICCAT is poor. Alternatively, the direct access to the observer data collected by National observer programs of each CPC offer an opportunity to estimate many of the ecosystem indicators proposed. Joint-CPC projects are recommended for the development of ecosystem indicators to understand the cumulative effects of fishing and climate on marine ecosystems and to override the confidentiality rules of the data.

    - There have been limited resources and capacity in ICCAT to conduct end-to-end ecosystem modelling to better understand the direct and indirect effects of fishing and environment on the population dynamics of tuna species and marine foodwebs. ICCAT lags behind other tuna RFMOs (WCPFC and IATTC) in terms of developing such ecosystem modelling analyses. Many of the ecosystem indicators proposed also rely on the development of ecosystem models since they are model-derived. On one side, ICCAT should promote and support studies of fish diet, feeding ecology and food habits to support the development of ecosystem models and better understand trophic interactions and foodweb dynamics in marine ecosystems. On the other side, ICCAT should promote and support the development and use of a suite of modelling techniques (from multispecies models, size-based community models, end-to-end ecosystem models, bioenergetic models).

- The identified interactions (and proposed management objectives and candidate indicators to monitor those interactions) intend to be an interim step towards informing the development of comprehensive regionalized ecosystem status assessments at the ecoregion level. Ecosystem status assessments aim to provide an integrated overview of the health and status of the ecosystem in a given region. Ecosystem status assessments can be a powerful tool to inform fisheries and marine resource decision making and advice for several reasons: (1) they can provide early signals of the impacts of pressures (fishing, climate) on ecosystem components that might warrant management interventions (2) they can spur new understanding of the connections between ecosystem components by bringing together the results from a blend of data observations, data analysis, models and indicators; (3) they can bring ecosystem indicators and research efforts that are not easily incorporated into single species stock assessments to the attention of managers, and (4) they can provide evidence on the efficacy of past management measures.

- This pilot ecosystem plan focuses on the operationalization of an ecosystem approach to “fisheries” management, by identifying and addressing issues that can only be dealt by the fisheries sector and by ICCAT. It does not cover other human sectors such as navigation, tourism or pollution as these are not under the manageable activities of ICCAT. However, this non-fishery derived pressures might also have an impact on marine ecosystems and ultimately the conservations and sustainable use of tuna and tuna-like species. Addressing them might require more cross sectoral management and coordination with other international and intergovernmental institutions. This plan does not address these cross sectoral interactions which could be addressed in future plans if deemed relevant.

- This pilot ecosystem plan only addresses the ecological component of an EAFM. While the process of operationalizing the EAFM process rests on the three pillars of sustainable development including the ecological well-being, socio-economic well-being and good governance (FAO 2003), this plan only focuses on developing the ecological aspects to be taken into account when providing ecosystem advice, and does not address the socio-economic and governance aspects of fisheries. Until the socio-economic considerations and governance are addressed properly, this pilot ecosystem plan will only be partially guiding the operationalization of EAFM in the tropical ecoregion.

6. Recommendations and future steps to formalize the development and use of ecosystem plans in ICCAT

We propose the following list of actions, research activities and capacity building activities to foster the development, use and implementation of ecosystem plans in ICCAT.

#	Recommendations/action item	Timing	Milestone
1	The pilot Ecosystem Plans should be presented, discussed and reviewed by the ICCAT Sub-Committee on Ecosystems (SUBECO) and the Standing Committee on Research and Statistics (SCRS) to evaluate its usefulness and promote further steps.	Short-term	Ecosystem plan presented at the ICCAT SUBECO 2019 meeting
2	The regionalization of the ecosystem plan, its potential benefits and drawbacks, need to be further discussed and reviewed by the SUBECO and the SCRS.	Short-term	Ecosystem plan and implications of regionalizing the ecosystem plan presented at the ICCAT SUBECO 2019 meeting
3	Future versions of an ecosystem plan should incorporate an ecosystem risk assessment, which will become a cornerstone of the plans. An ecosystem risk assessment will determine the degree of importance of each of the interactions and issues identified in the pilot ecosystem plans. It will help prioritize the main issues and research actions that need to take place to avoid unwanted risk through appropriate management actions to the Commission.	Short-term	ICCAT requests to the SCRS to develop formal ecosystem risk assessments to be developed as part of the pilot ecosystem plans
4	An EAFM engagement strategy and standardized EAFM road map materials for widespread use should be developed to communicate the importance of ecosystem planning and ecosystem assessments to the Commission.	Short-term	SCRS to develop outreach materials for Commission
5	The ICCAT SUBECO should continue the development of ecosystem assessments (and ecosystem report cards). The on-going assessments in ICCAT can benefit from the current ecosystem plan and vice versa and both efforts should be coordinated. The pilot ecosystem plan identifies and proposes candidate indicators that can inform the current development of ecosystem assessments in ICCAT.	Short-term	The ICCAT SUBECO develops the first version of an ecosystem assessment and ecosystem report card to be presented to the Commission
6	ICCAT Commission needs to agree on an ecosystem vision, goals and objectives for the pilot Ecosystem Plan (or any ecosystem plan). The Commission should request to the SCRS to develop a formalized Ecosystem Plan(s).	Medium-term	ICCAT Commission agrees on vision, goals and objectives for the Ecosystem Plans ICCAT requests to the SCRS to develop a formal ecosystem plan
7	An Ecosystem Plan Team should be created in ICCAT to oversight the development of the ecosystem plan(s) and to provide	Medium-term	Ecosystem Plan Team created by the SCRS or SUBECO

