REPORT OF THE ICCAT WORKSHOP ON THE IDENTIFICATION OF REGIONS IN THE ICCAT CONVENTION AREA FOR SUPPORTING THE IMPLEMENTATION OF THE ECOSYSTEM APPROACH TO FISHERIES MANAGEMENT

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SUMMARY

The Sub-Committee on Ecosystems (SubEco) convened a workshop to advance the identification of ecologically meaningful regions (ecoregions) in the ICCAT Convention area to support the implementation of the ecosystem approach to fisheries management (EAFM). Ecoregions may provide a spatial framework to support regional ecosystem planning and prioritization, incentivized ecosystem research and the development of integrated advice products for informing fisheries management-decisions. Prior to the workshop, a consultant was hired to prepare a baseline ecoregion proposal to be presented and discussed at the workshop. During the workshop, the Group discussed the potential benefits and potential uses of ecoregions in the context of ICCAT species and fisheries, and provided feedback on the technical aspects, the data and methodologies used in the derivation of the baseline ecoregions proposal. The Group refined the baseline ecoregion proposal which resulted in a proposal of eight candidate ecoregions within the ICCAT convention area. The Group recommends that the SubEco endorses the proposed candidate ecoregions to develop pilot projects to test the usefulness and utility of the ecoregions as a tool to progress on EAFM implementation in ICCAT.

RÉSUMÉ

Le Sous-comité des écosystèmes a organisé un atelier afin de faire progresser l'identification de régions écologiquement significatives (écorégions) dans la zone de la Convention de l'ICCAT afin de soutenir la mise en œuvre de l'approche écosystémique de la gestion des pêches (EAFM). Les écorégions peuvent fournir un cadre spatial pour soutenir la planification et la priorisation des écosystèmes régionaux, la recherche incitative sur les écosystèmes et le développement de produits d'avis intégrés pour éclairer les décisions de gestion des pêches. Avant l'atelier, un consultant a été engagé pour préparer une proposition d'écorégion de base qui sera présentée et discutée lors de l'atelier. Au cours de l'atelier, le Groupe a discuté des avantages potentiels et des utilisations possibles des écorégions dans le contexte des espèces et des pêcheries de l'ICCAT, et a fourni des commentaires sur les aspects techniques, les données et les méthodologies utilisées pour élaborer la proposition d'écorégions de base. Le Groupe a affiné la proposition d'écorégions de base, ce qui a donné lieu à une proposition de huit écorégions potentielles dans la zone de la Convention de l'ICCAT. Le Groupe recommande que le Sous-comité approuve les écorégions potentielles proposées afin de développer des projets pilotes pour tester l'utilité des écorégions comme outil pour progresser dans la mise en œuvre de l'EAFM au sein de l'ICCAT.

RESUMEN

El Subcomité de ecosistemas (SC-ECO) convocó unas jornadas para avanzar en la identificación de regiones ecológicamente significativas (ecorregiones) en la zona del Convenio de ICCAT para apoyar la implementación del enfoque ecosistémico en la ordenación de las pesquerías (EAFM). Las ecorregiones podrían proporcionar un marco espacial para apoyar la planificación y el establecimiento de prioridades regionales de los ecosistemas, la investigación incentivada de los ecosistemas y el desarrollo de productos de asesoramiento integrados para aportar información para las decisiones de ordenación de las pesquerías. Antes de las jornadas, se contrató a un asesor para que preparara una propuesta de ecorregión de referencia que se presentaría y debatiría en las jornadas. Durante las jornadas, el Grupo discutió los posibles

beneficios y usos de las ecorregiones en el contexto de las especies y las pesquerías de ICCAT, y aportó comentarios sobre los aspectos técnicos, los datos y las metodologías utilizadas en la derivación de la propuesta de ecorregiones de referencia. El Grupo perfeccionó la propuesta de ecorregión de referencia, que dio como resultado una propuesta de ocho ecorregiones candidatas dentro de la zona del Convenio de ICCAT. El Grupo recomienda que el Subcomité de ecosistemas respalde las ecorregiones candidatas propuestas para desarrollar proyectos piloto que pongan a prueba la utilidad de las ecorregiones como herramienta para avanzar en la implementación del EAFM en ICCAT.

KEYWORDS

Ecoregions, spatial framework, regional advice, integrated advice

1. Introduction

1.1 Background and purpose of this workshop

ICCAT has committed to operationalize the ecosystem approach to fisheries management (EAFM) in accordance with internationally agreed standards. EAFM is a spatially-explicit approach for the integrated management of fisheries that incorporates ecosystem knowledge and uncertainties, considers multiple external influences and endeavors to account for diverse societal objectives (Garcia *et al.* 2003, Fogarty 2014). Therefore, one of the starting points and fundamental requirements to effectively implement EAFM is the delineation of spatial units or ecologically meaningful regions, i.e. ecoregions (Staples *et al.* 2014, Fletcher *et al.* 2010). Ecoregions are generally geographically defined areas exhibiting relatively homogeneous ecosystems, and are designed to be units of analysis to support ecosystem planning, incentivized ecosystem research, integrated ecosystem assessments, and decision-making for the integrated management of natural resources (Ormernik and Bailey 1997, Ormernik 2004). Regionalization of the ICCAT convention area into areas that are ecologically meaningful, yet large enough to be practical, could provide a foundation for developing a wide range of integrated scientific and advice products. These may include the production of integrated ecosystem assessments, ecosystem risk assessments, and large-scale ecological modeling, among others, to assist in the production of more integrated ecosystem-based advice to the Commission (Zador *et al.* 2017; Koen-Alonso *et al.* 2019, Rice *et al.* 2011). Yet, it is not clear at what spatial and regional scales integrated research and advice products would be potentially useful to guide EAFM operationalization in the context of ICCAT species and fisheries.

In 2017, an EU funded project conducted some initial work towards a broad-scale delineation of the Atlantic and Indian Oceans into ecologically meaningful regions (Juan-Jordá *et al.* 2019). These ecological regions aimed to be large enough to be practical in providing ecosystem-based advice to inform fisheries management in the context of tuna and billfish fisheries. This project developed and tested evaluation criteria to identify regions, mainly based on: (1) the existing knowledge of biogeographic classifications of the pelagic environment, (2) the spatial distributions of major tuna and billfish species, and (3) the spatial dynamics of the main fishing fleets targeting these species. Based on these criteria, seven preliminary candidate ecoregions were proposed within the ICCAT convention area (Todorovic *et al.* 2019), and two preliminary candidate ecoregions were proposed in the IOTC convention area (Juan-Jordá *et al.* 2019).

In 2018, this initial work was presented at the ICCAT Subcommittee on Ecosystems (SC-ECO) and the IOTC Working Party on Ecosystems and Bycatch (WPEB), as a conceptual scientific exercise to discuss its potential utility and to explore avenues for future work. In IOTC, the WPEB recommended convening a workshop in 2019 to provide advice on the identification of draft ecoregions based on a revised set of criteria and to foster discussions on the operationalization of the EAFM in the IOTC convention area (IOTC-WPEB14). This IOTC workshop took place in September 2019 with the participation of CPC national scientists and external experts. The most important output of this workshop was the constructive and technical discussions that took place in framing the general process of ecoregion delineation, from defining a checklist of evaluation criteria to guide the classification, to evaluating data inputs and methods to derive the classification, and examining and refining candidate ecoregions based on expert knowledge within the Indian Ocean. This process resulted in a draft proposal of seven ecoregions within the IOTC convention area (Nieblas *et al.* 2019, Juan-Jorda *et al.* 2019b). In 2019, the WPEB recommended a second IOTC Ecoregion workshop to refine the entire process based on the expert advice and feedback received in the first IOTC ecoregion workshop (IOTC-WPEB15). The second IOTC Ecoregion Workshop took place in January 2022 (19th-21st) resulting in a refined process for guiding the delineation of ecoregions and a refined proposal of ecoregions for the IOTC convention area (workshop report in preparation).

In 2020, the process used to delineate candidate ecoregions in the IOTC convention area was presented to the SC-ECO. From this experience, the SC-ECO recommended convening a workshop in 2021 to advance in the identification of draft ecoregions and foster discussions on their potential use to facilitate the implementation and operationalization of the EAFM within ICCAT (Juan-Jorda *et al*. 2021).

1.2 Objectives and structure of workshop

A three-day online workshop entitled "Identification of regions in the ICCAT convention area for supporting the implementation of ecosystem-based fisheries management" was held the 15-17th of March 2022. A list of participants is included in Appendix 1. The workshop gathered 32 researchers, including researchers from ICCAT Member States and external experts from other research institutions and international organizations having a wide range of expertise in ICCAT species and fisheries, ecology, fisheries management and oceanography of the Atlantic Ocean.

The **Welcome Session** presented the main objectives and main motivation for this workshop (PRESENTATION1 in dropbox/workshop presentations). The **overall goal** of the Ecoregion Workshop is to advance in the identification of ecologically meaningful regions that can serve as a basis to produce more integrated ecosystem-based advice, and thereby support the implementation and operationalization of the EAFM in ICCAT. Ideally, candidate regions should have boundaries that make ecological sense, and at the same time be practical to structure and produce ecosystem-based advice to inform fisheries management in the context of tuna and billfish fisheries.

This work specifically addresses the **Terms of References (TORs)** agreed on during the 2021 SC-ECO meeting (Juan-Jordá *et al*. 2021). In preparation for the Ecoregion Workshop, a consultant (Anne-Elise Nieblas) prepared a **background report** describing the actions taken in preparation for this workshop, which were presented to the Group during the three-day workshop to inform open discussion and feedback to refine the ecoregion delineation process in ICCAT (Nieblas *et al*. 2022).

The Ecoregion Workshop was structured following the main Tasks included in the TORs:

- **Task 1:** Potential role of ecoregions in ICCAT and experiences from other fisheries organizations using ecoregions to structure ecosystem-based advice;
- **Task 2:** Review the current reporting structure of ICCAT data and stock boundaries and potential constraints of using ecoregions to structure ecosystem-advice;
- **Task 3:** Preliminary criteria to guide ecoregion delineation and expected qualities of ecoregions;
- **Task 4:** A review of existing biogeographic classifications in the Atlantic Ocean and their relevance in the context of ICCAT species and its fisheries;
- **Task 5:** A review of existing data sets to guide the choice of key data inputs for deriving the draft ecoregions;
- **Task 6:** Analytical methods for deriving a baseline ecoregion proposal;
- **Task 7:** Validating and testing ecoregions.

The delineation of ecoregions requires the implementation of multiple steps, each of them supported by multiple activities and decisions along the way (Loveland and Merchant 2004, Mackey *et al*. 2008). All the Tasks (1-7) addressed in this workshop were organized within a general framework that guides the entire ecoregion delineation process (**Figure 1**). This general framework was created to increase clarity about the process, the replicability of the process, and to encourage a participatory and iterative process. For further details on each of the steps of this framework see Nieblas *et al* 2022.

Maria José Juan-Jordá served as facilitator in the workshop and rapporteurs were assigned to cover each Task (see **Appendix 2**: Workshop agenda). The progress on each Task was presented followed by a general Group discussion. The presentations and the key discussion points for each Task are summarized below. All workshop presentations can also be downloaded from the workshop's Dropbox folder**.**

2. Workshop tasks

2.1 Task 1: Potential role of ecoregions in ICCAT and experiences from other fisheries organizations using ecoregions to structure ecosystem-based advice

2.1.1 PRESENTATIONS 2-4 Case studies using ecoregions to support EAFM implementation

In this session, three presentations gave an overview of three regional case studies with proven experience of using spatially explicit units or ecoregions to assist in the implementation of the EAFM in their convention areas.

