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Assessment of Regional Fisheries Management Organizations Efforts toward the Precautionary Approach and Science-Based Stock Management and Compliance Measures

Mervin Ogawa ^{1,*} and Joseph Anthony L. Reyes ² 

¹ Biological Oceanography Group/Marine Biosphere Environment, Department of Natural Environmental Studies, Graduate School of Frontier Sciences (GSFS), The University of Tokyo, 5-1-5 Kashiwanoha, Kashiwa-shi room 672, Chiba 277-8564, Japan

² The International Institute for Industrial Environmental Economics (IIIEE), Lund University, Tegnérsplatsen 4, 223-50 Lund, Sweden; joseph.reyes@iiiee.lu.se

* Correspondence: ogawa.mervin@s.nenv.k.u-tokyo.ac.jp; Tel.: +81-803-279-3139

Abstract: The sustainable management of the ocean as a global food source has been prominent in recent debates due to the disproportionate rate of human consumption, depletion of fish stocks and shortcomings in conservation efforts. Criticisms from various sectors on the effectiveness of Regional Fisheries Management Organizations (RFMO) in relation to their mandates have prompted performance reviews (PRs) to evaluate their efforts in fisheries management. Among concerns are slow implementation of comprehensive harvest strategies which use science-based indicators and management principles. Moreover, RFMOs are expected to apply the precautionary approach, in the hopes of anticipating, monitoring, preventing and mitigating potential threats. The emergent themes are revealed through content analysis pertaining to cooperation and compliance being essential to fisheries management activities in conjunction with choosing the right operational approaches and the proper implementation of various fisheries regulations. Government mandates and stakeholder's recommendations support fisheries management organizations to function more effectively. This article discusses the role of coercive, normative and mimetic pressures in RFMOs activities, as described in recent performance reviews. It then analyses how RFMOs have implemented the precautionary approach together with science-based stock management and compliance measures, utilizing recent PRs to assess progress on relevant recommendations.

Keywords: fisheries management; management performance; ocean governance; performance reviews; precautionary approach; science-based management



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1. Introduction

According to the United Nations, ninety percent of the global fish stocks are in danger of becoming depleted, occurring most notably in the common seas [1]. As fish and ocean waves do not distinguish national borders or Exclusive Economic Zones, governments and state parties banded together and entered into agreements forming regional fisheries management organizations (RFMO) to oversee fisheries in areas outside their geographical jurisdictions.

These organizations have a management mandate and adopt fisheries conservation and management measures which are binding on their members. They are tasked with collecting fisheries statistics, assessing resources, making management decisions and monitoring activities, playing a pivotal role in facilitating intergovernmental cooperation in fisheries management [2].

However as many stocks have declined, the capability and effectiveness of RFMOs in conserving fish stocks have been questioned [3,4] and criticised for not being able to curtail the scale and sophistication of illegal, unregulated and unreported fishing, and concerns over the wider environmental impacts of fishing activities' [5].

Due to these RFMOs deficiencies, non-governmental organizations, governments, and multilateral organizations have raised concerns and demanded action towards improving the effectiveness and accountability of RFMOs' activities via conducting external Performance Reviews (PR) [6] to objectively evaluate RFMOs' results in fisheries management efforts [5], set against criterion of their governing Conventions and relevant international agreements [7].

This paper assesses the performance of four RFMOs: the Commission for the Conservation of Southern Bluefin Tuna (CCSBT), the International Commission for the Conservation of Atlantic Tunas (ICCAT), the Indian Ocean Tuna Commission (IOTC), and the North East Atlantic Fisheries Commission (NEAFC) via their respective PRs. Figure 1 describes the areas covered by the four RFMOs included in this study (see also Table A3).

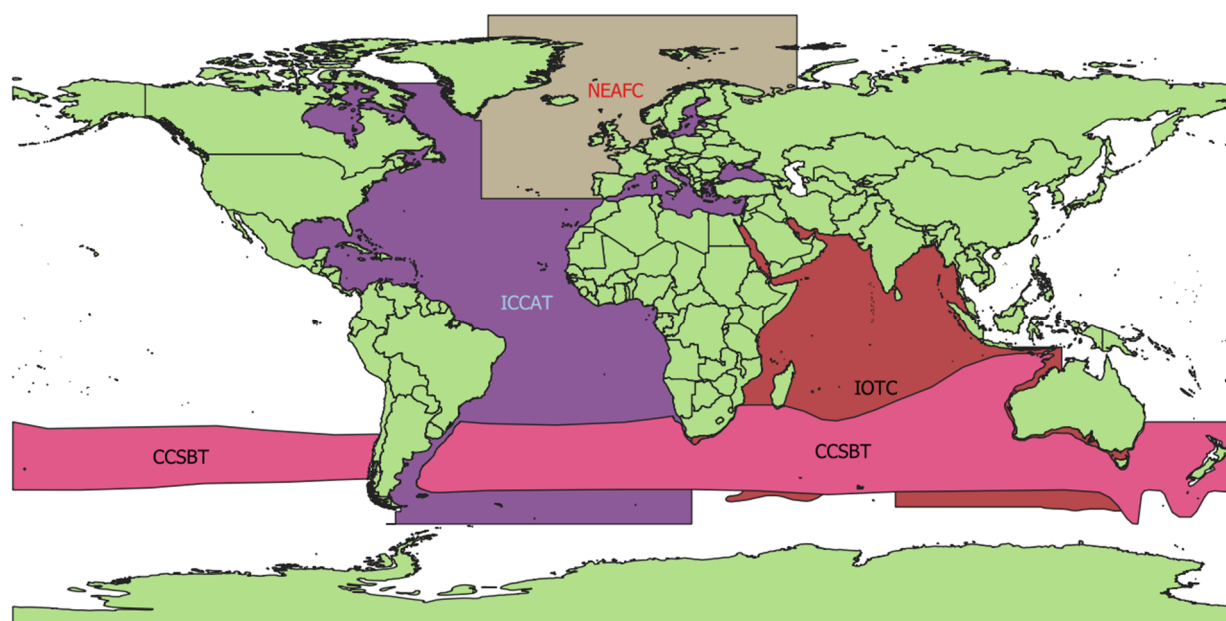


Figure 1. RFMO Area Management Overview. (Map created using QGIS, Sources: IOTC <http://www.fao.org/geonetwork/srv/en/main.home?uuid=fao-rfb-map-iotc> (accessed on 26 February 2020); ICCAT <http://www.fao.org/geonetwork/srv/en/main.home?uuid=fao-rfb-map-iccat> (accessed on 26 February 2020); CCSBT <http://www.fao.org/geonetwork/srv/en/main.home?uuid=fao-rfb-map-ccsb-t> (accessed on 26 February 2020); NEAFC <http://www.fao.org/geonetwork/srv/en/main.home?uuid=fao-rfb-map-nea-fc> (accessed on 26 February 2020); Earth data <https://hub.arcgis.com/datasets/UIA::uia-latitude-longitude-graticules-and-world-countries-boundaries> (accessed on 26 February 2020)).

The 1992 Rio Declaration on Environment and Development pushed for the “precautionary approach” and compelled states to take action in times of uncertainty [8]. This is because policymakers were inclined to wait for scientific evidence before making decisions. However, doing nothing can be risky when there are threats of irreversible damage. That is why the precautionary approach was prescribed to mitigate any potential danger.

This study acknowledges that the precautionary approach has become almost ubiquitous in modern marine fishery tools and emerging as a norm in conservation and management strategies. The precautionary approach is regarded as an integral part of science-based fisheries management [9,10]. If, on one side, the adaptive management (or feedback control) can rely on the preventive approach and the corrective approach when the uncertainty of scientific information useful for taking actions is low, on the other side, the precautionary approach becomes apt when scientific information is scant or the uncertainty of scientific information is high, with a great cost or risk of fisheries collapse [11,12]. However, the need to use the best available information as a basis for fisheries management decisions and actions is a fundamental requirement of the precautionary approach and of good management in general [12].

Nevertheless, the precautionary approach to management ‘can be applied at all stages of development of fisheries, not particularly associated with any single management approach’ [13]. It is stated as a ‘distinguishable concept operating in tandem with other conservation and management concepts, though it can be found in the legislation of many countries being stipulated together with other ecosystem approach to fisheries components’ [14].

