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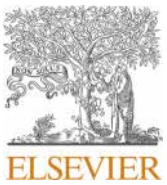

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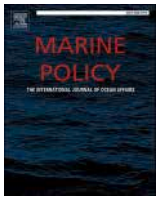

Oppositions and alliances between ICCAT contracting parties through an analysis of co-sponsorship of management recommendations

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ABSTRACT

We conducted a social network analysis (SNA) of the co-sponsorship of management measures at annual ICCAT Commission meetings from 2016 to 2022 with the aim of understanding the alliances between contracting parties. Our findings revealed that European Union, the USA and, to a lesser extent, Japan, Canada or the United Kingdom appear as key players in terms of cohesion and fragmentation centrality indicators, while the most central proposals in terms of management measures concern those on sharks (mainly focused on banning shark finning) and those on mitigating the effects of fishing on turtles. Based on the evolution over time of centrality measures of the SNA, the decrease in nestedness indicates that "specialist" CPCs (those who submit few proposals each year) are less and less associated with "generalist" CPCs (those who submit several management proposals each year). Although ICCAT's social network does not show a fragmented structure with small groups of CPCs isolated from each other, 2 co-sponsoring communities have nevertheless emerged: the COMHAFAT and OPESCA groups. both structured around a regional homophily. This paper also discusses the socio-economic and political factors external to ICCAT meetings that can influence partnerships in the management of large pelagic fishes in the Atlantic Ocean. These influential factors illustrate the complexity of asymmetric relationships between countries operating with long-distance fleets and developing coastal countries.

1. Introduction

Tuna regional fishery management organizations (RFMOs) are treaty-based bodies whose objective is to ensure the sustainable conservation and management of stocks of Large Highly-Migratory Species (LHMS) in specific oceans through international cooperation. These include delegations from coastal states, whose waters harbor part of the stock, and delegations from the "distant water fishing nations" (DWFNs), whose vessels go to areas where the target species is found, either on the high seas or in the EEZs of coastal states with which they have a fishing agreement. The International Commission for the Conservation of Atlantic Tunas (ICCAT) is the RFMO that manages the fisheries in the Atlantic Ocean for tunas and other major LHMS, such as swordfish, billfishes and pelagic sharks. In 2023, ICCAT was composed of 52 Contracting Parties (CPCs) and 5 Cooperating Non-Contracting Parties (Cooperators).[1]

It has been shown in the past that maintaining the abundance of a fish stock at an adequate level, without considering how to adjust fishing pressure to appropriate levels does not guarantee the long-term sustainability of the fishing system [28]. Specifically, how fishers develop dynamic fishing strategies as an adaptive response to changes in resource abundance, environmental conditions, and market or regulatory constraints, has often been ignored in fisheries management [43]. There are many ways to define sustainability, but in general, they all have in common the notion of sustainable development, a definition of which can be found in the Brundtland report:

> "Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs" [52].

This broad definition allows to cover quite different areas and it is therefore accepted that sustainable development is based on three

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[1] To become a contracting party to ICCAT, any government, member of the United Nations, or any inter-governmental economic integration organization must deposit an instrument of adherence with the FAO. Those wishing to obtain cooperating status must submit their application through the ICCAT Secretariat.

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fundamental pillars: social, economic and environmental. The counterpart of this wide choice of objectives is that in the decision-making process, the weight given to one of these pillars will differ according to the priorities chosen by each actor (fishermen, scientists, managers, NGOs). However, even if it can be argued that the social component is under-represented, there is no evidence of conflict between these 3 components which can be complementary when the fishery is well managed [3,24].

Despite their different interests, the CPC delegations attending the annual meetings of the ICCAT Commission are not independent actors, but members of social networks which, in principle, work together to find solutions to maintain the stocks at sustainable levels. By collaborating, CPC delegations can share information with each other, join together to propose co-management recommendations and, ultimately, participate in ICCAT networked governance by reducing the cost of confrontation and preserving, if possible, a certain balance between the 3 components of sustainability. All this relates to the concept of social capital, which presupposes a climate of trust between CPC delegates based on the links they have established with each other at other meetings. As Bourdieu [11] points out, this goes beyond short-term economic interests.

> "It has been seen, for example, that the transformation of economic capital into social capital presupposes a specific labor, i.e., an apparently gratuitous expenditure of time, attention, care, concern, which, as is seen in the endeavor to personalize a gift, has the effect of transfiguring the purely monetary import of the exchange and, by the same token, the very meaning of the exchange. From a narrowly economic standpoint, this effort is bound to be seen as pure wastage, but in the terms of the logic of social exchanges, it is a solid investment, the profits of which will appear, in the long run, in monetary or other form"

In the literature many studies have proposed the use of social network analysis (SNA) to measure and map the flow of relationships existing between people, groups, and countries. To mention a few examples, SNA has been used in very different research fields in order to identify important stakeholders in natural resource management [39], to assess the degree of communication between stakeholders involved in two U.S. Atlantic fisheries (i.e., Atlantic herring and Gulf of Maine sea scallop) [26], to analyze international cooperation on environmental laws and treaties [12], to use co-authorship network to enable better strategic planning of research proposals on neglected tropical diseases [35], to evaluate the alliances and network structure between organized crime cartels in Mexico [32], and to track protest communications on Twitter related to various political events [4].

In this study, we analyse the coalitions formed by the ICCAT contracting parties when they jointly submit management proposals at the Commission's annual meeting. We are trying to answer questions such as: which CPCs are the most influential in terms of management proposals? Does their influence enable them to rally other CPCs, or do they remain relatively isolated despite their known activism within ICCAT? Does their influence lead to the adoption of management recommendations? Is ICCAT's social network so fragmented that it hampers decision-making? Which management proposals, supported jointly by developing and industrialised CPCs, contribute to the cohesion of the ICCAT social network? Finally, we discuss how social and economic factors, not revealed in the formal structure of the ICCAT Commission, may influence alliances between CPCs and the collective action required to manage shared marine resources.

2. Data and method

2.1. Data

Alliances between CPCs can be demonstrated by the submission of joint management proposals during the sessions of the 4 species-group panels held during the Commission's annual meeting. The proposal may remain as originally submitted, with a single CPC or a group of several CPCs as author, or evolve in successive versions, sometimes with amendments, and obtain the co-sponsorship of other CPCs. The version of the proposal and the list of sponsors are updated daily throughout the Commission meeting and can be freely consulted on the ICCAT website. The final version of the proposal is presented to the plenary session of the Commission for discussion and possible adoption as a recommendation. In the event of non-adoption, certain proposals are presented again the following year. It should be noted that the list of CPCs on a panel may differ from one panel to another. To perform this analysis, we used the management proposals issued in one of the panels at ICCAT Commission meetings between 2016 and 2022. The information was collected by the authors during their participation in the annual meetings of the ICCAT Commission and is summarized in the different tables below. During this period, 44 Contracting Parties and Cooperators have submitted at least one proposal for a management recommendation (Table 1).