- PRESENTATION2 – **ICES ecoregions** (Mark Dickey Collas, ICES)
- PRESENTATION3 – **The Northwest Atlantic Fisheries Organization (NAFO)'s experience in delineation of ecoregions** (Pierre Pepin, Fisheries and Oceans, Canada)
- PRESENTATION4 – **Using Large Marine Ecosystems (LMEs) to support fisheries management in Alaska** (Stephani Zador, Alaska Fisheries Science Center, NOAA, USA)

For each case study, these presentations gave an overview on (1) how spatially explicit units or ecoregions have been identified, (2) the main drivers to delineate them, (3) their main uses including concrete examples, (4) the strengths and weaknesses of using ecoregions as an EAFM implementation tool, and (5) lessons learned.
The presentations reached the following conclusions:

- The **principal driver** to identify ecoregions in support of EAFM implementation was the desire to integrate across sectors and political boundaries to allow resource managers to characterize and produce more integrated advice and develop management approaches at the ecosystem scale;
- Ecoregions are used as individual areas used to address ecological objectives and act as regional frameworks for research, management, assessment, monitoring and enforcement;
- **Several strengths** of ecoregions were pointed out:
    - Ecoregions facilitate understanding of ecosystem status and trends. They are used for structuring ecosystem advice for fisheries management bodies, and provide a useful foundation for developing a wide range of products to assist in the production of advice. For example:
        - For each ecoregion, ICES develops "Fisheries Overview" reports which provide an overview of the impacts of fisheries on the ecosystem within a region and "Ecosystem Overview" reports which provide a description of the ecosystems, identify the main human pressures, and explain how these affect key ecosystem components;
        - NAFO develops a "State of the Ocean" report and a "State of the Ecosystem" report for each relevant spatial unit (referred to as Ecosystem Production Unit; EPU) to provide qualitative information for recommendations on Total Allowable Catches of single stocks by the Scientific Council;
        - The North Pacific Fisheries Management Council (NPFMC) develops "Ecosystem Status Reports" which are indicator-based integrated assessments for three ecoregions (referred to here as Large Marine Ecosystems) to provide ecosystem context for tactical fisheries management recommendations;
    - The ecosystem-scale products create a platform to allow dialogue and facilitate information sharing;
    - Ecoregions can enhance coordination with other ecosystem-based products and projects such as the development of multispecies, ecosystem and climate models, management strategy evaluations, fishery ecosystem plans, etc…;
- **Several weaknesses** of ecoregions were highlighted:
    - Ecoregions may add a level of complexity to discussions which fisheries managers may not be willing to deal with;
    - The justification and value of ecoregions needs to be strongly linked to clear and accountable management and conservation objectives, and this may be hard to obtain from the management bodies (e.g. NAFO's Commission has resisted the establishment of ecosystem-level objectives);
    - The cost of developing those products;

- A series of **best practices and lessons learned** were also shared:
    - Clear management objectives are pivotal for guiding the development of the science needs and approaches tailored to the ecoregions;
    - Establishing a criteria for defining ecoregions across a range of disciplines, considering both ecological and social processes, and the expected qualities of the ecoregions, while remaining flexible, was deemed important;
    - Engaging early with the Commission and fisheries managers in the discussions of ecoregion delineation and its potential uses, and being inclusive and transparent was deemed important to build trust, together with the design of an iterative process;
    - The use of quantitative approaches coupled with expert advice that linked the criteria with different data layers describing the ecosystems including fisheries were favored for informing ecoregion delineation;
    - Flexibility for future refinements of ecoregions as data improve or as management approaches are updated was deemed important. Ensure long-term management of the regionalization system and process;
    - Once adopting ecoregions, do it with commitment and visibility, to show that the ecosystem approach is at the heart of your science and advice.

2.1.2 Group discussion of case studies

The following main points were made during the discussion:

- The Group thanked the presenters for sharing these case studies, which were the result of many years of effort and represent ongoing processes.
- The Group noted how **ecoregions are used as spatial units to generate multiple ecosystem-level advice products** and further asked about their uses. It was discussed that ICES currently produces Ecosystem Overviews and Fisheries Overviews for each of the ICES ecoregions. In addition, ICES also provides mixed-fisheries advice for each ICES ecoregion and is working now on developing management plans to adapt fisheries advice to changes in productivity in each ecoregion in response to external factors (environment, climate). In NAFO, State of the Ocean reports are also produced, yet they mainly focus on reporting on the state of several functional groups of the ecosystems based on data collected through the multispecies trawl surveys. NAFO notes that it has been very challenging to produce bycatch reports due to the quality of the bycatch data collected in the NAFO area. In NAFO, the information generated in these ecosystem-level reports have not been taken up in any decision making process, as fisheries opportunities remain the main priority in NAFO and low priorities are given to ecosystem and conservation objectives.
- The Group discussed the **importance of timing in delivering ecosystem-level advice products** to the managers so they can be used effectively to inform tactical fisheries management.
- The Group found very useful the concrete examples and applications presented for the Alaska case study in the NPFMC showing how ecosystem considerations have improved the advice and management decisions. The **Group suggested developing similar concrete products and examples within the ICCAT context**.
- The Group asked for more information on the **risk tables** used in the NPFMC to better link ecosystem considerations into single species stock assessments and advice. It was noted how the risk tables have proven to be very useful to identify and formalize different types of risk concerns that might be relevant to single species advice and decisions, and the importance of tracking them over time.
- ICES is about to change the way fishery advice is provided **(the fishery advice sheets) to include conservation status and conservation actions**, in order to complement the fishing opportunities advice with the potential effects of environment, the effects of climate and any other ecosystem relevant information that might influence single-species fisheries advice. The Group noted ecoregions are important to aid in evaluating all the ecosystem impacts affecting fisheries as a whole.

- The Group discussed how in NAFO the **prey-predator relationships** have become important ecosystem considerations when formulating advice around the dynamics of the stocks. It also noted that the prey-predator relationships might become a relevant topic for managing ICCAT fisheries.
- The Group noted that **bycatch impacts and prey-predator relationships** are important elements that should be captured if ecosystem summaries products are developed for ecoregions in ICCAT.
- Since ICCAT is at the early stages of EAFM implementation, the Group noted the **importance of being proactive in ICCAT, engaging the Commission, including panel 4 and others, and the SCRS in early discussions** on the role and potential uses of ecoregions, and the importance of having well-established ecological/ecosystem level advice to drive the process.
- The Group asked the presenters to share their one best lesson learnt in developing and using ecoregions to support EAFM implementation, these were:
    - Expert-advice on stakeholder involvement and engagement can be useful to increase awareness and get feed-back in the ecoregion process.
    - Spend time identifying where in the management process ecosystem advice should inform and then tailor the science and effort to that.
    - Ensure stakeholder "buy-in". It is important that stakeholders across all the CPCs in ICCAT understand and validate the relevance of ecoregions as tools and their potential use.

2.1.3 PRESENTATION5 - Potential uses of ecoregions as tools to guide EAFM implementation in ICCAT

A **list of potential uses of ecoregions as tools** to guide EAFM implementation were presented for discussion at the workshop in the context of ICCAT species and fisheries. These are:

- **Planning and prioritization tool -** for assessing needs and risks at the scale of specific regions which can be used to inform planning and prioritization of resources, data collection and research;
- **Research tool -** steer the development of multiple scientific products and integrated approaches
    - monitoring the state and trends of multiple ecosystem complements (e.g. ocean, climate, bycatch/ vulnerable species, ecosystem structure and function, habitats of special concern);
    - Ecosystem status reports, integrated bycatch assessments;
    - Support multi-species and ecosystem modeling;
    - Ecosystem Risk assessments;
    - Support analysis linking ecological, economic and social models and analyses to understand interactions and trade-offs between management objectives;
- **Advice tool -** structure integrated advice to address regional management challenges
    - Provide the spatial framework for integrating ecologic and socio-economic information and visualize emerging trade-offs between multiple management objectives.

2.1.4 Group discussion

The following main points were made during the discussion:

- The Group noted the **potential use of ecoregions as a planning, prioritization and research tool with the aim of informing and improving advice (i.e., an advice tool)** is a good start and appropriate for the context of ICCAT species and fisheries, yet these were seen as general uses.
- The Group noted the **importance of establishing the potential uses of ecoregions *a priori*** since this determines the spatial scale of the ecoregions (aiming for a relatively small number of large ecoregions).

- The Group highlighted the **importance of consulting and engaging the Commission (e.g. Panel 4) early on** to share with them these potential uses, to measure their interest, exchange ideas and develop more concrete uses. It was noted that when engaging with the Commission it is important to (1) be extremely clear of what can be delivered and the potential benefits of it (avoid vague ideas, and focus on concrete examples), (2) show that ecoregions are a complementary tool with no intention to override the current management systems and (3) show that there is no intention to change the current data collection requirements.
- The Group noted that the SubEco already has an ecosystem product (the EcoCard) and highlighted the **importance of coordinating and finding synergies between the EcoCard and Ecoregions**. The Group noted the ecoregions could facilitate the reporting of ecosystem status, trends and impacts at the regional level. Yet the Group noted that the EcoCard tool should remain flexible, and should be used to report indicators at the ICCAT scale or regional scale, which will depend on the type of research questions being asked and the ecosystem components being monitored.
- The Group noted the importance of defining a small number of large ecoregions, and then defining the type of work/analysis that can be conducted within the ecoregions. It noted the **importance of trying to get a first preliminary ecoregion delineation (even if not perfect) from this workshop**, so the Group can start developing activities at the ecoregion level to test their usefulness, test if they are fit for purpose and identify where they should be refined if needed. The Group noted the ecoregion development at this stage should be seen as an **iterative and adaptive process** that would need to be revisited several times by the Group to keep refining the potential uses of ecoregions.
- The Group also noted that it is **important to establish objectives *a priori*** (for the Commission) since they will determine the purpose and uses of ecoregions and they will also help to evaluate the effectiveness of the defined ecoregions. The Group suggested having early discussions on the type of ecosystem-level objectives ICCAT would like to adopt which will drive the type of products that could be delivered (e.g. integrated ecosystem assessments) at the ecoregion level. Without having clear and specific objectives it will be very hard to test and decide on the effectiveness and usefulness of ecoregions.
- The Group also suggested ecoregions could be used to develop abundance indices for species, yet it was noted that if a small number of large ecoregions are defined for the ICCAT area, then environmental analysis to standardize abundance indices of species should be done at much smaller spatial scales than the ecoregion level.
- The Group also noted ecoregions could be used to characterize the impact of fisheries on bycatch species and inform mitigation measures that are different for each ecoregion if needed.
- The Group also noted that once a set of ecoregions are defined within the ICCAT convention area, they could help to represent the biophysical (combination of oceanography and lower trophic level), upper trophic level (target species), and human (fishery) criteria. Defining ecoregions can, therefore, help when conducting studies on the impact of environmental and anthropogenic drivers, trends among functional groups, and trophic interactions. Pressure and state indicators, developed as part of the DPSIR framework, can be used to monitor the response to mitigation measures, and for communication by providing fisheries and ecosystem overviews. This can help to develop a better understanding of the role of environmental drivers in ecosystem structure and dynamics as well as processes/environmental drivers affecting recruitment, growth, maturation and spatial distribution.