It is also acknowledged that there are other various sector- and species-based management strategies available that are applied in practice. A review of these would entail extensive discussions that would be beyond the scope of the current study [15–18]. As such, for the purpose of addressing the set research objectives of this paper and in the interest of brevity, we concentrate on the precautionary approach and relevant stock management and compliance measures within the context of the respective RFMO performance reviews.

2. Literature Background

2.1. Science-Based Approaches to Fisheries Management in RFMOs

Myriad studies conducted on species conservation, management, biodiversity attributes, and ecosystem services [19–21] purport that fisheries management relies upon scientific research and evidence as the basis for decision making and policy. However, the integration of science into marine management decisions is still far from being achieved. Institutional barriers and structural impediments can ‘cause science inaccessibility that limit knowledge exchange’ [22], and achieving the goals of the adaptive governance of marine resources requires improved knowledge exchange among scientists and decision makers [9].

A main challenge for RFMO decision making is to respect state sovereignty while limiting the capacity of states to impede adoption and implementation of management and conservation measures that science and the state of stocks require [23]. Even with continuing efforts to strengthen RFMO performance, substantial improvement has been hampered by historical and structural limitations. This can also be partly understood considering that many RFMOs and Regional Fishery Bodies (RFB) were created before the establishment of the modern law of the sea, with their mandates needing updates in order to incorporate recent treaties and multilateral agreements on ecosystem-based fisheries management, biodiversity conservation, straddling stocks, and the precautionary approach [24].

Furthermore, attention should be given to the specific treaty-mandated relationship between scientific information and management decisions in RFMO conventions, as well as RFMO management decisions themselves on issues such as: ‘gathering and evaluation of scientific information; processes for reaching agreement on scientific information; timeliness of the scientific information; and the manner of conveying scientific information to RFMO decision-makers’ [23].

Significant developments on capacity-building include the Intergovernmental Oceanographic Commission (IOC) Criteria and Guidelines on the Transfer of Marine Technology adopted by the XXII session of the Assembly of the IOC in 2003 that was drawn up by the Advisory Body of Experts on the Law of the Sea following the mandate established in Article 271 of the UN Convention on the Law of the Sea (UNCLOS). Herein, the transfer of marine technology should adhere to the ‘guiding principle of always being conducted on fair and reasonable terms and conditions, enabling all parties concerned to benefit, on an equitable basis, from developments in marine science-related activities, particularly those intended toward stimulating the social and economic contexts in developing countries’ [25].

Nevertheless, challenges can also still be found in regard to the nature of RFMO mandates which mainly focus on establishing regional maximum sustainable yield (MSY) despite the global nature of economic drivers and the shortcomings of the MSY strategy. This is a substantial consideration when taken together with institutional challenges pertaining to membership; cumbersome decision-making processes involving issues due to consensus-based approaches and veto powers; lack of compliance; and the limited capacity

and willingness of many member states to implement management measures, as well as the efforts in accommodating short term competing national fishing interests that often result to political gridlock and omission of available scientific recommendations [24].

As an example, in research done by Hillary and colleagues [26], they discuss the pressing international concern and extensive scientific debate about the current state and future of tuna stocks worldwide and the capacity of RFMOs to manage corresponding fisheries effectively.

Certain situations include predictions of imminent collapse with minimal chances of recovery despite the commercial catch moratorium. Taking the CCSBT as a case study, instead of full fishery closure for the depleted Southern bluefin tuna (*Thunnus maccoyii*) stock, the RFMO had alternatively adopted a viable, scientifically tested, adaptive rebuilding strategy wherein the management procedure (MP) adopted involves a harvest control rule that fully specifies the total allowable catch as a function of key indicators of stock status, determines the recommended level of catch or effort based on the specified data and analysis, and adjusting future harvest levels every three years so as to meet the rebuilding targets agreed by CCSBT [26]. The selection of the optimal MP from a subset of candidate MPs that were developed ‘was derived from extensive simulation testing, and involved first selecting a wide range of plausible scenarios for stock status and input data, ranging from pessimistic to optimistic, against which the alternative candidate MPs were tested and evaluated to ensure that they were robust to important uncertainties’ [26].

2.2. Precautionary Approach

Uncertainty and a lack of information have been ‘consistently utilized as reasons for avoiding, deferring, and/or opposing strong limitations on harvest levels’ [27] that impede efforts towards sustainability and conservation. In response, several regional fishery bodies have initiated actions towards incorporating the precautionary approach into fisheries management [28].

Considered ‘as a broad and promising guide for law, policy, management, and decision-making in cases of uncertainty, the precautionary approach shifts the balance in decision-making in favour of anticipating, monitoring, preventing, and mitigating potential threats’ [27]—rather than merely reacting to it. Among the various interpretations and formulations in different contexts, the common premise is that ‘complete certainty regarding environmental harm should not be a prerequisite for taking action to avert it’ [27]. Although the terminology ‘precautionary principle’ and ‘precautionary approach’ have been treated as equivalent and interchangeable at times, or even complementary in the case of fisheries wherein the precautionary principle is perceived as a hard-line approach requiring complete prohibitions, leading to favouring the precautionary approach—as such, extensive debates still arise up to the present on its requirements, implementation, methods, and obligations for dealing with uncertain risks.

With this in mind, the formal basis for the precautionary approach to fisheries management is provided in the voluntary Code of Conduct on Responsible Fisheries and the United Nations Fish Stocks Agreement (UNFSA). Within the framework of the UNCLOS, the UNFSA offers a significant clarification and development in the rules of international law relating to fishing and management of the high seas [29]. RFMOs are expected to apply the precautionary approach as the UNFSA requires States to apply this as a principle/measure and lists several requirements in Article 5 and Article 6 of the agreement. The IATTC and many RFMOs explicitly mention these codes in their conventions towards addressing the precautionary approach, while at the same time, other RFMOs are also developing means to take these codes into consideration.

The application of prudent foresight, taking account of the uncertainties in fisheries systems and the need to take action with incomplete knowledge is necessary for the precautionary approach [30]. Precautionary management is integral in implemented conservation measures as few organizations have assessed the fish intensity levels that result in significant adverse impacts. However, precautionary measures are not uniform

and have various challenges and contexts for their application—necessitating the bespoke assessment of the adverse impacts for each organization [31].

2.3. Relationship of Science-Based Fisheries Management and the Precautionary Approach

Most RFMOs rely on scientific analyses, in line with their objectives, based mainly on single-species stock assessment. Unfortunately, such approaches fail to take into account several social and ecological factors that interact and drive oceanic systems from local to global scales. Some RFMOs also lack the resources to consider scientific information and support scientific work, data collection, and fishery monitoring. At the same time, ‘others restrict access to data by outside experts, impeding the means for independent, transparent and peer-reviewed scientific analyses’ [24].

As such, the precautionary approach recognizes that decisions addressing environmental threats must be based beyond merely administrative or legislative determinations that such risks are acceptable in light of relevant targets and objectives. Precaution instead imposes a further requirement to give the environment the benefit of any doubts about such risk. Thus, the precautionary principle and approach enjoins decision makers to ensure that the lack of certainty is not used as basis for failure to protect against risk in instances where there is lack full certainty regarding a risk or where there are uncertainties regarding the sustainability of utilization [27].

The scientific obligations to precautionary approaches in practical terms are: determining stock(s) status relative to limit and target reference points; predicting outcomes of management alternatives towards achieving targets while avoiding the limits; and, defining the uncertainty in both of the cases [32]. Moreover, the approach recommends that the greater the uncertainty of management advice, the greater amount of precaution would be required in its management.

As described in Figure 2, when information has a high level of certainty or if the measure or countermeasure to be applied is likely to be successful, the corrective or the preventive approach is used [10,11]. In the absence of scientific data or in the case of its limited availability, the precautionary approach is taken into consideration, especially when there are threats of irreversible consequences to the fisheries systems [33]. In practice, reasonable assumptions are made based on existing science when taking the precautionary approach [34]. RFMOs, such as the North Pacific Fisheries Commission, adopt and implement measures based on the best scientific information available (science-based approach), the precautionary approach, and the ecosystem approach [35].