These proposals concerned 25 stocks/topics (Table 2) divided into the 4 following panels:

Panel 1: Tropical tunas (yellowfin, bigeye and skipjack);

Panel 2: North temperate tunas (albacore and bluefin tuna);

Panel 3: Southern temperate tunas (albacore and southern bluefin);

Panel 4: Other species (swordfish, billfish, small tunas, pelagic sharks).

Since the objective was to detect the priority topics for each CPC as well as the alliances that were formed to propose a management recommendation, we have omitted all proposals made by a panel chair as they came from discussions made prior to the annual Commission meeting, either in the previous year or during an intersessional meeting. Therefore, it was difficult to find the contributors to the proposal. CPC declarations reflecting a general position on a subject or expressing an individual request (e.g. a change in individual quota, a quantity to be transferred to another CPC, etc.) were also not included. The list of selected proposals is presented in **Table A.1** in the Appendix.

To measure the text-similarity between an adopted recommendation

Table 1
ICCAT CPCs and Contractors with at least one proposal for a management recommendation in one of the 4 panels during the period 2016-2022. The colors included on the Sub-Group column are assigned for the purpose of defining the colors of the simbols in the subsequent figures. It should be noted that the United Kingdom as part of its overseas territories (UKT) belonged to the European Union sub-group until its accession to ICCAT (UKG) as a separate CPC of the European Union on 21th October 2020. The term Chinese Taipei (I.e., Taiwan) being used by ICCAT will be used hereafter. Proposals made by the chair of a panel or dealing only with a renewal or an item affecting a single CPC are not included.

Sub-group	Contracting parties and Cooperators (CPCs)
Africa (AFR) Yellow	Angola (ANG), Cape Verde (CPV), Cote d'Ivoire (CIV), Equatorial Guinea (EGU), Gabon (GAB), Gambia (GIA), Ghana (GHN), Guinea Bissau (GBI), Liberia (LIB), Morocco (MOR), Namibia (NAM), Nigeria (NIG), Republic of Guinea (RGU), São Tomé & Principe (STM), Sierra Leone (SRL), Senegal (SEN), South Africa (SAF)
Asia (ASI) Pink	Japan (JAP), Chinese Taipei (TAI)
Central America (CAM) Red	Belize (BLZ), Costa Rica (CRI), Curacao (CUR), El Salvador (SAL), Guatemala (GUA), Honduras (HON), Mexico (MEX), Nicaragua (NIC), Panama (PAN),
European Union (EUN) Blue	European Union (EUR), France - St Pierre et Miquelon (FRA), United Kingdom Overseas Territories (UKT)
Mediterranean. (MDT) White	Albania (ALB), Algerie (ALG), Egypt (EGY), Turkyie (TUR)
North America (NAM) Grey	Canada (CAN), USA (USA)
Other Europeans (OEU) Dark Blue	Norway (NOR), Russia (RUS), U. K. of Great Britain & Northern Ireland (UKG)
South America (SAM) Orange	Brasil (BRA), St Vincent & the Grenadines (SVG), Uruguay (URU), Venezuela (VEN)

Table 2
Stocks/topics for which a management recommendation has been proposed during the annual meeting of the ICCAT Commission (2016–2022). In some cases, the proposal was for the whole Atlantic Ocean (e.g., ABFT for Atlantic bluefin tuna, AMAK for Atlantic shortfin mako shark, etc.).

Panel	Name of species	Stock/Topic
PA1	Bigeye tuna (*Thunnus obesus*), Yellowfin tuna (*Thunnus albacares*), Skipjack tuna (*Katsuwonus pelamis*)	Tropicals (TROP), Atlantic bigeye (ABET), Western skipjack (WSKJ), Fish aggregating devices (FADS), Observers on board (OBSE), Discards (DISC)
PA2	Bluefin tuna (Thunnus thynnus) Albacore (*Thunnus alalunga*)	Atlantic bluefin (ABFT), Eastern and Mediterranean bluefin (EBFT), Western bluefin (WBFT), Northern albacore (NALB), Mediterranean albacore (MALB)
PA3	Albacore (*Thunnus alalunga*),	Southern albacore (SALB)
PA4	Swordfish (*Xiphias gladius*), Billfishes (Istiophoridae), [e.g., Atlantic white marlin (*Tetrapturus albidus*), Blue marlin (Makaira nigricans), Sailfish (*Istiophorus albicans*)], Blue shark (*Prionace glauca*), Shortfin mako (*Isurus oxyrinchus*)	Northern swordfish (NSWO), Mediterranean swordfish (MSWO), Southern swordfish (SSWO), Billfishes (BILF), Atlantic shortfin mako (AMAK), Northern shortfin mako (NMAK), Southern shortfin mako (SMAK), Atlantic blue shark (ABLK), Northern blue shark (NBLK), Southern blue shark (SBLK), Sharks (SHAK), Turtles (TURT), Marine mammals (MAMM)

and the closest proposal, irrespective of their respective sizes, we used the cosine similarity after cleaning the texts[2] and transforming both texts into vectors (**Table A.2** in the Appendix). Excluding the year 2020 when the Commission was not held face-to-face due to the COVID19 pandemic, the number of CPCs that participated in at least one recommendation proposal in one of the 4 panels ranged from 16 to 37 and the number of proposals from 10 to 19 (Table 3). The percentage of draft proposals adopted as recommendation varied from 30 % to 61 % depending on the year.

2.2. Method

Social network analysis (SNA) is the process of investigating social structures through the use of networks and graph theory concepts. It explores the behavior of actors at the micro-level, their relationships (social structure) at the macro level, and the connection between the two. A typical social network graph consists of points (or nodes) representing actors and lines (or edges) depicting links or relationships between them. Depending on the purpose of the study, SNA can be applied on one-mode data or on two-mode data (i.e. a bipartite/Affiliation network).

Table 3
Number of active CPCs (i.e. with at least one proposal) and number of recommendation proposals submitted in one of the four panels to the annual ICCAT Commission meeting between 2016 and 2022. The percentage of adopted proposals is calculated in relation to those submitted during the annual Commission meeting. The proposals made by the Chair of a panel are not included in this table even though they may have led to an adopted recommendation.