2.2 Task 2: Review the current reporting structure of ICCAT data and stock boundaries and the potential constraints of using ecoregions to structure ecosystem-advice (PRESENTATION6)

Ecoregions are seen as tools to facilitate the development of the knowledge base, information and integrated advice products to support EAFM implementation. The objective of this presentation was to examine as a group whether ecoregions as a tool will impact the current activities of ICCAT/SCRS including the collection and submission of fishery statistics (Task 1, Task 2 data sets), the SCRS activities such as the stock assessments of the species WGs and their provision of advice.

2.2.1 Group discussion

The following main points were made during the discussion:

- The Group noted that using the ecoregions tool for supporting planning research and advice products **does not change or interfere with the way fishery statistics are being collected** and reported by Member states to ICCAT, and that the ecoregions **do not interfere with the current boundaries of stocks** used for stock assessment purposes.
- The Group noted that the use of the ecoregion tool **does not undermine the current practices and activities of the species WG** in providing single species-stock advice to the Commission or the research programs of the individual species groups. Instead, the Group noted that **if the ecoregion tool is used well, it might facilitate the connectivity between oceanographers and fisheries scientists,** by, for example improving single species assessments with abundance indices improved by habitat standardization within ecoregions. It was noted that ecoregions could also **facilitate the connectivity between multiple stakeholders** with interests in particular fisheries and processes in a particular ecoregion (e.g. Mediterranean ecoregion and ongoing research activities). It was suggested to use ecoregions as a hub to engage regional stakeholders with regional fisheries and regional issues.
- The Group noted **the ecoregion tool might change the SubEco activities** since this is a product developed within the SubEco for a specific purpose. The Group noted that the EcoCard tool and Ecoregion tool together could be used to provide regional integrated assessments to assist the ICCAT WGs and SCRS in general.
- The Group noted that **ecoregions can be used as an additional and complementary tool seeking to strengthen current practices in the SubEco and SCRS** for the provision of integrated scientific advice to the Commission. Ecoregions are not just a scientific product or exercise; the idea is to use the tool to facilitate the work of the SCRS to ultimately improve the management advice delivered to the Commission.
- The Group noted the importance of **reflecting on the feasibility of having ecoregions as an extra tool in ICCAT given current capacity and resources in ICCAT**, since having this extra tool will increase the work of the SCRS.

2.3 Task 3: Preliminary criteria to guide ecoregion delineation and expected qualities of ecoregions (PRESENTATION7)

This presentation provided an overview of a preliminary set of criteria, which establishes the main thematic factors used to guide the ecoregion delineation, and the expected qualities of the ecoregion based on the chosen criteria (**Table 1**).

The **first thematic factor** seeking to inform the delineation of ecoregions **is t**he **oceanography and biogeography of the pelagic waters in the Atlantic Ocean**.

The **second thematic factor** seeks to use **the spatial patterns of the distribution of ICCAT species (oceanic tuna and billfish species, neritic species) and the ecological communities they form** to contribute to the delineations of ecoregions.

The **third thematic factor** seeks to use **the spatial patterns of the main ICCAT fisheries and their fishing grounds** to contribute to the delineation of ecoregions.

The presentation also summarized a list of expected **properties of ecoregions** which were used to guide all the steps in the ecoregion delineation process. These are:

- Ecoregion boundaries should be considered **static** for use as a practical tool for resource assessment and management. However, it is a common practice to differentiate between the **core and periphery** of an ecoregion (Loveland and Merchant 2004). The homogeneity of ecoregion will be most manifested at the core; by contrast, transition areas will manifest at the periphery. Therefore, ecoregions will have boundaries that are generalized and not precise, and should be interpreted as gradients and transition zones rather than precise boundaries or management lines (Rice *et al.* 2011).
- Ecoregions should be relatively **few in number** to make them a practical tool to inform EAFM implementation. The spatial scale at which ecoregions are defined can have an important impact on their potential uses, therefore the ideal versus practical number of ecoregions may be considered to inform the delineation of ecoregions.

- Ecoregion classifications may consider involving some type of **nested hierarchy** to account for issues of scale and ecoregion extent (Loveland and Merchant 2004). The intended use and applicability of the ecoregions must be used as a guide in dealing with issues of scale and ecoregion extent, including whether hierarchical subdivisions are needed.
- Ecoregions should be **geographically distinct** to guide EAFM implementation. Ecoregions with similar characteristics, but in geographically diverse areas should be treated separately.

2.3.1 Group discussions

The following main points were made during the discussion:

- The Group noted how the three thematic factors proposed combined are used to inform potential boundaries of ecoregions and that **ecoregions at the end are a compromise among these three thematic factors**.
- The Group was encouraged to suggest other thematic elements that might be important to inform ecoregions. It was noted that the IOTC ecoregion process started with a simple criterion (with three thematic factors), later moved to a more complex criteria increasing the number of thematic factors, but in the end, for simplicity and practicality the simple criteria were readopted using the three main thematic factors presented here.
- The Group noted that the **distribution of bycatch species was not considered as part of the Criteria to define the ecoregions** and asked the reasons for this, and whether it could impact our ability to use ecoregions to report fishing impacts on bycatch species. It was explained that the intent here is only to use the core distributions of main target tunas and billfish species (and their fisheries) to inform ecoregion delineation (together with oceanography), and once the ecoregions are defined, then to use them as the spatial framework to describe and monitor the impacts of the fisheries on bycatch species at the ecoregion level. It was noted that this has worked well when defining the criteria and guidelines for delineating ecoregions in IOTC.
- The Group discussed the first thematic factor of oceanography and whether this thematic factor also included information on biological communities (and which ones, since bycatch is part of biological communities). It was clarified that the oceanographic/biogeographic thematic factor includes mostly physical characteristics of the water column, and biological characteristics based on primary production.
- The Group noted that the NAFO experience in the development of ecoregions emphasized the importance of considering species in the foodweb of the main target species and the trophic interactions. The Group also noted that in the case of ICCAT, for example, small pelagic species and squids, which are preyed upon by the main target species could be considered. Endangered, threatened and protected species such as cetaceans and seabirds could also be considered. It was noted that squids are an important element of the food web and are both predators and prey. How does the distribution of squids, which are increasingly being targeted by fisheries, impact on ICCAT species? Also, how do changes in the abundance of top-level predators such as sharks affect ICCAT species? While the abundance and distribution of jellyfish and small pelagics may affect larval recruitment in the main spawning areas of ICCAT species, whose data from larval sampling programmes should be used for the assessment? The Group clarified that at this first stage of the ecoregion process the distribution of bycatch species was not being considered as part of the core Criteria to define the boundaries and core regions of the ecoregions. The current core Criteria considers biophysical (consideration of oceanography and lower trophic levels - Criteria 1), the upper trophic level (ICCAT target species -Criteria 2) and human (ICCAT fisheries -Criteria 3). After ecoregions are delineated based on core Criteria, all the questions posted above could be answered for specific ecoregions.
- We learnt from the IOTC ecoregion process that **ecoregions are conceptual agreed-upon areas for the development of ecosystem-level products** to provide advice for informing fisheries management (and not ecosystem management). It was noted that any assessment based on ecoregions should be seen as a complementary assessment and not a replacement of the existing ICCAT management tools. It was also shared that in the IOTC ecoregion process the thematic factor of oceanography influenced the final ecoregion boundaries more than the other two thematic factors (i.e., spatial distribution of species and fisheries).

- **The Group agreed to use these three core thematic factors as the main criteria to continue the delineations of ecoregions in ICCAT.**

2.4 Task 4: A review of existing biogeographic classifications in the Atlantic Ocean and their relevance in the context of ICCAT species and its fisheries (PRESENTATION8)

This presentation gave an overview of eight marine pelagic biogeographic classifications in the Atlantic Ocean, which are often used to inform the delineation of meaningful ecoregion boundaries, and it showed their relevance in the context of ICCAT species and its fisheries (**Table 2**).

Based on this overview, the Longhurst's Biogeographic Classification (Longhurst provinces) and Spalding's Pelagic Provinces of the World (PPOW) were selected to guide the development of ecoregions in ICCAT since they are static classifications and both cover oceanic and coastal areas (the PPOW includes oceanic areas up to the continental shelf). Yet it was noted that all classifications reviewed in **Table 2** provide background knowledge for understanding major oceanographic processes in the Atlantic Ocean as well as provide understanding on the extent of the spatial and temporal variability of these processes and ecoregion boundaries.

2.4.1 Group discussion

The following main points were made during the discussion:

- The Group welcomed the comprehensive review of these eight biogeographic classifications.
- The Group noted that **most of the biogeographic classifications have static boundaries** and very few are characterized with dynamic boundaries. While it was acknowledged that marine ecosystems are dynamic (with inherent interannual and seasonal variability), **the static boundaries of biogeographic classification is a compromise for gaining simplicity and practicality for research and resource management.** It was also noted that the **boundaries of ecoregions should be seen as transition zones** which emphasize the variability of the system.
- The group noted that very **few biogeographic classifications used variability and variance in ecosystem processes as inputs for informing classifications**, and that this type of information might be useful, to distinguish between ecoregions that are very variable from those less variable, and identify regions that might be changing quickly in response to climate change.

The Group noted that each tuna RFMO already has predetermined areas to manage, except CCSBT whose area is determined by the southern bluefin tuna (SBT) distributions and can cover ICCAT, IOTC and IATTC convention areas. The Group noted that SBT was not included in the ICCAT ecoregion preliminary analysis, so the most southern areas of the Atlantic Ocean are not well captured in the current ecoregion analysis. **Future ecoregion analysis could include SBT distributions and its fisheries.**

2.5 Task 5: A review of existing data sets to guide the choice of key data inputs for deriving the draft ecoregions (PRESENTATION9)

This task has the objective of reviewing existing datasets and choosing those key data layers best characterizing each of the main thematic factors included in the criteria (**Table 1**) for guiding the delineation of ecoregions. This presentation reviewed:

(i) a selection of biogeographic classifications which capture the regional oceanography of the Atlantic Ocean,

(ii) the spatial distribution of catches for ICCAT species to identify the core distributions and co-occurrence of species assemblages, and

(iii) the spatial distribution of catches to identify the core fishing grounds of major ICCAT fisheries.

Each of the potential data layers (see Nieblas *et al*. 2022) were evaluated for their inclusion into the spatial analysis (Task 6) based on their availability, quality and completeness.

Under thematic **factor 1**–**oceanography**, the Longhurst and PPOW classifications were identified as the most useful to guide the development of ecoregions in ICCAT and were retained for their inclusion into the spatial analysis (Task 6).

The **thematic factor 2–spatial distribution of ICCAT species** used the spatial distribution of the species catches (the ICCAT CATDIS raised catch dataset) to identify the core distributions of ICCAT species and co-occurrence of species assemblages to inform the delineation of ecoregions. The ICCAT T2CE dataset was also explored to infer the spatial distributions of other species such as the small tunas and the targeted sharks (e.g. blue shark). It was suggested that the georeferenced raised catch data (CATDIS) for the nine oceanic tuna and billfish species were "good" in terms availability, quality and completeness, and that they will be retained to represent the spatial distributions and abundance of this species in later analyses in Task 6. It was suggested the catch data for neritic species of tunas, bonitos and Spanish mackerels, while easily available, were still incomplete and of low quality, and they will not be retained for further analyses in Task 6. Finally it was found that the data for some sharks are easily available; however its completeness and quality were not sufficient, and they will not be retained for further analyses.