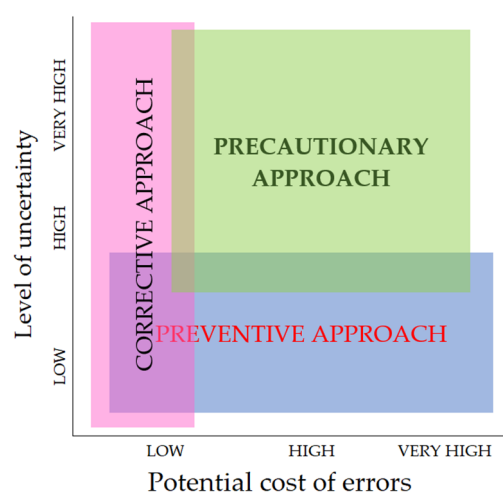


Figure 2. Domains of application of the various possible approaches to fisheries development and management in relation to the level of uncertainty and potential cost of errors. (Adapted from Auster 2001 [11]).

The specific needs for fishery monitoring and research for stock assessments are imposed by the above criteria to a certain extent. In relation to this, both the UNFSA and the Code of Conduct for Responsible Fisheries have similar wording corresponding to the precautionary approach and its principles [32], with Article 6.5 of the Code specifically providing for the precautionary approach to fisheries management [29]. The principle of reference points as crucial instruments for the application of the precautionary approach to fisheries management is incorporated in the UNFSA and the Code, with Annex II of the UNFSA offering guidelines for precautionary reference points and its application [32].

3. Materials and Methods

3.1. Framework and Methodology

The current study adopts established methods in previous research that conducted assessments utilizing RFMO performance reviews [4–6,28], with the premise that science-based management and the precautionary approach are central in effective operation of RFMOs [23–26,32,36,37]. It is approached through a descriptive analytical methodology together with content analysis from an institutional theory perspective [38–40], grounded on previous research in examining the progress and effective operation of RFMOs pertaining to the precautionary approach and the relationship to science-based management [4–7,23–26,32,36,37].

The study contributes to understanding RFMOs activities from an institutional theory perspective as it covers the different roles of intergovernmental, professional and other marine-related organizations in setting the standards, and practices for RFMOs, along with the compliance and the actions taken by the RFMOs based on the performance reviews.

According to DiMaggio and Powell [38], institutional theory discusses the attempts of organizations with similar institutional structures to acquire homogenous forms of activities and behaviour. As such, organizational activities and behaviour are derived from coercive, normative, and mimetic elements. To justify the choice of institutional theory, the established research in organizational studies and social institutions [38,41] have influenced this article in terms of examining the pillars of institutions and how institutional pressures influence behaviour, choice, and actions of people and organizations over time. Moreover, this study covers relevant aspects of both the old and new institutionalism [42,43]. The “old” highlights the rules, structures, and routines that are taken for granted by organizations [38]. “New institutionalism” is geared towards understanding the responses to institutional pressures and seeking legitimacy [42–44], which is more closely related to the activities and actions of RFMOs.

In the case of RFMOs, they find value and legitimacy in their actions by means of a “social contract” between them and their stakeholders or with society in general [39,40]. Moreover, an organization’s success can be “judged from its ability to adapt to popular organizational ideas and recipes, which in turn are legitimized by institutionalized norms and values” [41]. The roles of coercive, normative, and mimetic elements are assumed to be present on the way RFMOs operate (see also Table A2 in Appendix A):

- *Coercive* elements include the adoption of legal frameworks and policy-driven measures imposed by the state, regulatory, and other organizations [45,46]. Organizational actions are often steered and involve sanctions for the non-compliance of rules [47].
- *Normative* elements, in comparison, are subject to rules and standards set by professional communities, which are considered morally binding [48]. Due to their formal training and education, it is very common among professional groups to be active in information exchange [49,50]. They accept certain organizational perspectives and models as legitimate within their networks.
- *Mimetic* forces depict the tendency of organizations to imitate their successful counterparts in times of uncertainty, wherein problems such as ambiguous goals and concerns on organizational technologies arise [38,46]. Furthermore, organizations gauge how others are addressing the requirements of their environment and purposely follow those that they identify as more legitimate in terms of level of success or popular-

ity [51,52]. Moreover, in the case of RFMOs, there is an expectation to respond to panel recommendations during the performance review process [26,53].

This study utilizes as guide the categorizations implemented by Haas et al. [5] that adopted a scoring system based on Garcia and Koehler [54] in following the progress of implementing PR recommendations. The selection of the four RFMOs is based on the availability of recent PRs, corresponding recommendations, the replicability of methodologies, and the coverage in relevant literature concerning PR assessment and RFMO best practices [5,28].

In assessing the progress of the selected RFMOs since their first (or preceding) PR, we looked at the recommendations made at the time of their succeeding PR. Through this approach, ‘recommendations serve as an indicator of RFMO overall progress and impact of PRs in effecting change, and resultant analyses can provide early cross comparisons and learnings from the PR process across a range of RFMOs’ [5]. Items that are mentioned in succeeding PR but have not been identified from the preceding PRs are included in the analysis. However, items only indicated in the preceding PR were not considered as no in-depth analyses regarding their implementation progress were provided.

Due to the relevance of the precautionary approach and science-related items in fisheries management, the selection, appraisal, and extraction of relevant data follows the protocol based on identified recommendations pertaining specifically to the “precautionary approach”, and then its relationships to items are explicitly stated as relevant to “science” or “scientific” approaches, as well as other recommendations determined as relevant to the two themes by previous research [5,28].

Initial themes and categories were identified based on performing word frequency count of RFMO performance reviews, literature, and other relevant documents. Word frequency count can simplify the process of searching or skimming through the content of all documents used in the study. In addition to determining the number words occurring at particular instances within a sample, it is also helpful in discerning possible emerging themes and categories. Likewise, this process in content analysis is useful for identifying connections through keywords and can initially examine how words are contextualized and interpreted in various documents [55].

Data was processed by NVivo version 12 (QSR International) to facilitate the analysis and interpretation of results. The coding system used to organize results was based on the framework categories and emergent themes found in relation to the research questions [56,57]. During the initial round of coding, an Excel spreadsheet was compiled wherein authors individually examined each RFMO’s relevant PR excerpts and coded it inductively into corresponding themes. Authors then reviewed each other’s initial coding and sought agreement on the categorization as well as deciding on which sections would be included. Reappraisal was then performed by the second author and an external reviewer as relevant sections and their source documents were then imported and coded into nodes via NVivo—several confirmatory techniques available were used to support exploration such as: “text search”, “word frequency”, and “stemmed” search functions [58]. Results from these are also included as part of supplementary material for this article (See Appendix A, further details and datasets will be provided upon request). During the second round of analysis, sections that were coded were then reorganized into themes guided by the Institutional Theory framework. Three thematic elements (coercive, mimetic, normative) were identified across the PRs for the four RFMOs and were used to discern key insights relevant for the precautionary approach and science related items from the PR. These items are then further linked to other designated documents for corresponding resolutions, conservation and management measures, and status of implementation.

Relevant items are then presented with the discussion approached through a descriptive analytical methodology, grounded on previous studies in examining progress pertaining to the precautionary approach and the relationship to science-based management, utilized to extract contextual or process-oriented information from corresponding documents [56,59].

Furthermore, in order to classify items effectively and reduce arbitrariness, cluster analysis, as implemented in NVivo, was used to facilitate the organisation of words within the sample texts into groups where members of each group share common characteristics [60–62]. Data triangulation, defined as the convergence of methods on a particular phenomenon with the aim of producing more objective and valid results, is employed through several computer-assisted qualitative data analysis software (CAQDAS) methods such as word frequency and cluster analysis to support the documentary analysis [63].

The paper does not presume an all-encompassing coverage of geography or jurisdictions, representative sampling for all types of RFMOs, extensive discussion of all sector- and species-based management strategies, or expansive definition of the precautionary approach and concepts pertaining to science in fisheries management. Therefore, these aspects are taken and discussed only within the context of recommendations from the corresponding PR of the respective RFMOs and their relationship with each other.

3.2. Significance and Novelty of the Study

Despite the long history and operation of RFMOs, only a few studies have conducted research that utilizes available PRs utilizing Institutional Theory perspective to assess RFMOs in the application of the precautionary approach and its relationship to science-based fisheries management. This study addresses this gap identified in answering the following questions:

- How did RFMOs address recommendations towards applying the precautionary approach?
- What are the emergent relationships between the precautionary approach and science-based management approaches found in the performance reviews and their implications?