Year	No. of CPCs	No. of proposals	No. prop. adopted	% prop.adopted
2016	32	18	11	61
2017	23	19	8	42
2018	20	10	3	30
2019	37	19	6	32
2020	*7*	*5*	*0*	*0*
2021	19	17	6	35
2022	16	19	8	42

A bipartite matrix A with dimensions n × m consists of two disjoint modes of nodes, in which the n rows represent the first mode (i.e., actors), and the m columns represent the second mode (i.e., groups, events, etc.), in which $a_{ij} = 1$ if actor i participated in group j and $a_{ij} = 0$ otherwise. Each link represents a social actor's affiliation to a group, thus there can be no link between two nodes of the same mode [10]. As co-sponsoring requires reciprocal cooperation among the CPCs, all links are considered to be nondirectional. A concrete example of the data collected to analyze the collaboration between CPCs in developing joint management proposals is presented in **Table A3** in the Appendix.

The first approach to analyzing data of this form is known as the projection method, in which two-mode data are converted into a single mode. The number of times a pair of CPCs co-sponsors a proposition and the number of CPCs two propositions have in common are given by the matrix products AA^T and A^TA, where A is the affiliation matrix and A^T the transpose of A. The second approach is to analyze the network directly with the two modes considered jointly. The bipartite adjacency matrix B of an affiliation matrix A is given by:

$$B = \begin{bmatrix} 0 & A \\ A^T & 0 \end{bmatrix}$$

The matrix B is now a regular adjacency matrix in which the rows and columns have both the actors (i.e., CPCs) and the events (i.e., proposals). However, adjustments are needed to take account of the fact that there are no within mode relations, represented by the two zero blocks in the previous equation [19]. It should also be noted that in a bipartite network, the centrality of an actor depends on the centrality of the events in which he participates [9]. To be more explicit, observing two CPCs alone co-sponsoring the same proposal provides more information about a social relationship between them than observing these same CPCs collaborating with several other CPCs on a proposal.

A large number of indices (i.e., metrics) have been proposed to characterize the configuration of social networks, enabling us to see how this can influence the governance of natural resources. For this study, we have selected metrics that can be classified at different hierarchical levels: network level and node level (Table 4).

(1) at the network-level, we used the following metrics:

- the connectance, which measures the degree of network complexity,
- the modularity, which indicates the existence of groups,
- The nestedness which is used to detect networks displaying nested forms of interactions,

(2) at node level to analyze the position of actors within a network and the relationships they maintain with each other, in order to reveal the importance of the power they wield in decision-making. To determine influential nodes in single-mode social networks, Borgatti [8] proposed fragmentation and cohesion centrality to isolate actors who are either in a position of high vulnerability or high influence. These metrics for identifying key players have been extended to bipartite graphs by Duxbury [17] who proposes averaging the indicators of intramodal and cross-modal fragmentation/cohesion.[3]

[2] For the sake of simplicity stopwords have been eliminated as well as some words present only in proposals, such as: Draft, Doc, submitted by, presented by, November, Proposal, Original. The calculation of the cosine similarity was done using the R library (quanteda.textstats; [5])

[3] The R functions fragmentation_centrality.R and cohesion_centrality.R are available at the following address: https://github.com/sduxbury/Key-players-in-Bipartite-Networks, (accessed 31 January 2023)

Table 4
Social network analysis (SNA) metrics used in this study for characterizing the co-sponsoring of management recommendations among ICCAT contracting parties. Except for the nestedness (NODFc) calculated from the R library (maxnodof, V1.0.0), [29], the SNA metrics were calculated using the R library (bipartite, V2.17; [15]).

Metric	Definition
At the network-level	
Connectance	The number of observed interactions divided by the number of possible interactions. Connectance varies from 0 (no interactions) to one (all nodes interact with each other).
Q-Modularity	Indicates the presence of multiple sub-groups. A sub-group is defined as having significantly more links between its members than it has with non-members. Newman's Q-modularity ranges from −1 to 1, with 1 meaning optimal modularity. In practice it is found that a value above about 0.3 is a good indicator of significant community structure in a network.
Nestedness (NODFc)	Defined as a pattern of interactions in which "specialists" (e.g., CPCs that contribute to few proposals) interact with subsets of the CPCs with which "generalists" (e.g., CPCs co-sponsoring many proposals) interact. Since nestedness tends to correlate with network properties, we used NODFc which is expressed as a function of network size, connectivity and the maximum nestedness that can be achieved in a network with the same number of rows, columns and links.
At the node-level	
Total fragmentation (cohesion)	Where a node in the network is impacted (fragmentation) or influential (cohesion). Total fragmentation (cohesion) is the average of the intramodal and cross-modal fragmentation (cohesion).

3. Results

3.1. Actors and management proposals at ICCAT commission meetings

Three industrialised CPCs lead the ranking of management proposals submitted to one of the 4 panels between 2016 and 2022: the European Union (EU), USA and Japan with 53, 32 and 24 proposals respectively (Fig. 1). However, the way they operate within the social network represented by ICCAT is different: 58 % of the management proposals from the EU are submitted without partners, a percentage that even reaches 63 % for Japan, compared with just 28 % for the USA. With the exception of Norway (45 % of proposals made alone), the other CPCs show a clear trend towards co-sponsoring. Some CPCs, such as Canada, Brazil and Guatemala, tend to join an existing proposal, unlike the EU and USA, which tend to be leaders, even if they are joined by other CPCs during meetings. If we only consider CPCs that have submitted a minimum of 10 proposals between 2016 and 2022, we note the active participation of certain developing states (Senegal, Brazil, South Africa, Gabon, Guatemala) and in particular that they do not hesitate to position themselves, alone or with others, as proposal leaders. Even if it is sometimes difficult to distinguish which proposal contributed most to the adoption of a recommendation on the basis of cosine of similarity alone, the proportion of proposals adopted gives a good idea of the influence of actors within the social network. Half of the 53 EU proposals (51 %) end up being adopted as management recommendations, while the figure is slightly lower for the USA (43 %) and only around a third for Japan, Canada and Brazil. The adoption rate falls to 25 % for South Africa and 15 % for Senegal, to name but a few of the CPCs that make the most proposals.