	recommendations and guidance to the SCRS and the Commission.		
8	Future versions of an ecosystem plan should identify how the ecosystem plan interacts with other Commission processes as well as other SC activities and research programs.	Medium-term	Commission requests to the SCRS to develop a formal ecosystem plan
9	Future version of an ecosystem plan should consider including a section on skills and capabilities to support the implementation of the plan, as well as identify continuous financial support to ensure its implementation.	Medium-term	Commission requests to the SCRS to develop a formal ecosystem plan
10	An Ecosystem Plan Coordinator/Analysist at the ICCAT Secretariat would facilitate the development of many of the activities proposed here.	Medium-long	Ecosystem Plan Coordinator/Analysist hired at the ICCAT Secretariat
11	Future versions of an ecosystem plan should consider including the socio-economic and governance aspects of fisheries in the region covered by the plan. Until the socio-economic and governance considerations are addressed properly, an ecosystem plan will only be partially guiding the operationalization of EAFM in the covered region.	Long-term	Socio-economic Working Group created at ICCAT. Short term consultancy acquired to develop a strategy to develop the socio-economic components of an ecosystem plan. Each CPC develops a National Plant report on economic and socio-economic considerations of their tuna-and tuna-like fisheries.

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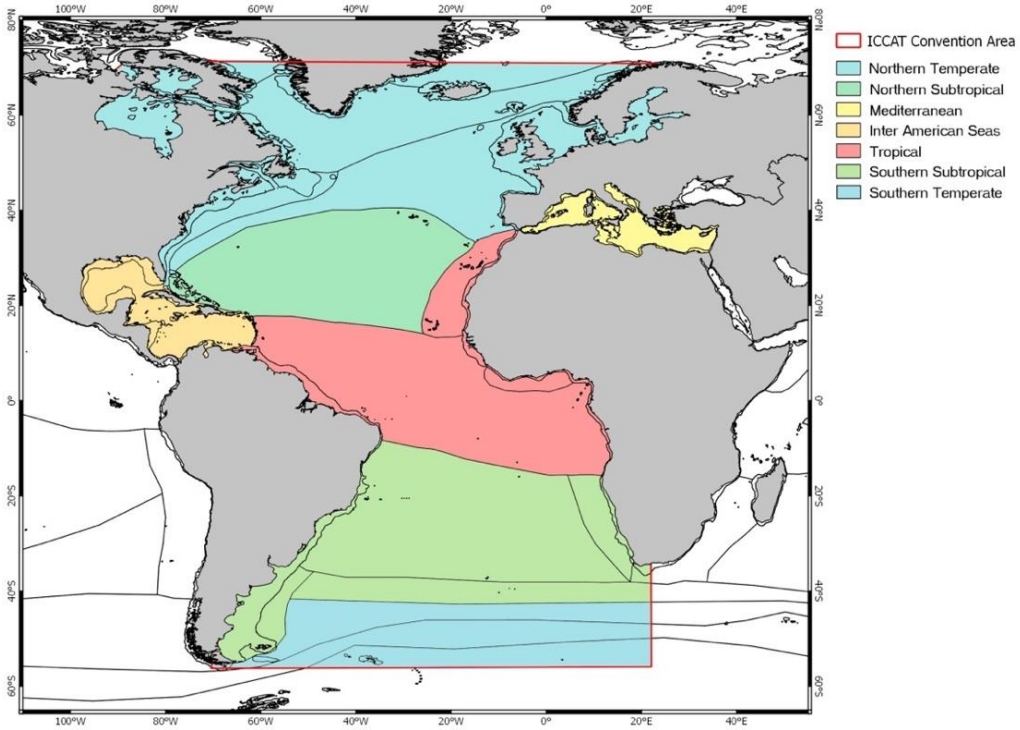