The **thematic factor 3– fishing grounds of the major ICCAT fisheries** used the spatial distribution of catches (the CATDIS raised catch dataset) to identify the core distributions and co-occurrence of fisheries assemblages as a proxy to determine the main fishing grounds of each fishery to inform the delineation of ecoregions. Upon examination of the spatial distributions of the fisheries in the raised catch CATDIS database, it was evaluated that the top seven fisheries by catch (purse seine - PS, longline LL, pole and line BB, trolling TR, gillnets GN, traps TP, trawling TW) were "good" in terms availability, quality and completeness, and will be retained to represent a proxy for the spatial distribution of fishing grounds of the main ICCAT fisheries.

2.5.1 Group discussions

The following main points were made during the discussion:

- Regarding thematic factor 1 – oceanography:
  - After revising the eight biogeographic classifications, **the Group agreed to use the Longhurst and PPOW classifications as the data layers to capture the thematic factor of oceanography, and to retain these two for further analysis.**
  - While the Longhurst and PPOW classifications were selected as data layers to capture regional oceanographic processes in the Atlantic Ocean, the Group also discussed that an **alternative analysis** could have been to start a new classification from scratch to quantitatively derive pelagic regions relevant to tuna and billfish species using fine scale temporal and spatial environmental variables. However, this option was discarded.
- Regarding thematic factor 2 – spatial distribution of ICCAT species:
  - The Group noted that the CATDIS database is an estimation of Task 1 nominal catch data for the nine major tuna and tuna like species of ICCAT, stratified in time (trimester) and area (5x5 degree squares). Therefore, **all caveats and restrictions of the CE are also reflected in CATDIS**. It highlighted this dataset contains the reported catch and any unreported data are simply not reflected in the dataset.
  - The Group noted that the CE/CATDIS data is in many cases only a sample of the total catch-and-effort of each CPC's fleets. While the CE/CATDIS data are believed to be a fairly good representation of the operations of some of the major industrial fleets, **most of the small scale/artisanal fisheries and recreational fisheries have limited data reported in the CE database**.
  - Despite the caveats of the CATDIS data, **the Group assumed the CATDIS data for major oceanic tuna and billfish species to be reliable and to be retained for further analysis in Task 6.**
  - The Group discussed the relevance of including data from small tunas in the analysis to delineate ecoregions, yet **it agreed the T2CE database for small tunas is incomplete and therefore unreliable to be retained for further analysis in Task 6.** The Group suggested to fill the gaps based on expert knowledge, or find alternative proxies for the small tuna species distributions.
  - The Group suggested looking at the **'Species Report Cards' prepared by the ICCAT secretariat** to assess the data gaps in the CE data and assess the reliability of the T2CE data used here.
  - The Group raised some **concerns about using only catch data to delineate species' spatial distribution**, since catch data may be influenced by various factors, including

gear catchability, targeting and the effect of management regulations. The Group discussed considering other data layers like tagging data, CPUEs, Effort distribution (FDIS), available habitat models etc... It was noted that 'catch' is the only metric available and common to most ICCAT major species, while other sources of data like tagging and/or CPUEs are only available for a small number of species.

- The Group noted the **relevance of including data from shark fisheries in the analysis to delineate ecoregions**. However, shark T2CE data tends to be more sparse than data for the ICCAT major tuna species derived from the CATDIS database. It was discussed that the aim is to include shark species that are targeted by ICCAT fisheries (and exclude bycatch sharks); thus the group could **consider including blue shark in future analysis.**
- The Group suggested checking **if the T2CE data used in the analysis include discards and not only landings.** This is because in some fleets one species (e.g. blue shark) might be targeted while not targeted in others (therefore discarded), so having both landings and discard data would be better to infer species distributions. Follow up on this point indicated that discards are not specified in the T2CE database.
- The Group suggested **removing dolphinfish from the analysis** since this species is no longer under ICCAT mandate.

- Regarding thematic factor 3 – fishing grounds of the major ICCAT fisheries:
  - The Group expressed **concerns about the incompleteness of the CATDIS database for representing the fishing grounds of major ICCAT fisheries.**
  - The Group spent time carefully **reviewing the catch maps by fishery** to correct any errors. For example, the purse seine maps show catches of BFT in the Gulf of Mexico, which based on expert knowledge may be an error. The longline catches for BFT in the east coast of the US also seem strange, and it was requested to check whether the maps show just landings or also discards (only landings were included).
  - The pre-workshop analysis excluded some of the **inshore gears (Handline LL, Rod and Reel - RR, and harpoon - HP)**, and the Group suggested including them to capture the inshore gears well and avoid biases towards the offshore gears.
  - The Group suggested **combining RR and HL, because of their similarities, into one gear** for the analysis.
  - It remains an open question how to treat gears whose data are known to be very incomplete (e.g., RR). To fill the gaps in these data, it may be necessary to use expert knowledge when interpreting the results of the preliminary ecoregions.
  - **The Group agreed to use the CATDIS database to capture major fishing grounds of major fisheries while understanding its caveats.** It also suggested considering the diversity of gears in an area as input for the analysis (e.g. using the total number of gears in each grid).
- General comments:
  - The Group emphasized the importance of **improving the data collection** in ICCAT and the ICCAT datasets (Task1, Task 2 and observer data sets), especially for coastal species and fisheries and oceanic sharks, since these affect all the analysis carried out in the SCRS and research for supporting EAFM implementation. The current ecoregion analysis relies mostly on the completeness and quality of Task 1 and Task 2 datasets. Once the ecoregions are defined, these will be used to develop more integrated assessments (e.g. bycatch assessments). Therefore, the Group also noted that the national observer data sets in ICCAT (their coverage, availability, completeness and quality) also need to be improved to support the development of ecosystem-level products at the ecoregion scale.

2.6 Task 6: Analytical methods for deriving a baseline ecoregion proposal

This task has the objective of (1) conducting a classification analysis based on the criteria outlined in Task 3 and the selected datasets outlined in Task 5 for **developing a baseline ecoregion proposal**, and (2) **refining the baseline ecoregion proposal using expert knowledge**. Some preliminary analyses were conducted as part of the preparation for the workshop which were presented to the Group for discussions. First, the classification analysis for deriving a baseline ecoregion and the group discussion was presented, and then the baseline ecoregion proposal and process to refine the baseline proposal was presented.

2.6.1 Task 6.1 Classification analysis - analytical methods for deriving a baseline ecoregion (PRESENTATION10)

This presentation introduced the classification analysis for deriving a baseline ecoregion in three steps: (1) a spatial overlapping analysis between the selected biogeographic classifications (Longhurst and PPOW) and spatial catches by species and fisheries, (2) a specificity and fidelity indicator analysis that measures the dominance (i.e. specificity) and spatial prevalence (i.e. fidelity) of individual species and fisheries within the provinces of the selected biogeographic classification, and (3) a hierarchical clustering analysis to cluster biogeographic provinces according to their degree of similarity in terms of species and fisheries composition based on the specificity and fidelity indicators. Each of these spatial analyses were based on those data layers which were classified to be "good" quality in Task 5.

The presentation reached the following conclusions:

- Both the **Longhurst and PPOW classification represented the spatial distribution of the major tuna and billfish species and fisheries** in the ICCAT convention area well enough to warrant further investigation and inclusion in subsequent spatial analyses.
- The **Specificity-Fidelity Indicator (SF Indicator)** was used to characterize the dominance and spatial prevalence of each species and type of fishery in each Longhurst and PPOW provinces. The SF indicator gives an indication of the community composition of a province in terms of its species or fisheries, highlighting those species and fisheries most dominant and prevalent in a province.
- The **application of thresholds on the fidelity indicator** aimed to evaluate the inclusion or exclusion of grid cells into the calculation of the fidelity indicator, in order to remove the rare or unrepresentative grid cells from the fidelity indicator. The thresholds were developed to filter the fidelity of species or a fishery to a province based on 1) the number of years a species or a fishery is present in a grid cell, hereafter referred to as the persistence threshold, and 2) the amount of catch in each grid cell, hereafter referred to as the catch threshold.
- **Based on our SF indicator analysis, it was found that the community assemblage of a province was best represented by both the species and the fisheries that occupy and operate in that province**. It was also found that the high catch and persistence thresholds helped to identify the most spatially prevalent species and fisheries in each province (spread broadly within the province with relatively high catches that persist over time), and they helped to filter out from the spatial analysis those provinces with little or no information, allowing clearer spatial patterns to be resolved. Therefore, it was concluded that the combined SF indicator, which includes both the specificity and fidelity of a species and fishery for a province filtered by high catch and persistence threshold levels, is the most representative method for spatially representing community composition in terms of species and fisheries, and **this combined SF Indicator was used as the input for the clustering algorithm**.
- A **hierarchical clustering algorithm** was run on the SF indicator values, including the specificity and the fidelity indicator with the high catch and persistence thresholds applied for species, fisheries and both species and fisheries combined for both the Longhurst and PPOW biogeographical classifications. This resulted in **six clustering analyses** for species, fisheries, both species and fisheries combined for each biogeographic classification (Longhurst and PPOW) (**Figure 2**).

2.6.2 Group discussions

The following main points were made during the discussion:

- Regarding the overlaps of species and fisheries catches on top of selected biogeographic classifications:
    - The Group noted **the Longhurst and PPOW classifications represented the major oceanographic features of the Atlantic Ocean and matched with the main distribution of oceanic tunas and fisheries targeting them**.
- Regarding the SF indicator analysis:
    - The Group discussed the **specificity indicator analysis for species and fisheries**, which is based on catch data, and noted that the catch data may not always reflect the species and fisheries distribution well. This was acknowledged and it noted that there are not easy fixes. The Group suggested examining the presence/absence of species (instead of catches) to calculate specificity for species and fisheries. The Group also suggested using expert knowledge for interpreting the SF indicator results to account for the caveats of the catch data.
    - The Group discussed the **SF indicator analysis for fisheries** and suggested using the individual species-gear combination as inputs for the indicator analysis. It was suggested to start examining this method using the longline fisheries since it would be most relevant for the longline fisheries which target different species in different areas.
    - The Group also expressed **concerns about the weighting of different gears by total catch**. The Group suggested examining using the presence/absence of gears (instead of catch) to give all gears equal weight.
    - The Group discussed the **fidelity indicator analysis** and it suggested there may be different ways to treat the grids cells in the analysis. They suggested calculating the area present in a pixel, using interpolation based on the extent of the overlap, since this may improve the representation of the coastal provinces. The Group also approved the type of thresholds and strictness level used in the fidelity indicator analysis.
    - The Group discussed the effects of management regulations on fisheries for interpreting catch data. The Group suggested developing an alternative indicator to capture the management regulations for inclusion into the indicator analysis. Alternatively, they also suggested using expert knowledge to account for this in a qualitative way when interpreting results. It also suggested that a larger number of years (more than the 15 years used now) may mask the effect of recent fishery regulations on the spatial patterns of catches.
    - The Group suggested considering the **diversity of gears in an area** as input for the SF indicator analysis.
    - The Group suggested examining the **temporal variability of catches** and their impact on the SF indicators and consequences for identifying regions.
    - The Group noted the importance of accounting for **uncertainty (quality of the reported catch, lack of data) in the estimation of the SF indicators** and consequences for identifying regions.
- Regarding the clustering analysis:
    - The **cluster analyses** were discussed by the Group with no further suggestions on the methods used.