If we now look at the stocks or topics linked to the exploitation of large pelagic fish, it can be seen that between 2016 and 2022, the focus of debate has been on tropical tunas (which includes 3 species and 4 stocks), and Bluefin tuna (Eastern Atlantic-Mediterranean stock, Western Atlantic stock and on the global scale of the Atlantic Ocean; Fig. 2). With the exception of proposals on turtles and sharks fully co-sponsored, or billfishes and Western Atlantic Bluefin tuna partially co-sponsored, the vast majority of proposals (61 %) are the work of a single sponsor

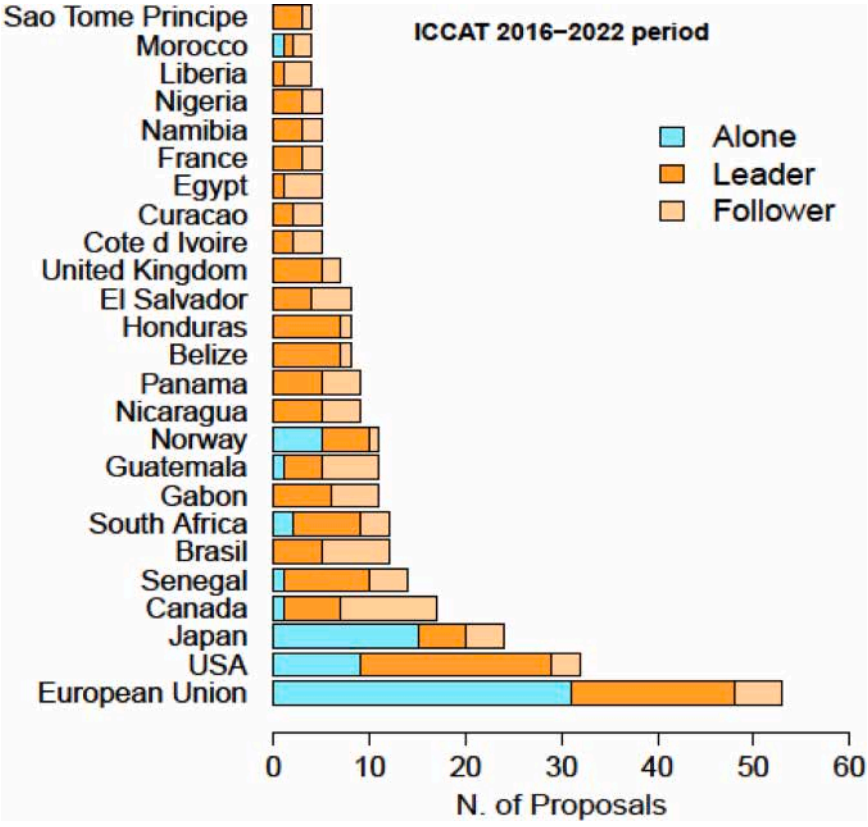

Fig. 1. Number of management proposals for the most active CPCs made either alone, as a leader or after joining a proposal made by other CPCs, at the annual ICCAT Commission meetings (2016–2022).

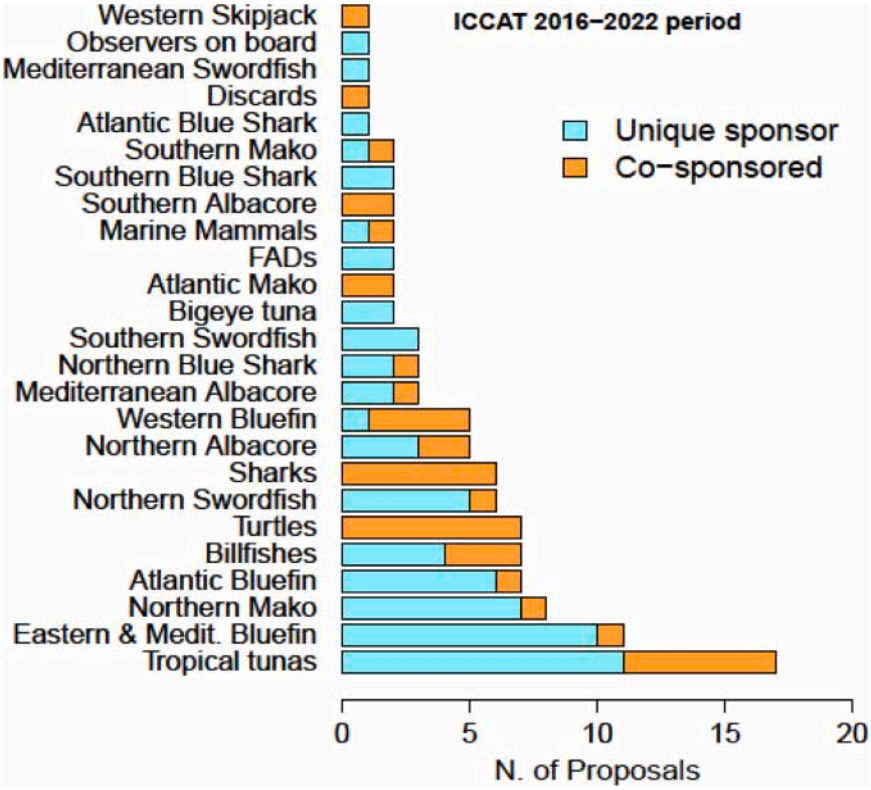

Fig. 2. Number of stock/topic management proposals made either by a single sponsor, or by several CPCs, at annual ICCAT Commission meetings (2016–2022).

(e.g., tropical tunas, Eastern Atlantic-Mediterranean Bluefin, Northern Atlantic Shortfin Mako shark, Northern Atlantic Swordfish). Management proposals for the Western Atlantic Bluefin tuna were the most widely adopted (80 %), as were those for the Northern Atlantic Swordfish (67 %) and billfishes (43 %). Proposals on Eastern Atlantic and Mediterranean Bluefin tuna and tropical tunas had only a one-in-four chance of achieving consensus leading to the adoption of a recommendation, and those on Northern Atlantic Shortfin Mako only a one-in-five chance.

3.2. *The ICCAT social network*

Metrics at network level show different trends throughout the period studied (Fig. 3). Connectance, (i.e., link density), is one of the most widely used metrics of network-wide connectivity. It increases very slightly between 2016 and 2022, but remains low (between 0.101 and 0.160). We can assume that these low values are due to the fact that many CPCs are only involved in the panel proposals that interest them directly, and therefore interact little with CPCs that are not part of the same panel.

Modularity measures the tendency of a network to divide into modules (i.e., groups of nodes that have more links to each other than to other nodes in the network). A network with a very high modularity of 1 would indicate that all links are within modules and none between modules. In the case of the social network of ICCAT Commissions the modularity varies between 0.402 (2019) and 0.577 (2017) without a noticeable trend over time. The absence of strong modularity does not indicate a total absence of groups, but rather that some CPCs maintains links with several groups. Thus, in 2016 the "SHAK803" proposal was co-sponsored by 20 CPCs who have sponsored only this proposal and 9 other signatories who have links with other groups via the submission of joint proposals. This was also the case in 2019, where the 11 CPCs that only co-sponsored the shark proposal “SHAK806” remain linked to the entire network, as this proposal was also supported by other CPCs that co-sponsored other proposals, thus opposing the creation of isolated CPC blocks.