Figure 1. Proposal of ecoregions within the ICCAT Convention area. The Tropical Ecoregion is the core area of this ecosystem plan.

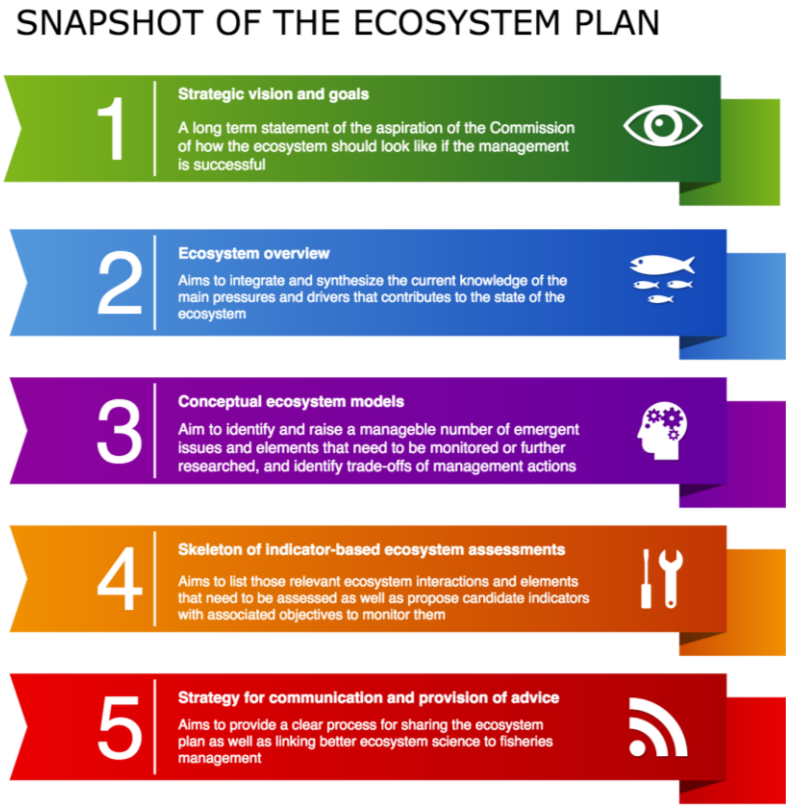

Figure 2. A snapshot of core elements of the pilot ecosystem plan for the Tropical Ecoregion.

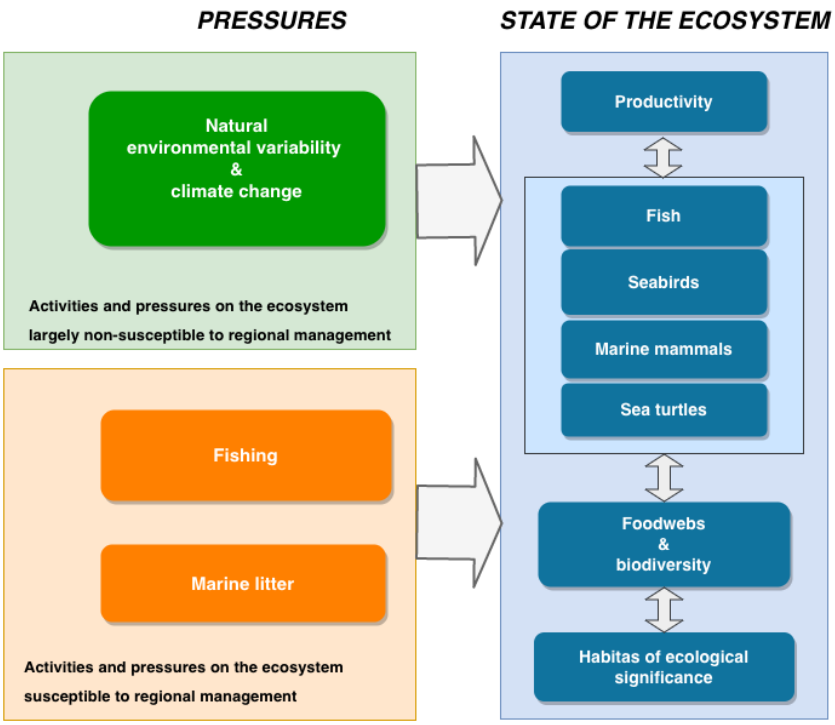

Figure 3. Major regional pressures affecting the state of the different ecosystem components in the tropical ecoregion of the Atlantic Ocean.