4. Results

Overall, as revealed from RFMOs responses in applying science-based management and the precautionary approach, there is movement towards more standardization and compliance to rules and procedures evident in all PRs. As presented in Figure 3, the elements considered as coercive, normative, and mimetic—through the lens of institutional theory—can be discerned among the PRs of the four organizations covered in the study. Further details from the word frequency and cluster analyses are included in the Appendix A (Table A1, Figure A1) of the paper, both also demonstrating that the normative and coercive elements feature more prominently within PRs in relation to science-based management and the precautionary approach as compared to mimetic elements among RFMOs. As also shown in the resultant dendrogram or cluster tree, words in the relevant data extracts of all four RFMOs can be broadly grouped into three groups with members of each group sharing common characteristics and indicating separate groupings for scientific advice, conservation measures, and the precautionary approach.

Details for themes found within PRs in relation to science-based management and the precautionary approach are described in Table A2. Normative elements were most evident in all four RFMOs. This can be attributed to the nature of the decision-making process in most conservation management agencies, which is driven by consensus to conform to the established norms and common best practices. Coercive factors were also identified, but they are less evident compared to the normative elements across the four organizations owing to the fact that policies and laws are required to be adopted in order to enforce restrictions and compliance in fisheries. The newer IOTC and CCSBT adopted policies and management measures that were similar to more established organizations such as the IOTC and WCPFC, thus exhibiting mimetic elements. On the contrary, these commonalities were not apparent in the ICCAT and NEAFC, presumably because they had been in existence long before other RFMOs. Furthermore, the obtained cluster analysis results (Figure A1) can be interpreted as an indication that the precautionary approach could still be implemented by institutions without having to be dependent on or necessitate

being taken together with scientific panel advice or the adoption of other fisheries measures. Thus, this also supports the findings derived through the institutional theory approach wherein the science-based management and the precautionary approach can be manifested among RFMOs via normative, coercive, and mimetic elements and not just be restricted to one particular aspect.

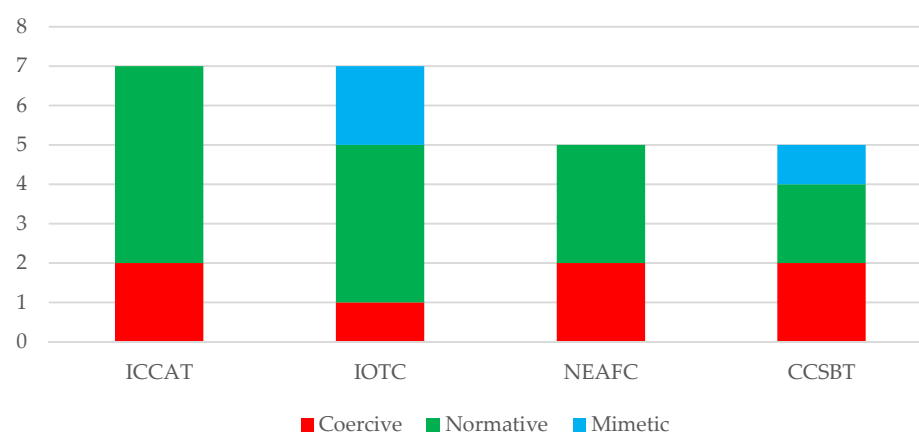


Figure 3. Coercive, normative, and mimetic aspects emerging in the four RFMOs.

The RFMOs' PRs commonly made reference to the precautionary approach mandated by the United Nations Fish Stock Agreement (UNFSA), specifically referring to Articles 5 and 6 (including the appendix). Other mandates come from the UN Convention on the Law of the Sea (UNCLOS), the Food and Agriculture Organization (FAO) of the United Nations Compliance Agreement, and the FAO Agreement on Port State Measures (PSMA). Although the application of precautionary approach is obligatory, RFMOs have varying responses in taking action towards fully adopting precautionary and science-based approaches.

The CCSBT reports that it has modified its rules to be compatible with the precautionary approach and at the same time conforms to international standards. They have justified that the quality of information and alternatives are relevant in decision making, particularly in taking this measure. A timetable was presented to highlight the implementation process. The recommendation has been incorporated in the CCSBT's best practice. Among the RFMOs, the CCSBT was rated "Advanced" and "Fulfilled" in most aspects except for the quality and provision of scientific advice, which was rated "Improving."

The ICCAT has adopted the use of the precautionary approach in its conservation and management measures, although it has treated such action as a non-binding measure. While it acknowledges the mandates supporting the application of the precautionary approach, the ICCAT believes itself to be effectively utilizing the best available scientific advice and as aware of the cautions when receiving insufficient, unreliable, and uncertain scientific information. In addition, the ICCAT's panel reviewers urge for more commitment and consistency in applying the precautionary approach to prevent overfishing and reduce fishing mortality. The ICCAT's panel reviewers made remarks about adopting management measures that are not science-based. In its strategic plan, the ICCAT adopted various resolutions pertaining to the presentation of scientific information. These were discussed in the SCRS Annual Reports, Working Group Detailed Reports, and Best Available Science. It is interesting to see the PR panel's recommendation to closely follow the IOTC's efforts in enhancing effective implementation of its port State measures. Though at this point, there is no indication of mimetic response and if ICCAT acknowledges them as successful in this matter.

In the performance review of the IOTC, science-based approaches are being enhanced through workshops that are geared towards capacity building. These activities include information exchange and technical training related to the management of IOTC species and their related ecosystem and assistance in the drafting of proposals for Conservation and

Management Measures. Thus, the activities mentioned suggest the influence of normative elements in the conduct of RFMO activities. The application of the precautionary approach is framed as essential for long-term sustainability and for achieving one of its objectives in relation to optimum utilization. They also rely on the best scientific advice available and also refer to following mandates set in Article 6 of UNFSA. The IOTC has implemented the precautionary approach through a resolution, but the action is marked as “Partially Completed and Ongoing” in the PR.

However, it was observed that insufficiency of data is often used as a non-compliance excuse:

“... that the Commission continues to use the data paucity as a reason not to implement the advice of the Scientific Committee despite their adoption of the precautionary approach (Resolution 12/01).”

The published PR has provided evidence of mimetic elements in relation to the IOTC’s adoption of a resolution that is similar to the ICCAT:

“IOTC adopted Resolution 12/06 which is binding and is similar in its provision to ICCAT Recommendations with a range of mitigation measures, including supplemental guidelines for the design and deployment of tori lines (a seabird bycatch mitigation measure used in both trawl and longline fisheries).”

Lastly, with regard to the NEAFC, the report indicates that there is no organized science effort to develop multispecies models to understand effects of the fisheries it considers. Their level of adopting conservation measures was only basic. While it has fulfilled requirements for transparency in international cooperation, problems in taking scientific advice have resulted in not being adequately able to implement a precautionary approach.

The following sections specifically discuss relevant aspects for each particular RFMO on science-based management and the precautionary approach together with progress in implementation of respective recommendations made within their performance reviews. Additional analyses for each RFMO are also provided in the Appendix (Appendix B).

4.1. *Commission for the Conservation of Southern Bluefin Tuna*

Overall, the CCSBT had made significant improvements in relation to the precautionary approach. Nevertheless, despite being among the more established RFMOs in existence, some improvements were still necessary in conservation and management, the quality and provision of scientific advice, and collaborative development [64].

It must be noted that the organization has come a long way since the findings from its first PR, wherein the CCSBT Convention, which entered into force prior to UNFSA, did not reflect contemporary concepts such as the precautionary approach, the ecosystem approach, and other norms that guide contemporary fisheries management. Nevertheless, CCSBT incorporated aspects of the precautionary approach in its management of Southern Bluefin Tuna (SBT) through its Management Procedure (MP) [28].

However, uncertainties and inaccuracies in the datasets that were used to assess historic catch rates and the inability to reach an agreement on stock recovery projections delayed the implementation of the proposed MP. The CCSBT had also received criticism prior to the development of the management procedure for the way it heeded scientific advice and did not reduce the Total Allowable Catch (TACs) until 2006/2007 despite increasingly pessimistic stock assessments and evidence that rebuilding objectives could not be feasible without corresponding TAC reductions [32].