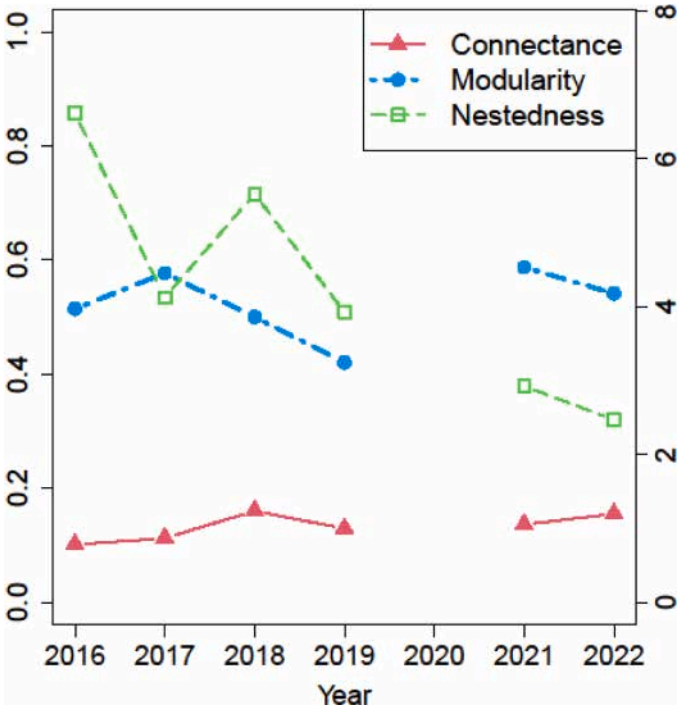

Fig. 3. Matric trends at network level for the period under review. The year 2020 is not considered for the reasons given in the text. The scale of changes in connectance and modularity is shown on the left-hand Y axis, while that of nestedness is on the right-hand Y axis.

In bipartite networks, nestedness is a central property of the network architecture that describes the pattern of interactions between

"specialist" CPCs and "generalist" CPCs. The former sponsor few proposals and interact only with a small subset of generalist CPCs which, unlike the former, interact with many other nodes in the network via their numerous proposals. To quantify the evolution of nestedness over the years we used the NODFc index that corrects for network size. There is a decrease in nestedness between 2016 and 2022 (see the 2nd y-axis in the right part of Fig. 3). This can be interpreted as a decrease over time in the number of co-sponsorships between the more generalist CPCs, e.g. the European Union, the United States and Japan, and the specialist CPCs.

At node level, centrality metrics make it possible to identify the actors who are positioned to quickly share their point of view on a subject with the greatest number of actors (cohesion centrality), or who are positioned to disrupt the network as much as possible when they are removed from it (fragmentation centrality). As an example, we will limit ourselves to an overall presentation of the cohesion centrality for the 2017 and 2021 networks. In 2017 (Fig. 4), among CPCs, the key players were the USA, the European Union and Japan, while the most influential proposals were SHAR802 (i.e., PA4-802–17) and to a lesser degree TROP505 (PA1-505–17), TURT809 (PA4-809–17) or NMAK812 (PA4-812–17). TROP505 was proposed by several African CPCs (Cape Verde, Senegal, South Africa, Namibia and Nigeria), joined by Uruguay, Brazil and Japan.

Overall, in 2021 (Fig. 5) we find the same leading CPCs: European Union, USA, Canada, with the addition here of the United Kingdom (which became a full ICCAT member in October 2020, and is coded as UKG in this figure) and the preponderance of the general SHAK807 shark proposal (i.e., PA4-807–21), as well as the TURT811 turtle proposal (PA4-811–21). We note the relatively isolated position of Japan, despite 7 sponsorships or co-sponsorships, and the core group of Central American CPCs (Nicaragua, El Salvador, Honduras, Panama, Guatemala and Curaçao) who co-sponsored the TROP511 proposal (PA1-511–21).

The total fragmentation centralities indicates the average disruption potential of a node across both projections when deleted. To identify which nodes have a vulnerable position within a network, we have taken the years 2018 and 2019 as an example. Fig. 6 shows that the most vulnerable player in the 2018 ICCAT Commission bipartite network is proposal SHAK806 (i.e., PA4_806_18). Indeed, eliminating this node would isolate a large number of CPCs from the rest of the network; this would be particularly the case for African delegations.

The situation is more complex for 2019 as a large number of CPCs have co-opted at least one proposal (Fig. 7). Once again, the proposal to ban shark finning appears to be a sensitive element in the structuring of the ICCAT social network, insofar as its elimination would isolate the CPCs that have only intervened on this aspect. The European Union's total fragmentation centrality highlights the vulnerability of this CPC in the 2019 social network, as the EU has made many proposals in isolation. It should be noted, however, that some of them have been adopted, for example with regard to northern and southern blue shark stocks (NBLK807, as Rec 07_2019 and SBLK808, as Rec 08_2019, respectively).

These annual bipartite networks give us several indications of the coalitions between CPCs that result from common interests in terms of sharing a geographical stock unit, or from the desire to form a collective of states likely to carry more weight in decision-making within ICCAT. Thus, in addition to frequent co-sponsorships, such as between the USA and Canada, we note the emergence in 2018 of a Central American group initially made up of Guatemala, Nicaragua, Panama (joined by Cape Verde) around the text on turtles "TURT809" (Fig. 6). This group is reinforced in 2019 (Fig. 7) by Costa Rica, El Salvador, Mexico and Belize with another proposal on turtles: "TURT812" but also on tropical tunas: "TROP505" (i.e., PA1_505_19), to which Mexico has joined (Mexico has been classified as a Central American CPC for the sake of simplicity, although this may be debatable in geographical terms). Also in the same year, another relevant aspect was the coalition of African states co-sponsoring TROP509 (PA1_509_19) with Nigeria, Côte d'Ivoire, Ghana, Guinea Bissau, Senegal and Gabon; the embryo of which had been created in 2017 with the "TROP505" proposal (Fig. 4). In 2019, this group of African CPCs (Senegal, Liberia, Angola, Gabon and Gambia) also submitted a management proposal for the Atlantic shortfin mako shark (AMAK805). Beyond the coalitions mentioned above, an example of consensus is provided by TROP506 (i.e. PA1_506_19) on a draft revised by South Africa which was finally adopted (Rec 02_2019) after being co-sponsored by the EU, USA, Senegal and Japan at the Panel 1 session held during the 2019 Commission meeting.