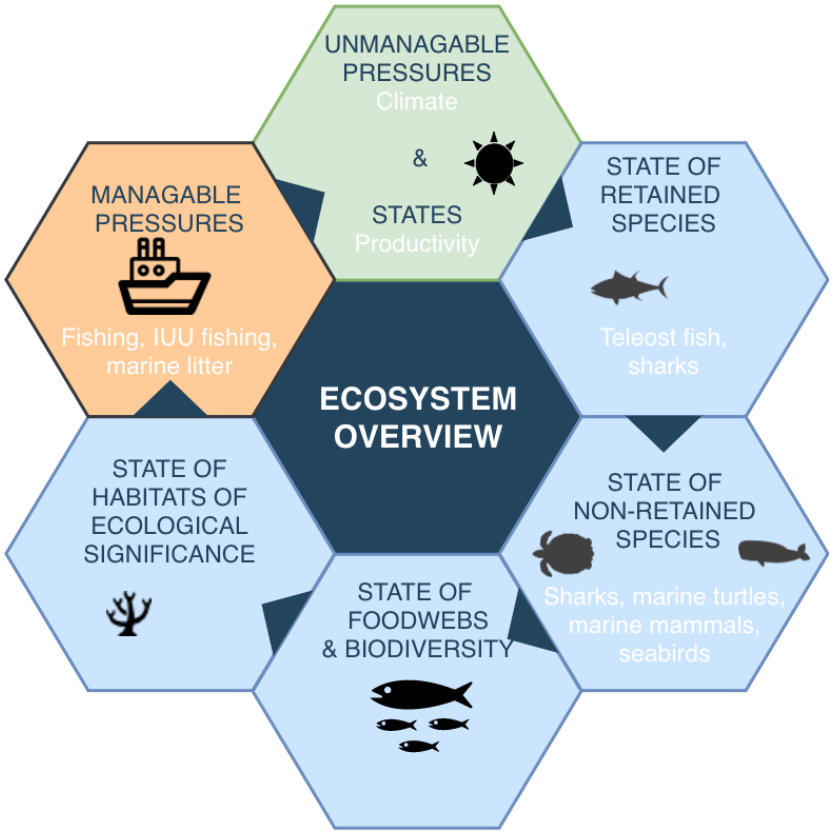

Figure 4. Main ecosystem components described in the ecosystem overview.