2.6.3 Task 6.2 Proposal of baseline ecoregions and refinement based on expert knowledge (PRESENTATION10 continued)

This presentation also introduced a baseline ecoregion proposal to the Group. The pre-workshop preliminary analysis suggested that the cluster analysis scenario that (1) best represented groups with distinct species and fisheries composition and (2) adhered to the criteria and the main properties of ecoregions, was the scenario based on the combined SF indicator using PPOW provinces (**Figure 2**, bottom right panel). One of the main properties of the ecoregions is that each ecoregion should be geographically distinct. Adhering to this guideline, the 7 clusters

of the combined PPOW analysis (in **Figure 2**) were disaggregated into 8 geographically distinct clusters (**Figure 2**). It was noted that the high threshold scenario excludes the southernmost provinces due to lack of data, and it was suggested that these provinces be treated as a single ecoregion as well. In the end, the baseline ecoregion proposal comprised 9 different ecoregions (**Figure 3**).

The Group was asked to develop a **refined proposal of candidate ecoregions** using the **baseline ecoregion proposal** as a starting point to be **refined with expert knowledge**. Expert knowledge was used to refine the cluster groupings and address any potential misclassifications and errors based on poor or incomplete data inputs (e.g. distribution of neritic tunas and targeted sharks). Expert knowledge was also used to refine the boundaries of the baseline ecoregions to ensure that the final candidate ecoregions comply with the expected qualities of the ecoregions based on the agreed upon criteria (**Table 1**).

Miro, a visual collaboration platform (miro.com), was used to structure the Group discussions and keep record of all the suggestions and proposed refinements to the baseline ecoregion proposal based on expert knowledge. Essential information including the biogeographic classifications, indicator analyses for species and fisheries, and clustering results were amalgamated in the MIRO platform to inform the Group discussions (**Figure 4**).

2.6.4 Group discussions

The following main points summarize the main discussions and group decisions that led to a refined proposal of candidate ecoregions (**Figure 5**):

- While acknowledging all the caveats in the datasets that were used in this data-driven classification proposal, the Group noted the **importance of agreeing a first refined interim candidate proposal of ecoregions in this workshop** to be used as a communication tool to present this work and the ecoregion process to the SubEco. This proposal ecoregion will also be used to seek funding and resources to test the usefulness of ecoregions in the context of ICCAT.

- The Group agreed to refine the proposed baseline ecoregion draft map (**Figure 2**) based on expert knowledge, but asked for clarification as to what expert opinion meant and how it could be validated. It was noted that expert opinion is the use of expertise on ICCAT processes and context (data, fisheries, species) to understand and modify the outputs of the spatial analyses to minimize the effects of incomplete or low quality data (i.e. adjust ecoregion boundaries that were derived from the cluster analyses). It is important that when decisions are made based on expert opinion, there is a clear record and clear justification on those decisions made, so these can be traceable, identifiable, verifiable and validated.

- The Group noted that differentiating coastal and oceanic areas across the entire convention area may increase the total number of final ecoregions, and may become impractical from an operational point of view (e.g., for developing advice products). Thus, the Group agreed to use the baseline proposal based on PPOWs to start the revision exercise, instead of Longhurst which differentiated between coastal and oceanic provinces. Furthermore, the Group also noted the spatial extent of the catches for the tropical tuna assemblage (SKJ, YFT, BET) conforms better with the PPOW boundaries of the Equatorial Atlantic province, than with the Longhurst equatorial provinces (WTRA, ETRA). Therefore, **the Group further supported the use of the baseline proposal based on PPOWs** based on the species and fishery-based SF indicators (**Figure 2**) **to start the refinement exercise.**

- The Group suggested several modifications to refine the baseline ecoregions and their justifications are summarized below:
-
    - The Group suggested the **Inter American Seas Province** in the PPOW classification (which includes the Gulf of Mexico and the Caribbean Sea) to be treated as a single ecoregion given the species and fisheries composition of this area differ from the wider Atlantic region. The different economic and political realities of this region also support treating this area as a unique ecoregion. The Group noted that while the species and fisheries might differ between the Gulf of Mexico and the Caribbean Sea within this PPOW province (e.g. BET not found in the Gulf of Mexico, BFT not found in the Caribbean Sea), the Group aimed for pragmatism by treating these two areas as one ecoregion and minimizing the number of potential ecoregions within ICCAT

convention area. **This ecoregion was named the Inter American Seas Ecoregion**. The Group noted that if for example, an ecosystem integrated assessment is done for the Inter American Seas Ecoregion, the two subregions (the Gulf of Mexico and the Caribbean Sea) and their regional differences in terms of fisheries, species, oceanography could still be accounted in the assessments; yet treated as one ICCAT ecoregion unit.

- The Group suggested that the **Mediterranean Province** in the PPOW classification to be treated as a single ecoregion given the species and fisheries composition of this area differ from the wider Atlantic region. **This ecoregion was named the Mediterranean Ecoregion**.

- The Group agreed that the Equatorial Atlantic cluster (in **Figure 3**) which included the Equatorial Atlantic, the Guinea Current and Canary Current PPOW provinces should be treated as a single ecoregion given the similarity of the species and fisheries composition across these provinces. **This ecoregion was named the Tropical Atlantic Ecoregion**.

- The Group agreed that the South Atlantic cluster (in **Figure 3**) which included the South Central Atlantic Gyre and the Benguela Current PPOW provinces should be combined with the Southern Transitional cluster which included the Subtropical Convergence and the Malvinas Current PPOW provinces into a single ecoregion given similarity of the species and fisheries composition across these provinces. The Group further suggested extending the northern boundaries of this ecoregion further north to include the waters off Angola as the Benguela current reaches Angola. **This ecoregion was named the Southern Subtropical Atlantic Ecoregion**.

- The Group agreed that the Subantarctic cluster and the Antarctic cluster (in **Figure 3**) be combined into a single ecoregion given the similarity of the species and fisheries composition across these clusters. The group noted that this ecoregion covers the fishing grounds and the distribution of southern bluefin tuna. **This ecoregion was named the Southern Temperate Atlantic Ecoregion**.

- The Group suggested the Northern Transitional cluster (in **Figure 3**), which combines two PPOW provinces (i.e., the Gulf Stream province and the North Atlantic Transitional province), did not represent a homogenous assemblage of species, fisheries and oceanography within the region. Therefore, the Group suggested splitting the Northern Transitional cluster into a western region (mostly covering the Gulf Stream PPOW province) and a eastern region (mostly covering the North Atlantic Transitional PPOW province). The Group noted that the Gulf Stream region has unique oceanographic features and a mixture of species and fisheries that are very distinct from the Sargasso Sea area further east. Therefore, the Group suggested that the Gulf Stream area be treated as a single ecoregion, and it suggested a second ecoregion be defined using the Gulf Stream PPOW province boundaries extended slightly north- and eastwards due to knowledge on the distribution of the species and fisheries in the area. **This ecoregion was named the Gulf Stream Ecoregion**.

- The Group suggested joining the remaining areas off the North Atlantic Transitional province with the Subarctic Atlantic province into a single ecoregion. **This ecoregion was named the Northern Temperate Atlantic Ecoregion**.

- The Group agreed to treat the North Central Atlantic Gyre PPOW province as a single ecoregion given the distinct species and fisheries composition of this region relative to the region just north (i.e., the North Atlantic Transitional PPOW province). **This ecoregion was named the Northern Subtropical Atlantic Ecoregion**. The Sargasso Sea is a characteristic Ecologically or Biologically Significant Marine Areas (EBSA) within this ecoregion and the Group suggested to ensure that the extent of the Sargasso Sea remains within the boundaries of this ecoregion.

2.7 Task 7: Validating and testing ecoregions (PRESENTATION11)

The quantitative proposal of baseline ecoregions produced under Task 6 and adjusted by expert knowledge in the course of the workshop may appear to be definitive. Yet candidate ecoregions should be considered a working hypothesis to be tested, validated and refined before they are used for resource planning, research and management (Bailey 1983, Loveland and Merchant 2004). Task 7 has for its objective the validation and testing of the draft ecoregions against their intended use (as described in Task 1).

In general, there are two ways ecoregions are validated (Bailey 1983, Loveland and Merchant 2004). One way is that the candidate ecoregion is validated by **statistically evaluating the hypothesis underlying the regionalization and the expected qualities** of the resultant ecoregions (see **Table 1**), so that the core areas and boundaries of the ecoregions can be objectively evaluated. A second common practice is to **develop pilot products to test the general applicability for the intended uses of the ecoregions**. The ultimate test of the utility of ecoregions as tools for resource planning, research, assessment and provision of advice may be the extent to which they meet the end user needs (Bailey 1983, Loveland and Merchant 2004). A pilot study to validate and test the draft ecoregions could have multiple objectives that can include (1) testing the usefulness of an ecoregion framework as "units of analysis" for regional assessments (e.g. impact and risk assessments), and (2) identifying the advantages, disadvantages, challenges and benefits of using ecoregions as "units of analysis".

2.7.1 Group discussions

The following main points were made during the discussion:

- The Group noted that it may be challenging to validate the ecoregions by **statistically evaluating the hypothesis underlying the regionalization and the expected qualities** of the resultant ecoregions, since the defined ecoregions are a compromise between the three thematic factors (oceanography, species and fisheries) and adjusted by expert knowledge. This compromise to delineate boundaries according to the three criteria makes it hard (if not impossible) for the defined ecoregions (especially their boundaries) to meet the expected qualities as defined in **Table 1** to a high degree. Similarly, since ecoregions are a compromise among the three thematic factors, it will be challenging and not advisable to use data for bycatch taxa (e.g. seabird, sharks, sea turtles) to validate the boundaries of the defined candidate ecoregions. It was explained that these statistical evaluations could focus on evaluating the "core areas" of the defined ecoregions, as opposed to the boundaries since boundaries should be treated as transition zones. The core areas could be evaluated to determine if they meet the expected qualities of the ecoregions based on the agreed criteria (**Table 1**). With the current methodology used to inform ecoregion delineation, bycatch species are treated as the end users of the ecoregion tool, e.g. integrated bycatch assessments at the ecoregion level. By regionalizing the integrated bycatch assessments using ecoregions as the spatial framework for the analysis, it might be easier to capture multispecies and cross-taxa issues, for example, the impact of mitigation methods across multiple taxa.

- The Group noted the importance of clearly defining what is meant by validation in the context of ecoregion development. It was explained that in general terms, **validation** requires ensuring that objectives are met. Therefore, as well as identifying the general aims for establishing ecoregions, it is necessary to identify the specific objectives, the steps required to achieve them and then to verify that the agreed objectives are met. Validation is also an iterative process - if it is shown that a given procedure cannot meet the objectives, then either the procedure or the objectives should be changed.

- Within a modeling context, it was explained that **model validation** requires showing that a system, equivalent to the model, generated the data (Hodges and Dewar 1992), and requires observations unless model estimates are well known. Using the example of the CATDIS database used in the ecoregion analysis, it was explained that this presents a problem if CATDIS data, based on Task 2 catch data raised to total landings, are used to define ecoregions, since CATDIS are estimates, not observations, and CATDIS are affected by biases due to management, targeting and the quality of monitoring, control and compliance. Furthermore, CATDIS has not been formally validated, and when an attempt was made to validate the estimates of overall fishing effort (EFFDIS), these were found not to agree with reported effort and were subsequently withdrawn from the ICCAT website. The Group acknowledged these complexities and caveats of using CATDIS data, and it noted that catch data continues to be the most common metric to describe spatial distributions of ICCAT species and fisheries, yet it was encouraged to find alternative data sources and metrics.