4. Discussion

4.1. Collaborations and points of tension at ICCAT commission meetings

The structure of the ICCAT social network is the product of historical interactions between actors, but at the same time it can affect its effectiveness in terms of consensus-building and the adoption of co-management measures for tuna resources in the Atlantic Ocean. It is therefore important to analyze its evolution over time in order to understand how management recommendations are developed as part of networked governance decision-making. Connectance (hereafter synonymous with density), which measures the connectivity within the network increased slightly between 2016 and 2022. It is recognized that connectivity may influence effective natural resource governance. Where there are few links between actors, effective collective action is difficult to achieve. On the contrary, high density of ties can help build mutual trust between actors, thereby increasing the scope for social control. This reduces the risk and cost of collaborating with others, which is an essential prerequisite for collective action and collaboration [6]. However, excessive high density can have negative effects such as homogenization of information which may limit innovation and adaptability in the network [7,37]. It is worth mentioning that due to differences in the characteristics and priorities of each CPC, many controversial issues persist from one year to the next, such as the impact of bluefin tuna transatlantic migrations on the diagnosis of the western stock assessment, the impact of billfish catches by longliners versus sport fishing yields, the impact on tropical tunas stock status of drifting fish aggregative device (dFAD) catches of juvenile by purse seiners versus adult catches by longliners, the impact of implementing pelagic shark and turtle mitigation measures on catch rates of target species, etc. However, the ability to establish links with other CPC groups, who may have different points of view, can lead to the establishment of a consensus acceptable to these different groups. Over and above these controversies, the search for a balance between collective and individual interests refers to the concept of "social capital" [11]. The term 'social capital' contains the idea that social ties and social norms are key elements of sustainability. It postulates that people have the confidence to invest in collective activities, knowing that others will too. They are also less likely to engage in individual actions with negative outcomes, such as the degradation of resources [40,41]. This could explain why the majority of CPCs are more inclined to adopt a recommendation by consensus than to take the option of a vote, which could isolate the losing CPCs in small groups on the periphery of the social network and thus make future negotiations more difficult.

Over the study period, modularity shows no apparent trend, but a value close to 0.5 suggests the presence of sub-groups formed by CPCs that share clearly identifiable common interests in a given stock/topic (e.g. USA-Canada, African CPCs, Central American CPCs). Less predictably, we also observe that certain proposals, dealing with more general recommendations than those targeting specific stocks, create circumstantial groups that go beyond the usual alliances. In the case of the general shark proposal (submitted from year to year during panel 4 in 2016: "SHAK803", in 2017: "SHAK802", in 2018: "SHAK806", in 2019: "SHAK806", in 2021: "SHAK807 "and in 2022: "SHAK805"), what the CPCs have in common is the desire to regulate shark finning, notably by banning shark finning at sea and requiring all sharks to be landed with their fins naturally attached, as well as promoting live discards of sharks

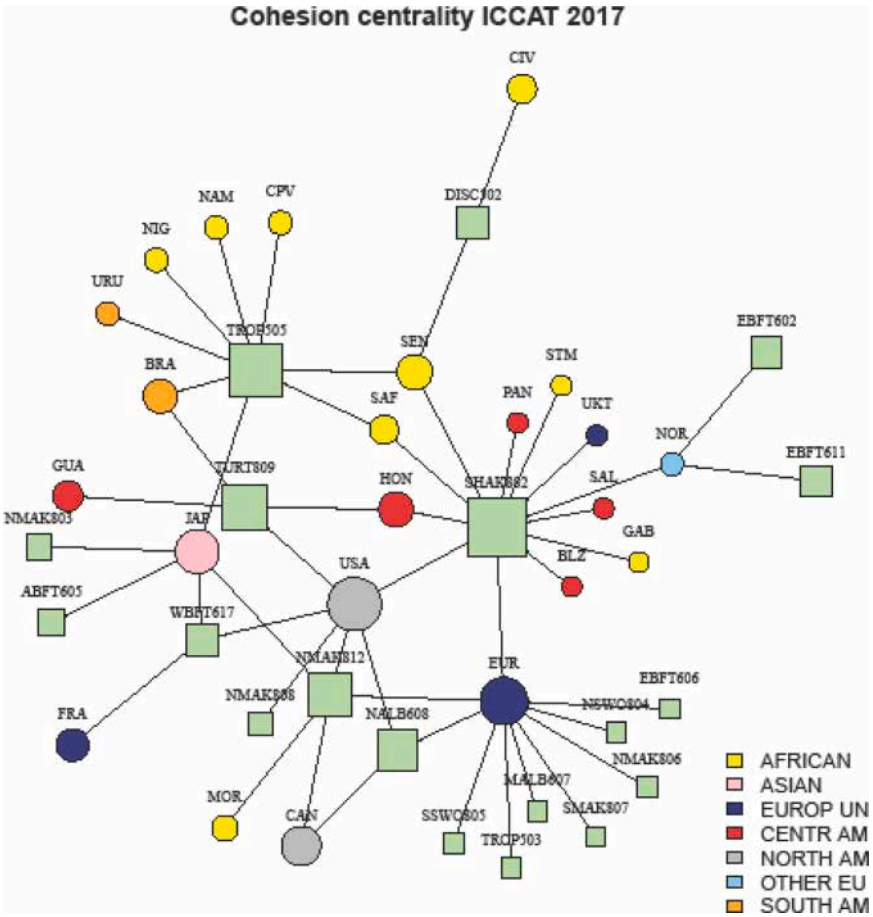

Fig. 4. Total cohesion centrality for CPCs (circles) and for management proposals (squares) of the social network to the 2017 ICCAT Commission. The size of the nodes is proportional to their total cohesion centrality score. CPCs have been classified according to their geographical location. The CPC and proposal codes are shown in Table 1 and Table A.1 in the Appendix, respectively.

in fisheries that do not target them. Despite the fact that several United Nation General Assembly (UNGA) resolutions call on all states to consider requiring sharks to be landed with each fin naturally attached (e.g., UNGA Res[62/177], [49]), the text of proposals PA4_803_2016 and PA4_806_2018 were extensively redrafted to arrive at the final recommendations (Rec 13_2016 and Rec 06_2018, respectively). The issue of shark finning remains a sensitive one for Asian CPCs with longline fleets (China, Japan, Korea, Chinese Taipei), who argue that the measure does not concern species conservation. It should be pointed out, however, that this difficulty with shark measures does not mean that all shark proposals are doomed to failure, since during the 2016–2022 period, several proposals relating to the management of a specific shark stock have been adopted (see **Table A1** in the Appendix).

Another example of a unifying topic is that of turtle catch mitigation ("TURT809" in 2017; "TURT809" in 2018; "TURT812" in 2019; "TURT811" in 2021; "TURT812" in 2021; "TURT803" in 2022; "TURT806" in 2022). These proposals concern the use of circular hooks, the nature of the bait and the use of non-entangling FADs. Despite the consequences their implementation can have on both longline and purse seine fleets, they have brought together CPCs of very different characteristics. However, it was not until the Commission's annual meeting in 2022 that a proposal on measures to reduce accidental turtle mortality was adopted (Rec 12_2022 based on proposal PA4_806_2022). Generally speaking, we must not minimize the fact that these circumstantial groups give CPC specialists, who only co-sponsor one or a few proposals a year, the opportunity to feel involved in ICCAT's decision-making process.