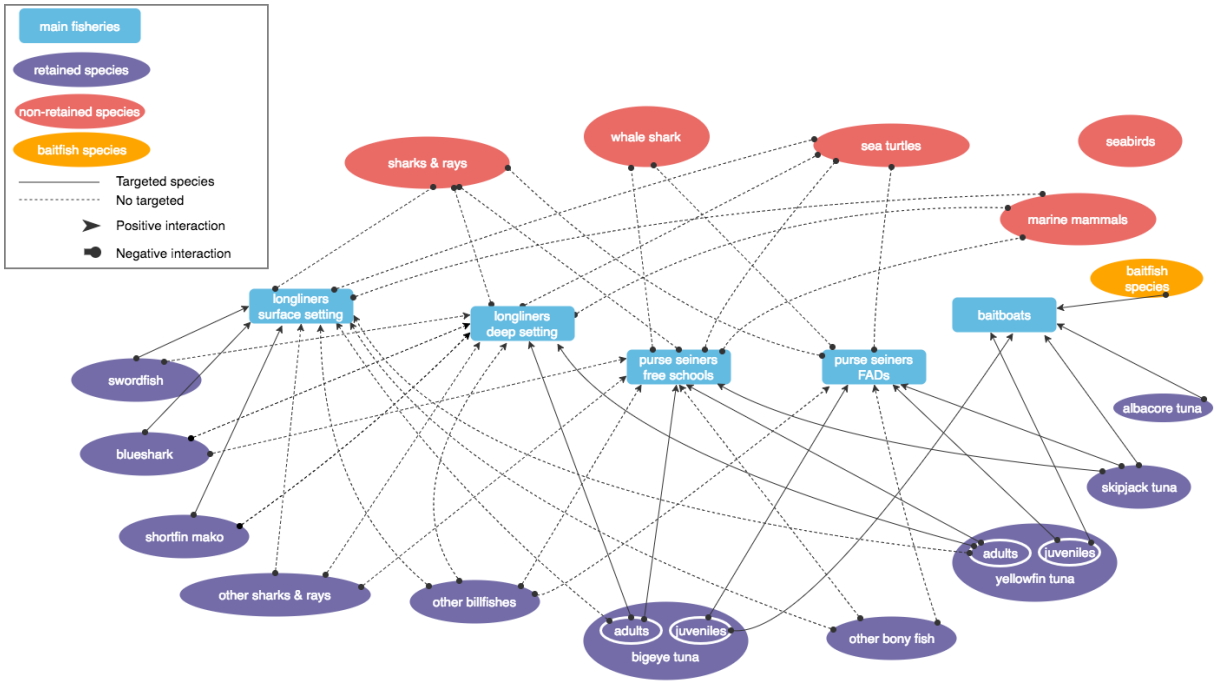

Figure 5. General multifishery conceptual ecosystem model of the tropical ecoregion linking the main gears to their main retained and non-retained species. The lines indicate links or interactions between components, where an arrow indicates a positive effect on the terminal group, a dot indicates a negative effect on the terminal group, a stripe indicates a neutral effect on the terminal group and a diamond indicates an unknown effect on the terminal group.