- It was shared with the Group that there is an ongoing project in the Sargasso Sea (which is an EBSA in the Atlantic Ocean), under the FFEM and GEF projects, that is now working to validate pressure indicators using fisheries independent data to develop state indicators. In addition, an elicitation exercise is being conducted with stakeholders to identify objectives and potential responses. A potential next step could be to use risk tables to link indicators to management and would require verification that a given procedure can achieve the agreed objectives. The Group noted that there are multiple areas which are ecologically significant (e.g. EBSAS, Important Shark and Ray Areas (ISRA)) that have been identified within the Atlantic Ocean (e.g. the Sargasso Sea being one the EBSAs in the Atlantic). The Group discussed how this type of information (the EBSAs) should not be used as a data layer or part of the Criteria to inform the ecoregion delineation process. Instead, EBSAs should be treated as a feature and a characteristic to be highlighted within an ecoregion (after the ecoregions have been defined) when integrated ecosystem assessments are done at the ecoregion level. Each ecoregion (as defined in Figure 5A) may contain multiple EBSAS and other ecological important areas for other taxa groups that might be relevant to highlight in the ecosystem-level products derived at the ecoregion level. The Group also noted that when refining the ecoregions based on expert knowledge in Task 6, the proposed refined ecoregions were defined in a way that the Sargasso Sea was included within one ecoregion (not split between several ecoregions), allowing the Sargasso Sea to be a relevant feature of interest to take into account within the ecoregion where it takes place.

- The Group noted Task 7 is not seeking to do a **model validation**, instead Task 7 seeks to find an approach to test the usefulness of ecoregions for their intended use (as established in Task 1, which should be further defined with input of the Commission). Therefore, it was suggested to abandon the terminology of "validation" in the context of ecoregion development and instead use the term "testing" with concrete case studies as opposed to statistically validating/evaluating the boundaries of the ecoregions per se.

- The Group noted the importance of identifying concrete case studies and pilot studies to test the ecoregions, and that this could be an activity to be covered in the next workshop meeting. These pilot studies could be presented as concrete examples to the Commission to show the potential benefits of using ecoregions as tools for better ecosystem planning, prioritizations, research and provision of integrated advice.

- The Group noted that the adoption of ecoregions as a tool to develop ecosystem-level advice products represents a lot of work for the SubEco, and the SubEco is already invested in the development of the EcoCard tool, including the indicators and types of analyses needed to inform the EcoCard tool. It was noted that it is important to find synergies between these two activities. For example, it was noted that EcoCards (and associated ecosystem assessment) could be developed at the ecoregion level.

3. Conclusion and future steps

- The Group noted that **an important output of this workshop was the constructive and technical expert Group discussions that took place for refining the entire ecoregion delineation process** (**Figure 1**), from discussing the potential roles of ecoregions, to establishing the guiding criteria, principles and methods to derive a proposal of candidate ecoregions within the ICCAT convention area. The Group noted the ecoregion development at this stage should be seen as an **iterative and adaptive process** that would need to be revisited several times by the Group. The Group suggested the ecoregion process discussed during this workshop could be refined based on the advice and comments received from the Group and would like to have future opportunities to refine the process.
- This workshop resulted in **a proposal of eight candidate ecoregions within the ICCAT** convention area (**Figure 5**). Expert knowledge was used to mitigate the limitation of the datasets used to develop this data-driven classification proposal, and the Group noted the **importance of achieving a first proposal of candidate ecoregions from this workshop** so it can be used to develop concrete examples and as a communication tool to present the ecoregion objectives and delineation process to the SubEco/SCRS/Commission.
- The Group acknowledged the **importance of consulting and engaging the Commission (e.g. Panel 4) early on** in the process to establish clear objectives for guiding the potential uses of ecoregions as a planning, prioritization, research and advice tool, and measure their interest and exchange ideas.

- The Group acknowledged the importance of **identifying and developing concrete case studies/pilot studies to test the usefulness and utility of ecoregions for their intended purpose** as tools for better ecosystem planning, prioritizations, research and provision of integrated advice.
- The Group requests that this **Workshop Report** be presented to the 2022 SubEco meeting and makes the following **recommendations to the SubEco**:
    - **The Group recommends that the SubEco review and comment on the ecoregion delineation process and the proposed candidate ecoregions within the ICCAT convention area and invites the SubEco to provide future directions.**
    - **The Group recommends that the SubEco supports further refinements of the ecoregion process based on the suggestions described in this report as well any suggestion received from the SubEco and/or SCRS**
    - **The Group recommends that the SubEco endorses the proposed candidate ecoregions to develop pilot projects to test usefulness and utility of the ecoregions as a tool to progress on EAFM implementation in ICCAT.**

4. Acknowledgements

We are grateful to all the workshop participants for their positive engagement. We also thank Dr. Mark Dickey-Collar, Dr. Pierre Pepin and Dr. Stephani Zador for kindly accepting our invitation to attend this workshop and share with us their experience developing and using ecoregions as tools for deriving ecosystem-level products to provide more integrated advice to fisheries management bodies. We also thank Donna Hayes (CSIRO Australia) for producing the shapefiles and final draft ecoregion maps. MJJJ and AEN were supported by "*la Caixa"* Foundation Postdoctoral Junior Leader Fellowship under agreement No 847648. We also thank the ICCAT Secretariat/SubEco group for their support in planning and hosting this workshop.

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Table 1: Criteria for evaluating and guiding the delineation of ecoregions. This table includes the main thematic factors informing the classification analysis and also the expected qualities of the resulting ecoregions.

Criteria	
Thematic factors	**Expected qualities**
Oceanography and biogeography of the Atlantic Ocean	•The boundaries of proposed ecoregions appropriately demarcate areas with a clear oceanographic/biogeographic justification •The proposed ecoregions are characterized by distinct environmental/oceanographic conditions •It should be possible to link ecosystem research, assessment and monitoring of environmental/climate effects to effectively provide integrated advice and support integrated management
The distribution of the main ICCAT species and the spatial composition of the ecological communities they form (biogeography of tuna and billfish communities)	•The proposed ecoregions demarcate the core distribution of ICCAT tuna and billfish species (including both neritic and oceanic species) •The proposed ecoregions are characterized by distinct communities of tuna and billfish species
The spatial patterns of the fishing grounds of the main IOTC fisheries	•The proposed ecoregions demarcate the core distribution of major ICCAT fisheries (artisanal and industrial) operating in the convention area •The proposed ecoregions are characterized by distinct ICCAT fisheries •It should be possible to link ecosystem research, assessment and monitoring of fishing impacts to effectively provide integrated advice and support integrated management (e.g. mixed fisheries scenarios, cumulative impacts of fisheries)

Table 2. Comparison of eight selected marine biogeographic classifications.

Biogeographic classification	**Methodology used**	**Type of input data used**	**Characteristics**	**Resulting classification**
Large Marine Ecosystems (LMEs) Sherman and Alexander 1986 Sherman 1991, Sherman 1994	Qualitative analysis, expert knowledge	Informed by oceanographic processes and ocean productivity. Informed by hydrography, bathymetry, productivity, trophically dependent populations, fisheries and geopolitical considerations.	•Coastal (omits some coastal areas of islands) •Includes the benthic and pelagic environments •Static boundaries	66 regions
Longhurst biogeochemical Provinces (Longhurst) Longhurst 1995, Longhurst 2007	Qualitative analysis, expert knowledge	Informed by satellite chlorophyll and physical variables associated with large-scale circulation patterns including sea surface temperature, ice fraction, and maximum mixed layer depth.	•Coastal and oceanic •Surface pelagic (0-200 m) •Static boundaries •Hierarchical classification	4 biomes, 57 BGCPs
Dynamic Longhurst Biogeochemical Provinces (Dynamic Longhurst) Reygondeau *et al* 2013	Quantitative analysis	Physical and biological properties of the water column (4 environmental parametres)	•Coastal and oceanic •Surface pelagic (0-200 m) •Dynamic boundaries	58 provinces
Marine Ecoregions of the World (MEOW) Spalding *et al.* 2007	Qualitative analysis, expert knowledge	Based on a critical review of existing classifications. Informed by biodiversity attributes (including taxonomy, patterns of dispersal and isolation of species, and their evolutionary history) and oceanographic processes.	•Coastal •Includes the benthic and pelagic environments •Static boundaries •Hierarchical classification	12 realms, 58 provinces and 232 ecoregions
Pelagic Provinces of the World (PPOW) Spalding *et al.* 2012	Qualitative analysis, expert knowledge	Based on a critical review of existing classifications. Informed by oceanographic processes, ocean productivity, and biodiversity patterns of species distributions and communities.	•Oceanic •Surface pelagic (0-200 m) •Static boundaries •Hierarchical classification	4 realms, 7 biomes, 37 provinces

Biogeography of tuna and billfish communities (BTBC) Reygondeau *et al* 2012	Quantitative analysis	Informed by tuna and billfish species distributions derived from fisheries statistical data (catch per unit effort of major longline fleets targeting tuna and billfish species)	•Coastal and oceanic •Surface pelagic (0-200 m) •Static boundaries	9 distinct tuna and billfish communities distributed globally
Global open-ocean biomes (GOOB) Fay and McKinley 2014	Quantitative analysis	Informed by satellite chlorophyll and physical variables associated with large-scale circulation patterns including sea surface temperature, ice fraction, and maximum mixed layer depth (4 environmental variables)	•Oceanic •Surface pelagic (0-200 m) •Dynamic boundaries	5 biomes globally distributed
Near surface global marine ecosystems (NSGME) Zhao *et al* 2019	Quantitative analysis	Physical and biological properties of water column (20 environmental variables)	•Coastal and oceanic •Surface pelagic (0-200 m) •Static	Seven-clusters of marine ecosystems

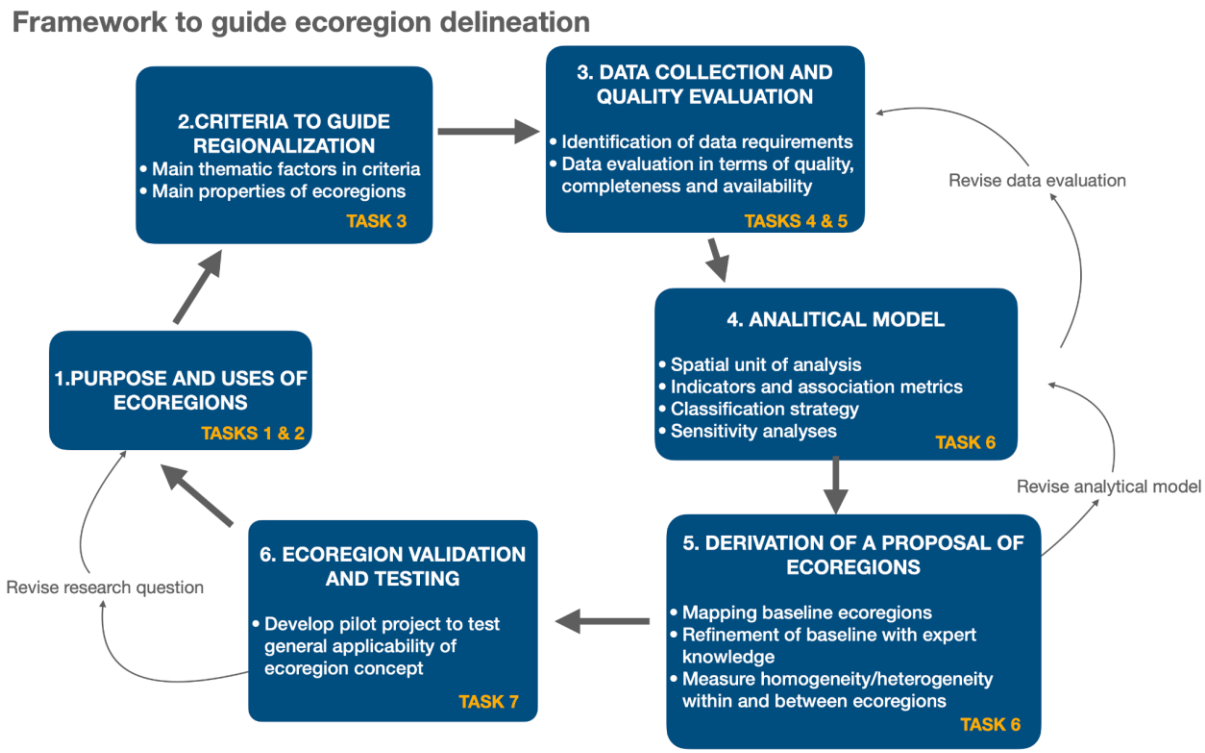


Figure 1. General framework with main steps and key activities guiding the delineation of ecoregions to support implementation of the EAFM in the context of international tuna fisheries (adapted from Mackey *et al*. 2008). Main tasks addressed in this report are mapped to the framework.