In social networks, nodes are not linked at random, but according to similar characteristics. This tendency is known as homophily. Here, links with specific CPCs are explained by the fact that they share a common interest (target species/stocks, main fishing gear, joint-venture) or socio-cultural characteristics (geographical, historical or linguistic) that make them more likely to form coalitions to advance their fisheries management priorities. For all of these reasons the interaction between homophily of economic interest and homophily of socio-cultural origin may be useful for analyzing collaboration between CPCs within tuna RFMOs such as ICCAT.

Although the 2 types of homophily can interact, it makes sense for CPCs exploiting the same geographical stock to join forces to propose management measures. This is the case for Western Bluefin tuna (WBFT) between the USA, Canada and sometimes Japan, and for the South Atlantic stocks of Albacore (SALB) and Shortfin Mako shark (SMAK) between South Africa, Namibia, Uruguay and sometimes Brazil and Japan. In the case of tropical tunas, one of whose stocks was in a critical state in the second half of the 2010s (i.e., Bigeye tuna), the interests and motivations behind the CPCs' proposals are likely more complex. In fact, several factors divide the CPCs among themselves, such as (1) the opposition between longline fisheries targeting adult bigeye and yellowfin tuna, and purse seine fisheries targeting skipjack under dFADs, but catching many juveniles of the other two tropical tuna species at the same time. (2) the opposition between coastal states, which claim the right to develop their own fisheries and do not consider themselves responsible for the overexploitation of tropical tuna resources, and the distant water fishing nations of developed states, which emphasize the efforts they have made to reduce their catches and the fact that they provide quality fishery data that can be used for stock assessment

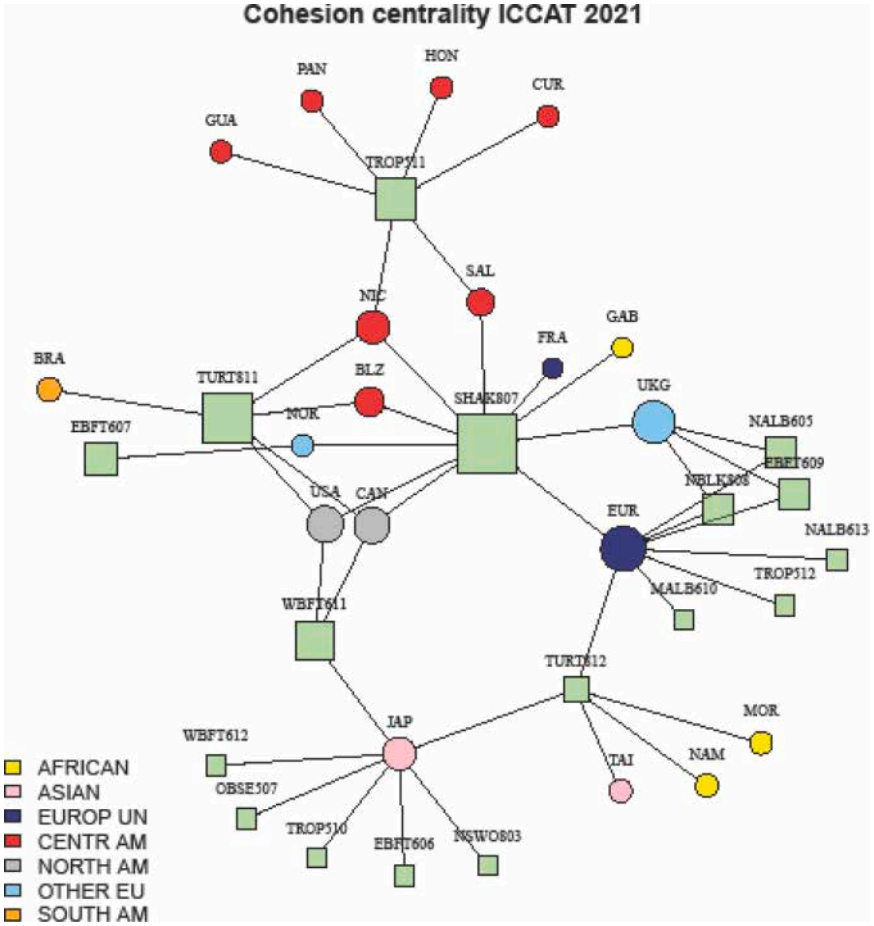

Fig. 5. Total cohesion centrality for CPCs (circles) and for management proposals (squares) of social network to the 2021 ICCAT Commission. The size of the nodes is proportional to their total cohesion centrality score. CPCs have been classified according to their geographical location. The CPC and proposal codes are shown in Table 1 and Table A.1 in the Appendix, respectively.

diagnostics, and finally (3) a precautionary approach advocated by CPCs with little social and economic involvement in the exploitation of these tropical tuna species, but which, beyond the overexploitation of bigeye tuna, see the opportunity to implement specific measures to reduce the impact of dFADs on by-catches of vulnerable species (e.g., turtles, pelagic sharks).

This complexity in the interplay of alliances and oppositions to implement management measures for tropical tunas is reflected in the emergence in 2017–2018 of two CPC blocks in the bipartite social network of the ICCAT Commission. With a few exceptions, such as the joint proposal from Côte d'Ivoire, Gabon, Sao Tomé et Principe and Senegal made in 2014 (PA1-503–2014), EU proposals on the multi-year conservation and management program for tropical tunas have often been co-sponsored by African CPCs (e.g. Ghana for PA1-503–2014, Gabon for PA1-502–2015, Senegal and Côte d'Ivoire for PA1-503–16). In 2017 these CPCs broke away from the EU and joined South Africa in formulating their own joint proposals, such as PA1-505–17 (see TROP505 left-hand side of Fig. 4), which benefited from the partnership of other non-African CPCs such as Brazil, Uruguay and Japan.

The 2018 ICCAT Commission meeting held in Croatia during the bigeye tuna crisis was to confirm this turning point in relations between CPCs from developed and developing states. The debate surrounding the long-term management plan for tropical tuna highlights the particular sustainability challenges and differences of opinion among ICCAT members. Although the CPCs agreed that the bigeye tuna stock was in a critical state, and that management measures needed to be taken to allow the stock to recover, the three proposals for tropical tunas submitted in 2018 by the EU, Guatemala and South Africa (PA1-504–18, PA1-505–18, PA1-506–18, respectively) contained a number of major disagreements. These include the level to be set for the bigeye tuna TAC (from 65,000 t to 55,000 t, with one proposal letting this point open to discussion), the limits on the number of active dFADs per purse seiner (from 400 to 250 dFADs, with different reduction schedules over time), on the number of supply vessels (from a ratio of 2 supply vessels per 5 purse seiners to no limit), and the period and content of the moratorium on drifting FADs (i.e., 2 months, 3 months, open to discussion, moratorium on dFAD-fishing only vs total closure, etc.). In addition, points of consensus between the 3 proposals, such as the ban of at-sea transhipment operations and the increase in scientific observer coverage on board longliners, were strongly contested by Japan, China, South Korea and Chinese Taipei. Following Brazil's plea on behalf of developing states, and oral interventions by several CPCs calling for the aspirations of the coastal states to be taken into account in the establishment of the bigeye TAC, the African CPCs, despite not having made a proposal on tropical tunas in 2018, followed Canada's lead in advocating the use of South Africa's proposal (PA1-506–18) as a basis for discussion.[4] This structuring of African states on the basis of economical homophily, and probably cultural homophily, was made possible by the support of