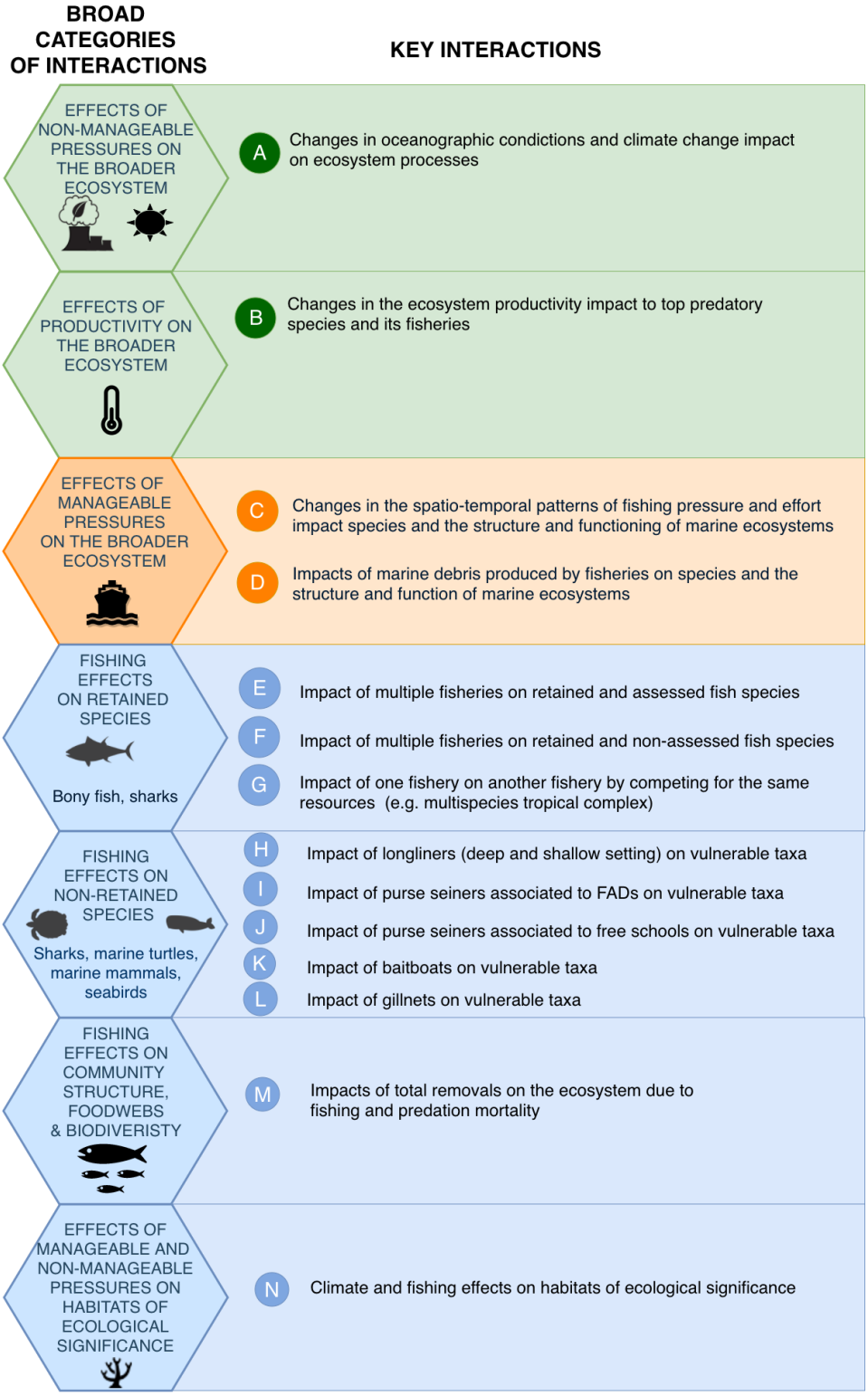

Figure 6. Key interactions considered relevant in the tropical ecoregion to be monitored by the Commission.

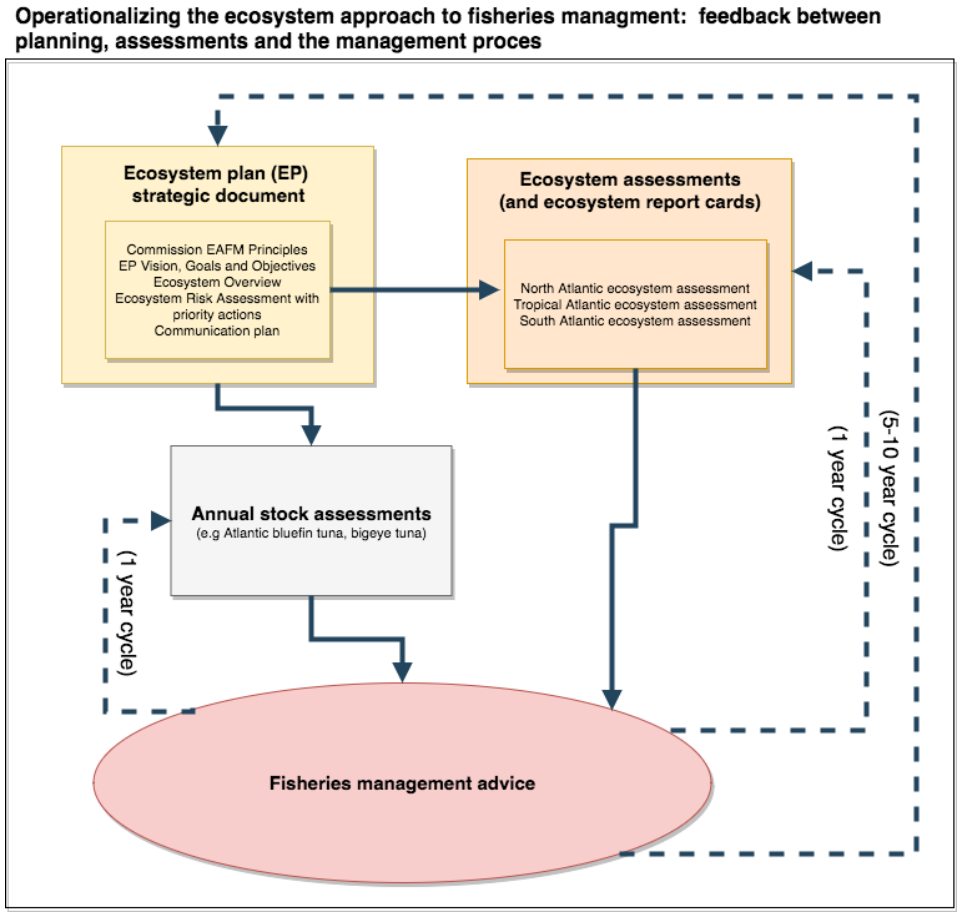

Figure 7. Operationalizing an EAFM requires the feedback between ecosystem planning, ecosystem assessments and fisheries management