4.2. *International Commission for the Conservation of Atlantic Tunas*

Several positive developments since its first PR in 2008 have been noted within the Second Performance review report [65], as well as some negative aspects that still needed to be addressed by the Commission. Through the years 2007–2017, the ICCAT has undergone many changes and accomplishments towards the improvement of conservation, management, compliance, and enforcement [66].

Being among the oldest RFMOs to date, along with the necessity to update the mandate within its Convention to address contemporary issues in fisheries and sustainability, the ICCAT has engaged in vigorous modernization since 2009. Strengthening its performance is challenging due to its relatively large number of Contracting Parties, disagreements over scientific assessments, and continued impediments over the proper management of overexploited key tuna stocks [66].

The report for the second PR indicates that the precautionary approach featured prominently within the process category of Conservation and Management. Particularly for the Adoption of Conservation and management measures, the performance criterion is stated as the extent to which the precautionary approach has been applied by the ICCAT, as set forth in UNFSA Article 6 and the Code of Conduct for Responsible Fisheries Article 7.5, including the application of precautionary reference points [65]. Moreover, as described among the 2008 Panel Recommendations, it was noted that all RFMO Conventions adopted or amended recently such as those of the WCPFC, SEAFO, and NAFO make the application of the precautionary approach obligatory to Contracting Parties and, as such, recommends that the 'ICCAT formally and systematically adopt the precautionary approach' [67].

4.3. Indian Ocean Tuna Commission

There were substantial challenges identified by the IOTC PRs from 2009 and 2016 for the Indian Ocean region, as further noted in the 2019 IOTC progress implementation report. These challenges include inadequate management measures implemented with the lack of scientific data, which impede informed management decisions, as well as the weak coordination of current governance that oversees the monitoring and enforcement of sustainable fisheries management [68]. Although the IOTC is capable of tackling IUU fishing, multilateral and governance instruments need to be strengthened through proper coordination at the national, regional, and international levels. If developing coastal states within the region are to address contemporary sustainability challenges, it would entail 'cross-jurisdictional programs that facilitates ocean-wide scientific monitoring of ecological processes and anthropogenic impacts, and enables integrated monitoring, control and surveillance (MCS) of fisheries and compliance of management measures to improve certainty of the management' [68]. To this respect, the IOCT acknowledged the need for developing of a five-year regional fisheries capacity development program to ensure coordinated capacity building activities across the region [69].

Although the IOTC had made considerable improvements in pursuing the precautionary approach covering the adoption of conservation and management measures, as well as quality and provision of scientific advice, the second performance review report [70] describes how 'the Commission has not given effect to the advice of its Scientific Committee and the associated Working Parties.

There is still a lack of adequate management measures being implemented for most species, and the ongoing paucity of scientific data continues to impede the ability to make informed management decisions. Moreover, the Commission continues to use the paucity of data as a reason not to implement the advice of the Scientific Committee despite their adoption of the precautionary approach as per Resolution 12/01' (p. 30).

4.4. North East Atlantic Fisheries Commission

Several aspects had been identified by PRs for the NEAFC as needing improvement in relation to the application of the precautionary approach and the extent to which it had adopted conservation and management measures based on the best scientific advice available to ensure the long-term conservation and sustainable use of living marine resources. Although a separate organization is currently responsible for provision of scientific advice—the International Council for the Exploration of the Sea (ICES)—further development in the existing interface with the ICES is needed. Furthermore, additional input from groups such as its Permanent Committee on Management and Science (PECMAS)—envisioned to review, evaluate and comment on, and add value to the

scientific advice towards implementing an ecosystem approach and other initiatives for the needs of the Commission [71]—are requested.

The need for the precautionary approach and the ecosystem approach for informing and legitimizing resource management and conservation becomes salient within the context of the North Atlantic region. It is necessary to avoid the frontier mentality and to build resilience in fisheries governance as new and exploratory fisheries will continue to expand in the future with existing constituents striving to maximize yields from their allocations while new participants seek to secure access to stocks in a climate of increasing protectionism. RFMOs in the region such as the Northwest Atlantic Fisheries Organization (NAFO) and the NEAFC have advised prospective new participants that their respective stocks have been fully allocated with fishing opportunities for new members therefore likely to be restricted to new fisheries [72,73].

However, it was observed by the review panel that when there is no coastal state agreement for conservation and optimal utilization, the NEAFC has limited or no scope for management within its regulatory area, and the panel recommended that possible solutions consistent with the precautionary approach should be examined for the regulatory area despite the absence of coastal state agreements. It was also suggested that management plans for certain species should be consistent with the precautionary approach, addressing deep-sea species as a priority situation and suggesting that the NEAFC play a critical role in ensuring that new exploratory or expanding fisheries be developed in accordance with the precautionary approach [28].

5. Discussion and Conclusions

The performance reviews conducted among RFMOs have the potential to meaningfully address sustainability of fisheries resources, as well as help ensure the compliance and engagement of RFMOs and parties with the fundamental principles established within relevant treaties such as UNFSA—particularly with the scientific obligations to precautionary approaches in practical terms.

The analyses of individual RFMOs and their progress in addressing key recommendations from their PRs revealed that these organizations covered in the present study have, overall, made substantial progress towards implementing the precautionary approach and science-based fisheries management and conservation. However, challenges still persist with respect to the RFMOs particular area contexts and configurations. As evident in the various stages of implementation, all four RFMOs had demonstrated commitment and continued development towards the adoption of the precautionary principle within their mandates.

The findings indicate that organizations such as the CCSBT and the IOTC made significant and ongoing progress for implementing the precautionary approach, while the ICCAT and the NEAFC were still in need of additional improvements towards adoption into their management strategies. Given the developments in the last decade made within the covered RFMOs, it is very likely that the recommendations from their recent PRs would be addressed accordingly. The possible recommended improvements should include specific reference to the Code of Conduct for Responsible Fisheries by organizations in their updated conventions, agreed recommendations, and resolutions to augment the obligations of contracting parties to apply and adhere to the precautionary approach [32].

The precautionary approach should be applied in every stage of the management process including data collection, assessment, decision making, monitoring, control, and surveillance. Meaningful stakeholder involvement should also entail reversing the burden of proof to demonstrate that activities will not negatively affect fish stocks and the environment and no longer waiting to realize and prove negative outcomes prior to taking corrective management measures. Actions should be pre-emptively taken when it is assumed that further activities will damage the resources or the environment, such as the development and utilization of more selective fishing gear [32].

Since several political and societal considerations influence the future governance of the high seas, achieving sustainable resource management and conservation will also require robust and proven scientific methods [36]. Likewise, in order to support a systematic multilevel cross-sector approach towards sustainability and conservation goals, governance of the high seas necessitates improvements through a new international legal agreement building on the existing UNCLOS framework. Moreover, enhanced regional arrangements strengthened by a renewed impetus towards international scientific cooperation are recommended.

For contemporary challenges in fisheries to be addressed, environmental degradation to be halted and reversed—states need to act in precautionary, progressive, and pro-active ways at the national, regional, or global level complementarily. The incremental processes for regime building could take a substantial amount of time and thus immediate attention to flexible, short-term action would be prudent. For instance, the regulation of discrete high seas fish stocks is still possible on the basis of customary international law in the absence of a global treaty. This basis can be relied on for the fundamental role and authority of RFMOs in fisheries management and their ability to call for or take action against non-cooperating non-members as well as adherence to concepts such as the precautionary approach [3].

Furthermore, in order to integrate the science and management perspectives, there is a need for the adoption of science-based limit and target reference points related to management objectives [32]. Though there may be agreement on the science behind the reference points used by RFMOs, scientific knowledge and technological capacities among members may not be equal in collecting, interpreting, and using the available information, and discord and disagreements can become rife when discussing how organizations and contracting parties should approach implementation, with opt-outs and non-compliance also becoming leveraged for political advantage.

Methodologically, the differences in assessment criteria or scoring of performance of RFMOs by their review panels present some challenges in reporting, interpreting and comparing progress made by the organizations. It would therefore be particularly helpful in future assessments and research if more consistent scoring and criteria would be available for PRs and summary reporting. Together with an established standard review process under umbrella organizations such as the FAO and the UN, it would become possible to share results of PRs, corresponding actions and gains made by RFMOs during events such as the Committee on Fisheries (COFI) sessions as part of the agenda.