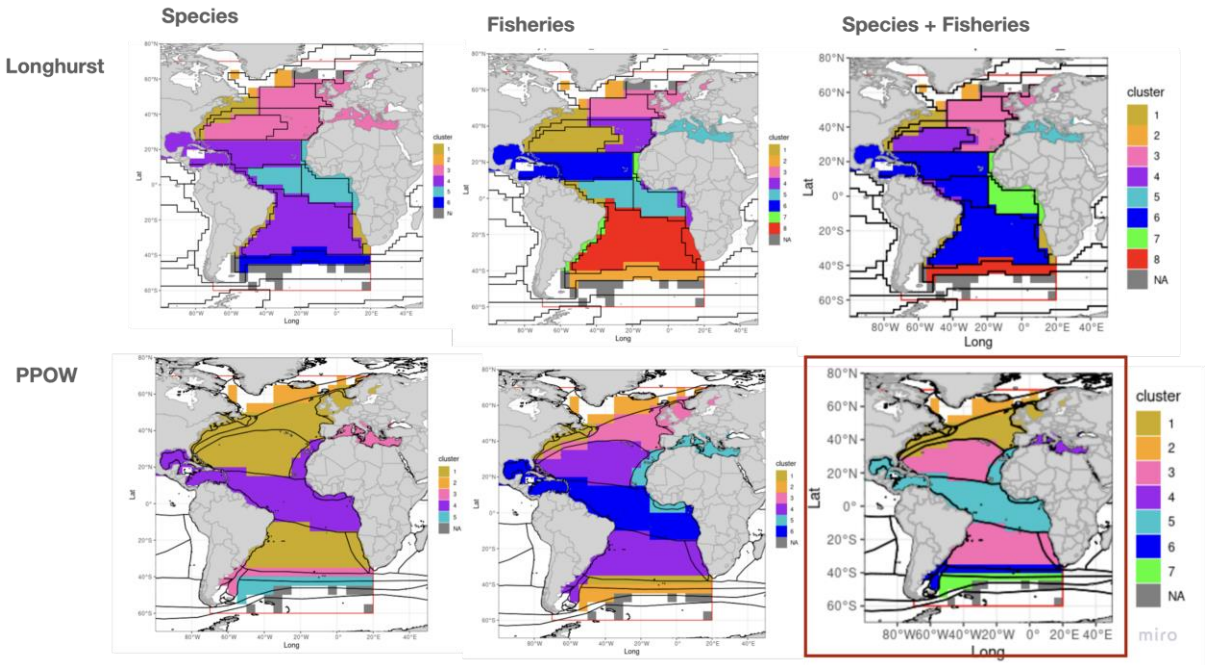


Figure 2. The cluster analysis results for the (1) species-based SF indicator (in first column), (2) the fishery-based SF indicator (in the second column) and (3) the combined (species and fishery) SF indicator (in the third column) for each of the biogeographic classifications (Longhurst and PPOW provinces in rows). The red square shows the clustering analysis used as the baseline proposal to start discussions about expert based refinements (see further details on methods in Nieblas *et al* 2022).

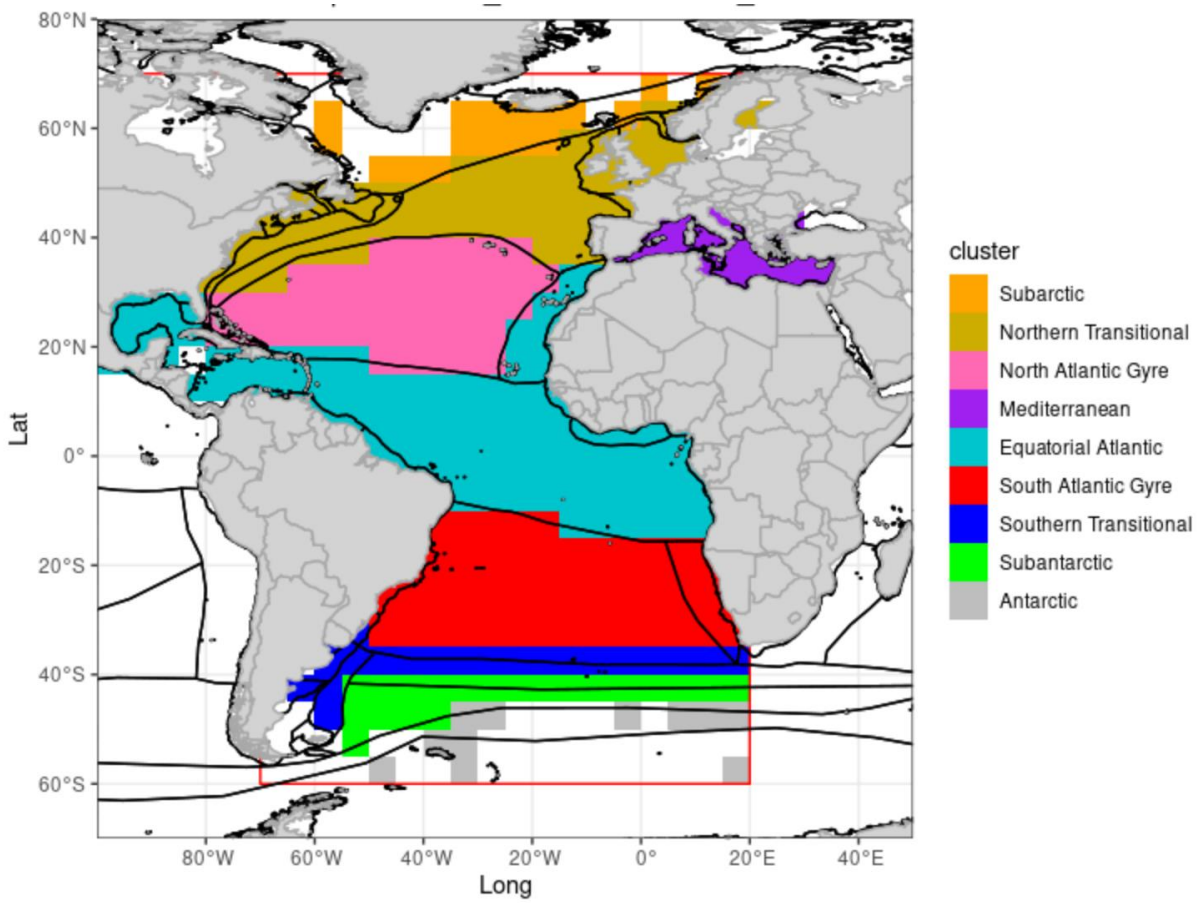


Figure 3. The baseline ecoregion proposal was derived from the cluster analysis on the combined species- and fishery-based SF indicator for the PPOW provinces (Figure 2, button right panel), which was selected as the most representative clustering result that adheres best to the criteria (Table 1) and main properties of ecoregions for this study. The button right cluster in Figure 2 was further modified for geographically continuity, and the southernmost cluster is proposed as an additional ecoregion. The final baseline ecoregion proposal comprises nine different ecoregions.

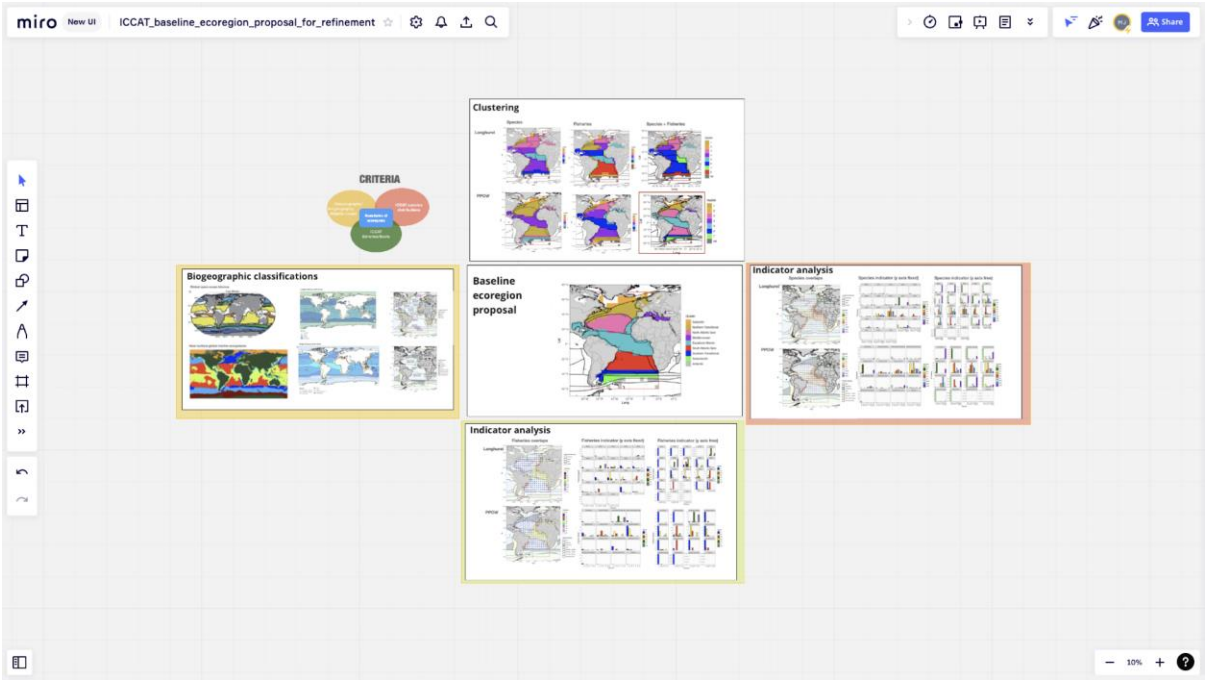
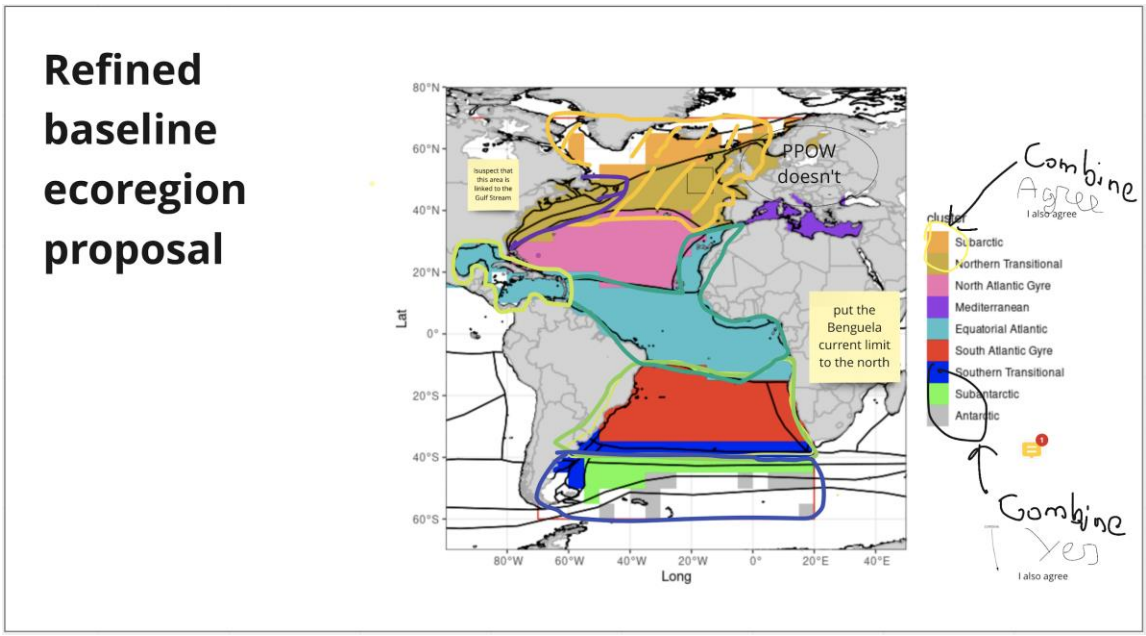


Figure 4. Essential information including the biogeographic classifications, indicator analysis for species and fisheries, and clustering results were amalgamated in the MIRO platform to inform the Group discussions.

(A)



(B)

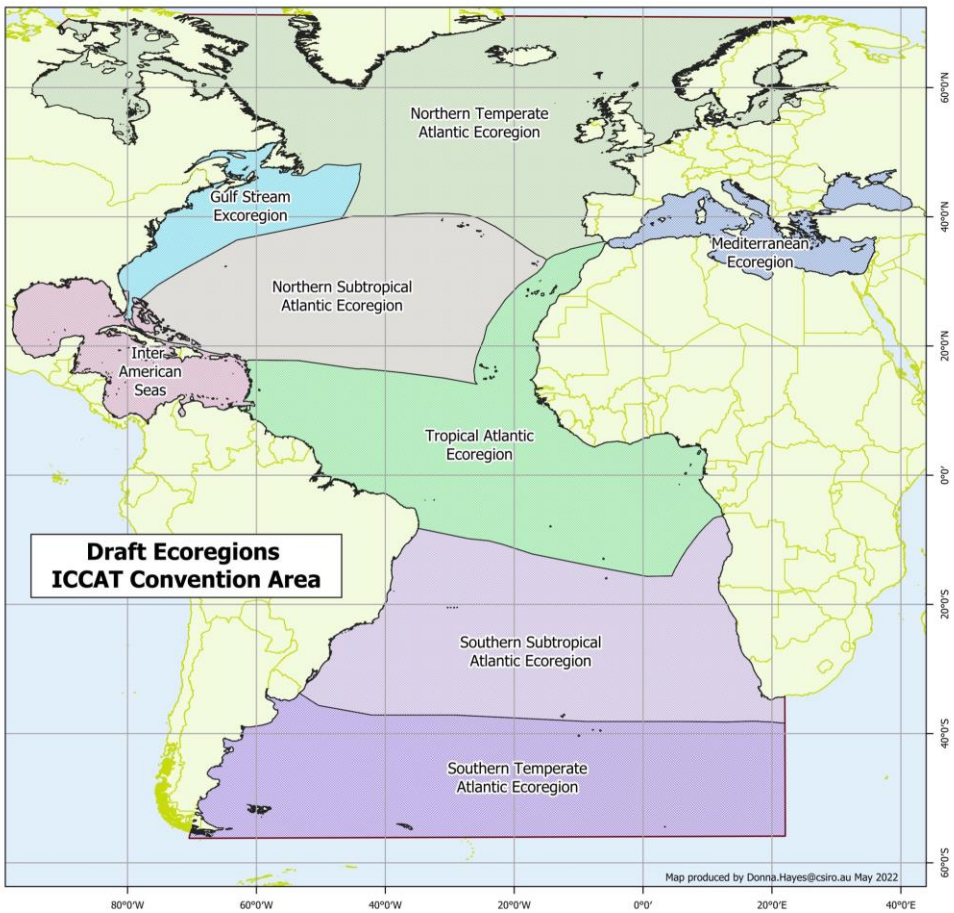


Figure 5. Refined proposal of candidate ecoregions for ICCAT. (a) Baseline ecoregion refined by expert knowledge during the workshop using the MIRO platform. (b) The refined proposal ecoregion map prepared as a shapefile using Geographic Information System (GIS). Map produced by Donna.Hayes, CSIRO, Ausralia.

Appendix 1.

List of participants

Name	**Affiliation**
Agata Malczewska	MARE, EU
Alex Hanke	DFO, Canada
Anne Nieblas	COOL, La Reunion, France
Antonio Di Natale	Aquastudio Research Institute, Italy
Brian Luckhurst	Sargasso Sea Commission, Bermudas
Craig Brown	NOAA, USA
David Die	University of Miami, USA
Diego Alvarez Berastegui	IEO-CSIC, Spain
Dimas Gianuca	Birdlife
Eider Andonegi	AZTI, Spain
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Fernando Niemeyer Fiedler	Ciencia e Tecnologia de Santa Caterina - IFSC, Brazil
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Maria Jose Juan Jorda	AZTI, Spain
Mariana Tolotti	IRD, France
Mark Dickey-Collas	ICES
Nathaly Cardona	Honduras
Oli Yates	Birdlife
Patricia Reglero	CSIC-IEO, Spain
Pierre Pepin	DFO, Canada
Sachiko Tsuji	National Research Institute of Far Seas Fisheries, Japan
Stephani Zador	NOAA, USA

Appendix 2

Workshop Agenda and rapporteurs

ICCAT ECOREGION WORKSHOP

"Identification of regions in the ICCAT convention area for supporting the implementation of ecosystem based fisheries management"

Online meeting, 15th-17th March 2022

(from 12:00 to 16:30 CET)

1. Meeting information

The ICCAT ecoregion workshop will take place on the 15th-17th of March 2022 from 12:00 to 16:30 Madrid Time (each day 4.5 hours long).

2. Tentative agenda

SESSIONS	TIME (CET)
TUESDAY, 15TH MARCH	
WELCOME SESSION	***12:00-12:30***
● Welcome (Alex Hanke) ● Logistics ● Background and structure of workshop (presentation – MJ Juan-Jordá) ● Main objectives and expected outputs ● Agenda	
TASK 3 - CRITERIA TO GUIDE ECOREGION DELINEATION AND EXPECTED QUALITIES OF ECOREGION	**12:30-13:15**
● Preliminary criteria for guiding ecoregion delineation, their expected qualities and main properties (presentation- AE Nieblas)	**RAPPORTEUR:** MARIA JOSE
TASK 4 - A REVIEW OF EXISTING BIOGEOGRAPHIC CLASSIFICATIONS IN THE ATLANTIC OCEAN	**13:15-14:00**
● A review of existing biogeographic classifications in the Atlantic Ocean and their relevance in the context of ICCAT species and fisheries (presentation- AE Nieblas)	**RAPPORTEUR:** *ANNE*
COFFEE BREAK	**14:00-14:30**
TASK 5 - A REVIEW OF EXISTING DATASETS TO GUIDE THE CHOICE OF KEY DATA INPUTS FOR DERIVING DRAFT ECOREGIONS	***14:30-15:15***

● Thematic factor 1 -Data layers to describe the oceanography and biogeography patterns in Indian Ocean (presentation – AE Nieblas)	**RAPPORTEUR:** *ANNE*
TASK 1 - CONTINUATION: EXPERIENCES FROM OTHER FISHERIES ORGANIZATIONS USING ECOREGIONS TO STRUCTURE ECOSYSTEM-BASED ADVICE	***15:15-16:30***
● Experiences and lessons learned from the International Council of Exploration of the Sea – Mark Dickey Collas, ICES ● Experiences and lessons learned from the North Atlantic Fisheries Management Organization (NAFO) – Presentation – Pierre Pepin, DFO, Canada ● Experiences and lessons learned from the North Pacific Fisheries Management Council, USA – Stephani Zador, NOAA, USA ● Group discussion – Potential uses of ecoregions in ICCAT	**RAPPORTEUR:** *EIDER* *MARIA JOSE*
WEDNESDAY, 16TH MARCH	
TASK 2 - CURRENT REPORTING STRUCTURE AND STOCK BOUNDARIES IN ICCAT	
● Review the current reporting structure of ICCAT data and stock boundaries and potential constrains of using ecoregions to structure ecosystem-based advice (presentation- MJ Juan-Jordá)	***12:00-12:30*** **RAPPORTEUR:** *ALEX* *MARIA JOSE*
TASK 5 - CONTINUATION: A REVIEW OF EXISTING DATASETS TO GUIDE THE CHOICE OF KEY DATA INPUTS FOR DERIVING DRAFT ECOREGIONS	***12:30-13:30***
● Thematic factor 2 – Data layers to describe the spatial distributions of main ICCAT species (presentation – AE Nieblas) ● Thematic factor 3 – Data layers to describe the spatial distributions of main IOTC fisheries (presentation – AE Nieblas)	**RAPPORTEUR:** GUILLERMO MARIA JOSE
TASK 6 - ANALYTICAL MODEL FOR DERIVING A BASELINE PROPOSAL OF ECOREGIONS	**13:00-14:00**
● Overlaps of biogeographic classifications and ICCAT species and fisheries (presentation -– AE Nieblas) ● Specificity and fidelity indicators (presentation -– AE Nieblas)	**RAPPORTEUR:** SACHIKO MJJJ
COFFEE BREAK	***14:00-14:30***
TASK 6 - CONTINUATION	**14:30-16:30**
● Analysis of specificity and fidelity indicators of species to a province (presentation– AE Nieblas) ● Analysis of specificity and fidelity indicators of fisheries to a province (presentation– AE Nieblas)	**RAPPORTEUR:** SACHIKO MARIA JOSE

THURSDAY, 17TH MARCH	
TASK 6 CONTINUATION - ANALYTICAL MODEL FOR DERIVING A BASELINE PROPOSAL OF ECOREGIONS	**12:00-14:00**
• Clustering analysis for deriving baseline ecoregions (presentation– AE Nieblas) • Mapping and proposal of baseline ecoregions (presentation– AE Nieblas)	**RAPPORTEUR:** HILARIO MARIA JOSE
COFFEE BREAK	**14:00-14:30**
TASK 6 - CONTINUATION	**14:30-15:30**
• Adjustment of baseline ecoregions based on expert knowledge (MJ Juan-Jorda - Group discussion)	**RAPPORTEUR:** ANNE
TASK 7 - ECOREGION VALIDATION AND TESTING	**15:30-16:00**
• Test and validate the usefulness of candidate ecoregions with respect to monitoring large scale changes in the ecosystems (presentation– MJ Juan-Jordá)	**RAPPORTEUR:** LAURIE ANNE
SYNTHESIS AND FUTURE STEPS	**16:00-16:30**
• Synthesis and future steps (presentation– MJ Juan-Jordá)	**RAPPORTEUR:** ALEX MJJ

3. Workshop materials

All workshop materials will be shared in the following Dropbox folder link:

https://www.dropbox.com/sh/5h6qjexqwmi9zya/AADJ_vC0FkY9m0i-dzz849u9a?dl=0