This study shows how most performance review exercises have resulted to being ‘fit for purpose’ because governments and regulatory institutions as well as professional communities are expecting them to address issues according to the agreed rules and standards, which are generally obligatory. Thus, the actions dealt by RFMOs are aimed towards improving the compliance and commitment to the regulatory and professional practices. This may not be necessarily fulfilling the RFMOs’ long-term goals, but the intention is to satisfy routine practices imposed by fisheries management standardization requirements or regular reviews conducted by professional communities through their membership. Likewise, institutional theory was able to address this aspect by means of identifying the coercive, normative, and mimetic elements contained in the RFMO PRs—demonstrating that, for RFMOs, operational strategies and activities are influenced by institutional pressures.

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Appendix A. Supplementary Materials

Table A1. Word frequency analysis results with stemmed words from RFMO data extracts pertaining to the precautionary approach and science-based measures.

Word	Length	Count	Weighted Percentage (%)	Similar Words
managers	8	78	2.56	manage, managed, management, managers, managing
approach	8	68	2.23	approach, approaches
precautionary	13	67	2.20	precautionary
stock	5	41	1.35	stock, stocks
recommendation	14	35	1.15	recommendation, recommendations, recommended, recommends
fisheries	9	32	1.05	fisheries, fishery
conservation	12	32	1.05	conservation, conserve
panel	5	30	0.99	panel
scientific	10	29	0.95	scientific
advice	6	28	0.92	advice
species	7	24	0.79	species
adoption	8	23	0.76	adopt, adopted, adopting, adoption
measures	8	23	0.76	measure, measures
fish	4	22	0.72	fish, fishing
implementing	12	22	0.72	implement, implementation, implemented, implementing, implements
NEAFC	5	22	0.72	neafc
considers	9	22	0.72	consider, considered, considering, considers
CCSBT	5	21	0.69	ccsbt
apply	5	21	0.69	applied, apply, applying
use	3	20	0.66	use, used, useful, using

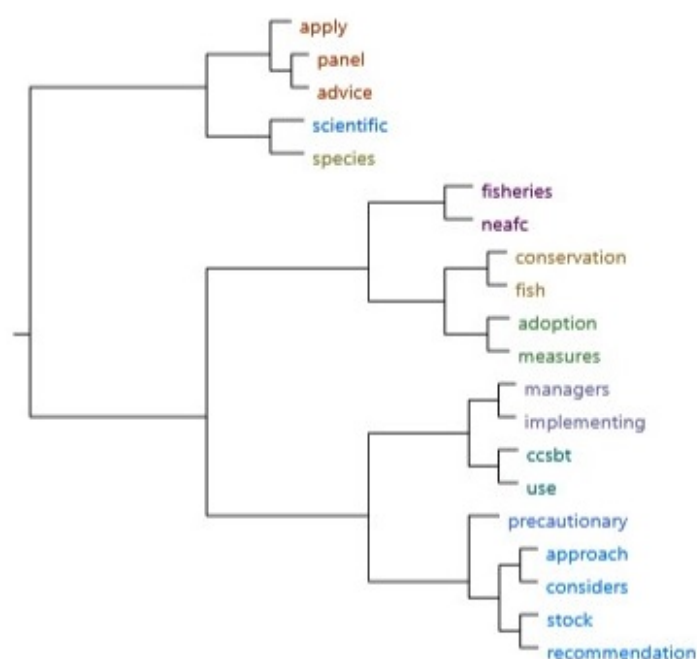


Figure A1. Results from the cluster analysis of RFMO data extracts via NVivo 12.

Table A2. Coercive, normative, and mimetic elements found within PRs in relation to the precautionary approach and science-based management.

Elements	ICCAT	IOTC	NEAFC	CCSBT
Coercive	Extent to which ICCAT has applied the precautionary approach as set forth in UNFSA Article 6 and the Code of Conduct for Responsible Fisheries Article 7.5, including the application of precautionary reference points.	... to adopt measures to ensure their “long term sustainability” and promote the objective of their optimum utilisation, to ensure that such measures are based on the best scientific evidence available and to apply the precautionary approach in accordance with Article 6 of the UNFSA.	Such recommendations should apply the precautionary approach in accordance with Article 4 of the NEAFC Convention and the relevant provisions of Article 6 of UNFSA.	Apply the precautionary approach as set forth in UNFSA Article 6 and the Code of Conduct for Responsible Fisheries Article 7.5, including the application of precautionary reference points (PR-2008; Kobe I, § I.I.4 and 1.10)
Normative	<p>‘Science-managers dialogue WG’ (TOR in Rec 13-18, as amended by Rec 14-03), at its 2015 meeting ICCAT adopted two important recommendations (Rec 15-04 on Harvest Control Rules for N-ALB and Rec 15-07 on the development of Harvest Control Rules and on Management Strategy Evaluation). Harvest control rules based on management strategy evaluation should help improving the consistency of the scientific advice. In the report of the meeting in Madrid in March 2016 of the WG on Convention Amendment, the Panel notes that the current draft Convention contains in Art III (bis) the following provision: The Commission and its Members, in conducting work under the Convention, shall act to:</p> <p>a) apply the precautionary approach and the ecosystem approach to fisheries management in accordance with relevant internationally agreed standards and, as appropriate, recommended practices and procedures</p> <p>... that all RFMO Conventions adopted or amended recently make the application of the precautionary approach obligatory to Contracting Parties (e.g., WCPFC B4 - Most of the scientific work in ICCAT being done by CPC scientists in the various subsidiary bodies of the SCRS, IATTC and WCPFC each have a science provider to ensure and monitor continuity, quality control and standardization. -Closely follows IOTC’s efforts to enhance effective implementation of its port State measures through, inter alia, its e-PSM system, and, where appropriate, adopt similar efforts within ICCAT.</p>	<p>-That PRIOTC01 also advised to consider a framework to take action in the face of uncertainty in the scientific advice, to which the Scientific Committee has responded by initiating a development of a management strategy evaluation process. It was further recommended to use the full range of available decision-making processes under the IOTC Agreement, and it is noted that voting was used for adopting a Conservation and Management Measures for the first time. Despite the ongoing legal constraints related to the IOTC Agreement, the IOTC has adopted several Conservation and Management Measures to give effect to modern fisheries management principles such as the precautionary approach and ecosystem based fisheries management.</p> <p>-There are inadequate management measures implemented for most species and the ongoing paucity of scientific data continues to hamper the ability to make informed management decisions. Finally, the PRIOTC02 noted that the Commission continues to use the data paucity as a reason not to implement the advice of the Scientific Committee despite their adoption of the precautionary approach (Resolution 12/01).</p>	<p>- The advice from ICES takes account of the uncertainties, applying the precautionary approach.</p> <p>...and the advice received from ICES is based on application of the precautionary approach as interpreted by that body, including specification of precautionary reference points. However, as presented in sections 2.1 and 3.5.1, the Commission has experienced problems in implementing the scientific advice for a number of the most important fisheries under its mandate. Those problems have inevitably resulted in failures to implement the precautionary approach as accommodated in the scientific advice.</p>	<p>-This generic recommendation has very long-term implementation implications and could be considered as being implemented continuously as long as a precautionary MP is used together with the metarule.</p> <p>-The 2010 Brisbane WG on bycatch made a number of very relevant recommendations aiming at reducing the impact of the SBT fishery on ERS. The content of some of them has already been considered in the recommendations identified elsewhere in this report, e.g. on the precautionary and ecosystem approaches (cf. recommendations PR-2008-2; PR-2008-4 and KOBE-2)</p>

Table A2. Cont.

Elements	ICCAT	IOTC	NEAFC	CCSBT
Mimetic		<p>-Acknowledging ICCAT's Experience on Convention Amendment which also covers the issue of precautionary approach (see Appendix IV IOTC PR)</p> <p>-IOTC adopted Resolution 12/06 which is binding and is similar in its provision to ICCAT Recommendations with a range of mitigation measures, including supplemental guidelines for the design and deployment of tori lines.</p> <p>-Adopting a discard ban on tropical tunas during fishing operations, similar to the WCPFC. (as mentioned in ICCAT PR page 23).</p>		<p>-CCSBT's port State measures laid down in its 2015 Resolution for a CCSBT Scheme for Minimum Standards for Inspection in Port are virtually identical to ICCAT Rec 12-07. (as reported by ICCAT PR)</p> <p>-Adopting the Bali procedure->to provide a 70% probability to rebuild the stock to 20% of the virgin stock biomass level by 2035.</p>

Table A3. Overview of RFMOs included in the study.

RFMO	Members	Entry into Force	Year of 1st PR	Year of 2nd PR
CCSBT	Australia (Headquarters), European Union, Indonesia, Japan, New Zealand, South Africa, South Korea, Taiwan.	1994	2008	2014
ICCAT	Albania, Algeria, Angola, Barbados, Belize, Brazil, Canada, Cape Verde, China, Côte d'Ivoire, Curaçao, Egypt, El Salvador, Equatorial Guinea, European Union (Headquarters: Spain), France (St. Pierre & Miquelon), Gabon, Gambia, Ghana, Guatemala, Guinea, Guinea-Bissau, Honduras, Iceland, Japan, South Korea, Liberia, Libya, Mauritania, Mexico, Morocco, Namibia, Nicaragua, Nigeria, Norway, Panama, Philippines, Russia, Republic of Grenada, Senegal, Sierra Leone, South Africa, St. Tome and Principe, St. Vincent and the Grenadines, Syria, Trinidad and Tobago, Tunisia, Turkey, United Kingdom (Overseas Territories), United States, Uruguay, Vanuatu and Venezuela.	1969	2008	2016
IOTC	Australia, Belize, China, Comoros, Eritrea, European Union, France, Guinea, India, Indonesia, Iran, Japan, Kenya, South Korea, Madagascar, Malaysia, Maldives, Mauritius, Mozambique, Oman, Pakistan, Philippines, Seychelles (Headquarters), Sierra Leone, Somalia, South Africa, Sri Lanka, Sudan, Tanzania, Thailand, United Kingdom, Yemen.	1998	2009	2014
NEAFC	Denmark (in respect of the Faroe Islands and Greenland), European Union, Iceland, Norway, Russian Federation, United Kingdom (Headquarters).	1982	2006	2013

Appendix B. Supplemental Information

Appendix B.1. Commission for the Conservation of Southern Bluefin Tuna

The Commission emphasized the need to take a precautionary approach in adopting the MP to increase the likelihood of the spawning stock rebuilding in the short term and to provide the industry with more stability in the TAC, reducing the possibility of future total allowable catch decreases. At its eighteenth annual meeting in 2011, the CCSBT agreed to adopt a precautionary approach during the early stages of the spawning stock rebuilding, and that an MP would be used to guide the setting of the SBT global TAC in order to ensure that the spawning stock biomass achieves the interim rebuilding target of 20% of the original spawning stock biomass [74].

It was also observed that due to organization's concentrated efforts on managing one species and a relatively small number of members, the management and conservation measures are well designed in the CCSBT as compared to other RFMOs—its MP is exemplary, based on the scientific perspectives wherein external scientists and members' scientists make recommendations that enable members to set reliable TACs and manage fishery resources [75]. Furthermore, as indicated in the Report of the twenty-fifth annual meeting of the Commission in relation to its Strategic Plan, it requires incorporation of advice consistent with the precautionary approach together with the best scientific information available [74].

As specifically mentioned in its PRs, in terms of the precautionary approach to SBT management, the recommendation to take a precautionary approach to management and lower the TAC as the uncertainty increases has been fulfilled, as well as proposing that the organization could undertake tests for the robustness of the MP to climate change, and should take opportunity in prioritizing stock rebuilding above increasing catch when exceptional positive recruitment spikes occur above the variations against which the MP has been tested [54].

For its SBT stock rebuilding strategy, it was further recommended that effort should be made to enhance (speed-up) the rebuilding trajectory in line with the precautionary approach to fisheries, and special efforts should be made towards identifying additional measures (e.g., protected areas) to support spawning and recruitment and improving resilience to fishing and climate change [54].

However, in terms of scientific skills required under conservation and management—quality and provision of scientific advice—the development process of the MP in recent years necessitates the acquisition and application of advanced scientific skills as well as the development of such skills in less endowed countries to promote consensus. It was recommended that gaps in scientific skills should be assessed and correspondingly addressed through recruitment and capacity building in partner countries.

As for the adoption of conservation and management measures, significant progress had been noted in terms of the scientific foundations of management measures, and the application of the precautionary approach implemented by the CCSBT through the use of an MP, which has been optimized in relation to many data and process sources of uncertainty, as well as the possibility the precautionary approach being formally adopted as a principle inserted in a revised Convention [54]. Haas [5] purports that the performance of the CCSBT in terms of the precautionary approach has “advanced”, while the relevant aspects such as conservation and management, quality, and provision of scientific advice are “improving” in the scientific skills required. This study concurs with the findings, particularly considering the substantial progress that the Commission had since its first PR in 2008.

Appendix B.2. International Commission for the Conservation of Atlantic Tunas

For action taken by the ICCAT, the adoption of Res 15–12 concerning the use of a precautionary approach in implementing the ICCAT conservation and management measures along with the relevant provisions were highlighted which included: the utilization of best

available scientific advice; caution being exercised when scientific information is uncertain, unreliable, or inadequate; determining stock-specific reference points on the basis of the best scientific information available, in particular limit reference points, and the actions to be taken if exceeded; and not using the absence of adequate scientific information as a reason to postpone or to not take conservation and management action in relation to the species under its mandate [65].

However, the adoption of Res 15–12 was also noted as being a non-binding measure, and among the panel assessments and recommendations it was emphasized that on the basis of the stock-by-stock analysis presented in the second PR, the precautionary approach has not been applied in a consistent manner by the ICCAT. Though it was noted that the organization has based its management on the best available scientific advice when assessments were considered to be reliable, the ICCAT has generally not applied the precautionary approach where scientific information is uncertain, unreliable, or inadequate. Thus, it was proposed by the panel that the content of Res 15–12 be transformed into an ICCAT recommendation, and that the new Convention should contain an explicit commitment towards applying the precautionary approach (p. 34).

In dealing with the status of major fish stocks under living marine resources in the performance category of conservation and management, the Panel assessment noted that most stocks under rebuilding programs, such as the Western Bluefin tuna, Eastern Bluefin tuna, Northern Albacore, and Northern Swordfish, were improving or were within safe biological limits. Yet, several other stocks such as Bigeye Tuna, Southern Albacore, and Swordfish in the Mediterranean had remained overfished. It was then recommended that the precautionary approach be applied more consistently to prevent the occurrence of overfishing and reduce fishing mortality to aid in the necessary rebuilding [65].

As for trends in the status of non-target species, the panel had considered the ICCAT as scoring reasonably well compared with other RFMOs on associated species such as marine mammals, seabirds, sharks, and turtles. It was then suggested that the precautionary approach be consistently applied for associated species considering that the assessments for these species are highly uncertain and have poorly known status with lack of information (p. 17).

In terms of science-based management, it was observed that under the Brazilian mandate as chair of the Commission during the past decade, there was a substantial change in the image of the ICCAT from an institution that did not venerate science into its committed role to applying advice and recommendations from the scientific community even towards the reduction of total admissible catches of valuable stocks such as the Eastern Bluefin tuna [66].

As further noted as management recommendations in the report of the Standing Committee on Research and Statistics [67], precautionary management measures should be considered for stocks where there is the greatest biological vulnerability and conservation concern on a species-by-species basis and for which there are very few data and/or great uncertainty. Particularly, for instance, the SCRS had recommended a precautionary approach towards the Blue Shark, considering the uncertainty in stock status results for the South Atlantic stock (p. 228).

The recent initial improvements towards the effectiveness of the ICCAT could be attributed to the power of listening to science. The case of the Eastern Bluefin tuna stocks recovering from 2004–2014 has shown the value of heeding science and implementing advice under a social learning process, allowing the main goal of the Commission to be achieved.

Overall, this study somewhat agrees with the findings of Haas [5] purporting a “Basic” scoring for the ICCAT in terms of the precautionary approach. Nevertheless, significant developments have been observed such as the adoption of Res 15–12 concerning the use of a precautionary approach in implementing the ICCAT conservation and management measures. Further improvements towards implementation, formal mechanisms, and addressing inaction when faced with unreliable data or uncertainty is still paramount

towards its development, and the precautionary approach should be consistently applied to ensure the recovery and sustainability of fish stocks for the species under their mandate as well as for associated species.

Appendix B.3. Indian Ocean Tuna Commission

Among its key limitations, the IOTC has an outdated treaty that does not give effect to the precautionary approach and ecosystem-based fisheries management—which are part of the fundamental principles of the UNFSA. In addition, there is a very limited number of fishery-independent scientific research and monitoring programs that, if implemented, could have the potential to improve the understanding of the status of the resources [68].

Specifically, the second performance review report [70] recommended the following:

- (a) The Commission acknowledges the inherent difficulty in managing small scale and data-poor fisheries, to continue efforts to adopt adequate fisheries management arrangements, and to assist developing coastal States to overcome constraints to implement the conservation and management measures.
- (b) As the IOTC has faced the management of the main targeted stock under its purview only through a regulation of the fishing effort, other approaches should be explored, such as those envisioned in Resolutions 05/01 and 14/02, including catch limits, total allowable catch (TAC), or total allowable effort (TAE).
- (c) The Science–Management Dialogue is strengthened to improve the understanding of the modern approaches to fisheries management, including the implementation of Harvest Strategies through the use of Management Strategy Evaluation (MSE). The Commission adopts a formal process of developing and implementing Harvest Strategies within a prescribed timeframe.

Substantial progress had been made in the implementation of recommendations (a) and (c), with both being reported as “completed and ongoing” within their respective timelines. Developments have been made on issues of data-limited methods, the establishment of a Technical Committee on management procedures, the formalization of a process to facilitate discussion and adoption of harvest strategies, and the ongoing development of MSEs and adoption of harvest control rules. Recommendation (b) had been indicated as “ongoing” with consideration of alternative management tools underway and is set as a high priority for the Commission and Scientific Committee [69].

It must also be noted that the preliminary analyses conducted by Herrera and Báez [76] found that ‘the system European scientists use to sample purse seine landings and estimate catches and catch-at-size could be potentially subject to bias which and have repercussions on the statistics, stock assessments, management advice, and management measures adopted by RFMOs such as IOTC and ICCAT’, and both organizations should consider appropriate alternative scenarios that adjust for the biases in the data.

Particularly on the implementation of the precautionary approach in accordance with relevant internationally agreed standards, in particular with the guidelines set forth in the UNFSA, action for the corresponding recommendation (PRIOTC02.07, para. 112f) had been indicated in the timeline as “ongoing” in the IOTC update on progress regarding resolution 16/03—on the second performance review follow-up report [69]. As of 7 December 2018, the precautionary approach is utilized by the Scientific Committee in the provision of the scientific advice for fishery management; a harvest control rule is being adopted for skipjack tuna, with work progressing on Yellowfin, Bigeye, and Albacore tunas with the support of external funding; and an MSE for swordfish is being considered a high priority by the Commission.

In terms of progress in science-based management, particularly in the quality and provision of scientific advice, the IOTC had made substantial developments on the corresponding recommendations (PRIOTC02.07, para. 112a–e) in their previous PR, indicating “completed and ongoing” in the timeline, with ongoing efforts noted with the Scientific Committee continuing work undertaken since the first PR and ‘improve in the way it communicates information about stock status and future prospects for the stocks to the

Commission, and further address the way the uncertainty in stock assessment advice based on data-limited methods is presented' [69] and acted upon.

Haas (2019) purports the IOTC as “improving” in relation to its performance in the adoption of conservation and management measures and quality and provision of scientific advice, and by moving away from circumstances wherein an RFMO such as the IOTC had used the lack of data as a reason for inaction. Moreover, improvements were reported in the management of small-scale and data-poor fisheries as well as in the implementation of harvest strategies through the use of management strategy evaluation—the findings of this study agree that the situation has become notably better and is progressing.

Appendix B.4. North East Atlantic Fisheries Commission

Despite the identified shortcomings, the NEAFC is still considered among the top performing RFMOs. Utilizing a conceptual risk–reward framework for fisheries management and performing comparisons between the fishery–ecosystem value of various RFMOs' area of competence and their historic activity, the NEAFC was categorized as among RFMOs that as within the zone of thresholds for optimal and sustainable in terms of management action and fishery–ecosystem value [31].

The Commission's actions on the Orange can roughly be considered as a relevant example case of its accomplishment of its effective implementation of provisions as part of the enhanced bottom fisheries regulation it adopted in 2014. Therein, drawing from UNGA resolution 64/72, paragraph 119(d), the new objective for the management of deep-sea fisheries was agreed towards ensuring the long-term sustainability of deep-sea fish stocks and non-target species, rebuilding depleted stocks, and moreover, that conservation and management measures will be established consistent with the precautionary approach when scientific information is uncertain, unreliable, or inadequate [77].

Haas [5] observed that since its first PR, the NEAFC had numerous new or updated measures (40), with three measures updated or newly implemented after the first PR, while 37 measures were found after the second PR (p. 5).

Specifically on the quality and provision of scientific advice, the panel for the second PR had found the relationship of NEAFC and ICES satisfactory and gave recommendations on improving the efficiency and implementation of the arrangement between the two. These included improvements in the interfaces of the organizations, strengthening the scientific capacity of PECMAS and its contributions to scientific advice, recruitment of a scientific officer to join the Secretariat, and the development of a multi-year research programme that pays particular attention to critical gaps and limitations in existing information, the status of key deep-sea species, and improved management approaches [71].

In terms of the extent of adopting conservation and management measures based on the best scientific advice available to ensure the long-term conservation and sustainable use of living marine resources, the review Panel for the second PR considered the situation noted in the preceding PR—of significant problems in the adoption of conservation and management measures consistent with scientific advice and the precautionary approach—as still unsatisfactory and that the Commission had at the time not yet fulfilled key aspects of its mandate [71].

Similarly, the Panel had expressed concern on the extent to which the Commission had applied a precautionary approach as set forth in Article 6 of the UNFSA and the application of precautionary reference points. The first PR had recommended the NEAFC examine possible solutions consistent with a precautionary approach for the Regulatory Area, even if the coastal States had not reached agreement, and the second PR had commented that during failure to reach agreements on management measures or allocations, unilateral action by coastal States undermined the application of the precautionary approach (pp. 52–53).

As argued by Shephard and others [78], the Arctic is a poorly understood region in various aspects of the natural sciences with limited scientific understanding of the ecological development of the central Arctic Ocean under a changing climate. Until more is known about the impacts of human activities and effects of climate change to the central

Arctic Ocean ecosystem, it would be prudent that a precautionary approach must be applied. Furthermore, the success and relevance of RFMOs in preventing unregulated fisheries by providing regulations is tied to the current scientific knowledge base.

Fortunately, the NEAFC may be up to the task as, at present, it is considered as being a relatively high scoring organization with capabilities such as: high standards of data collection for target fish stocks; utilization of vessel position data; development of VME species/habitats identification and habitat suitability models; definition of fishing footprint and the implementation of fishery closed areas; and conducting studies of significant adverse impacts and implementation of monitoring plans [31].

Haas [5] purports that the performance of NEAFC in terms of relevant progress towards the precautionary approach as being “basic”, particularly to the extent to which it has pursued a precautionary approach in line with Article 6 of the UNFSA and the application of precautionary reference points. At the same time, relevant aspects such as conservation and management and the quality and provision of scientific advice were considered as “improving”, and recommendations are “fulfilled” in terms of international cooperation and transparency pertaining to the NEAFC’s decisions, meeting reports, scientific advice upon which decisions are based upon, and other relevant materials are made publicly available in a timely manner.

As such, this study agrees with the findings particularly in consideration to the substantial progress that the organization had since its first PR in 2006, it is also very likely that given its capacity, structure, and resources as a leading RFMO in the Arctic region, the NEAFC would be able to adopt based on the best scientific advice available apt conservation and management measures to ensure the long-term conservation and living marine resource sustainability in the near future. Moreover, progress made in adopting conservation and management measures based on the best scientific advice available would lead towards progress in application of a precautionary approach [71].

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