[4] An illustration of the structuring of this group is the support given in 2019 by Côte d'Ivoire, Gabon, Ghana, Guinea-Bissau, Nigeria and Senegal to proposal PA1–509–19 by the chairman of panel 1. As indicated in the Materials and Methods section, given the objective of the study, we have not retained the proposals made by the panel chairmen in the analysis of bipartite social networks.

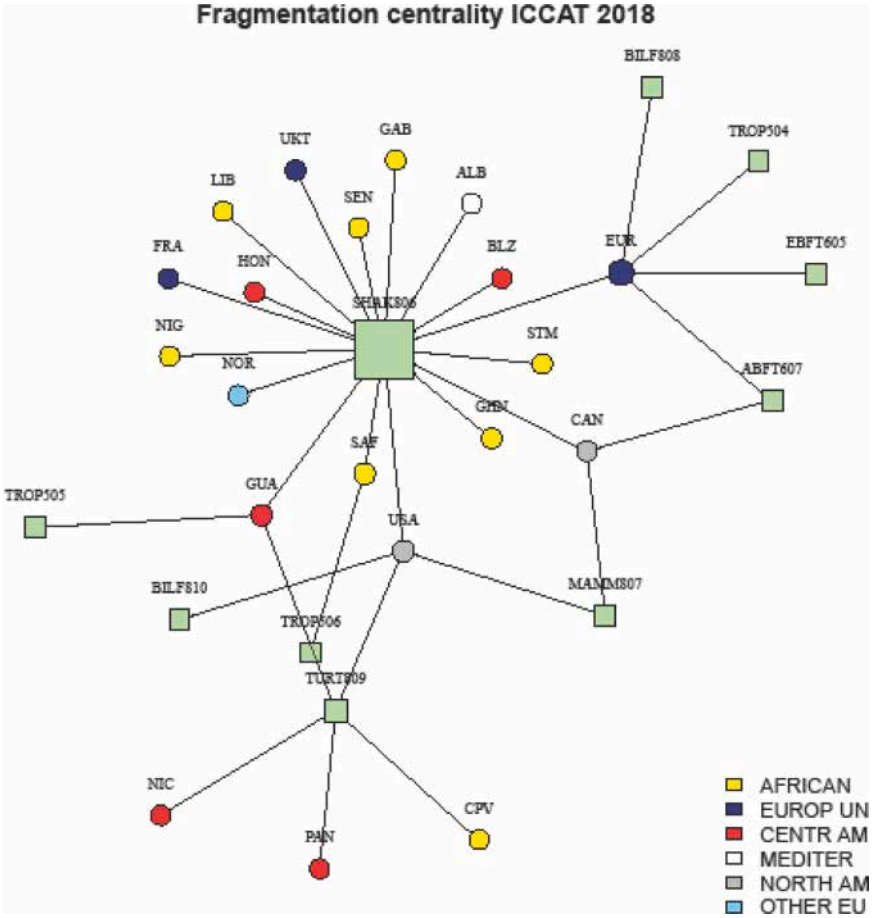

Fig. 6. Total fragmentation centrality for CPCs (circles) and for management proposals (squares) of social network to the 2018 ICCAT Commission. The size of the nodes is proportional to their total fragmentation centrality score. CPCs have been classified according to their geographical location. The CPC and proposal codes are shown in Table 1 and Table A.1 in the Appendix, respectively.

COMHAFAT (Conférence Ministérielle sur la coopération halieutique des États Africains riverains de l'Océan Atlantique, also known by its English acronym ATLAFCO), an intergovernmental organization comprising 22 coastal states on the Eastern Atlantic ocean, from Morocco in the north to Namibia in the south.

Another aspect that could explain the failure of this meeting for tropical tunas is the fact that in 2 of the proposals the quota allocation table was not filled in. This was a major concern for most developing coastal states, who wanted to ensure that the allocation key was fair, so as not to hamper the development of their fisheries. Considering that the quota allocation mechanism based on catch history was not favorable to developing CPCs, the delegate of Gabon even called for a revision of the allocation criteria as part of the revision of the ICCAT Convention. A situation quite similar to that of tropical tuna occurred during the same year in Panel 2 for Eastern and Mediterranean Bluefin tuna, where Turkey, Tunisia, Algeria, Egypt and Libya formed a coalition to review all parts of the proposal concerning vessel capacity limits, and that of fattening farms for developing states. As a result, the stringent conservation measures introduced by the EU delegation were ultimately weakened by negotiations with these Mediterranean CPCs, with the result that the final agreement included considerable flexibility without sufficient controls [31]. Over the years, the issue of quota allocation has become central and has delayed the adoption of management recommendations when the latter contained only technical stock management measures (global TAC, effort reduction measures, etc.).

At all levels of governance, the allocation of fisheries resources is an essential prerequisite for conservation, and it is recognized that in the absence of agreement on the allocation key, competition is highly likely to hamper conservation [27,45]. It is worth mentioning that over the last few decades, tuna RFMOs have taken steps to play a role in distributive justice, and in particular in resource allocation. In the case of ICCAT, resolution [13–15] includes four general allocation criteria: (1) past/-present fishing activity of qualifying participants, (2) the status of the stock(s) to the allocated and the fisheries, (3) the status of the qualifying participants and (4) compliance/data submission/scientific research by qualifying participants [30]. This resolution therefore includes a mix of criteria aimed at establishing a certain balance between taking into account the historical catches of each CPC, the status of stocks evolving from year to year, the distribution area of species and fleets in relation to the high seas and EEZs, the socio-economic and food dependence of coastal states, and the degree of cooperation of each CPC in terms of compliance, data provision and participation in scientific research on these large pelagic fish stocks. Despite this wide range of criteria the allocation of quotas between CPCs remains a difficult point of negotiation when it comes to reducing catches in the event of overexploitation, or redistributing an increase following an upward revision of the TAC. In addition to the fact that an ICCAT resolution is not binding, in the absence of calculation formulas or a weighting procedure to be applied to the various criteria, TAC allocations are strongly influenced by the position of national delegates during annual negotiations, and the inclusion of these criteria is not clearly reflected in the final result of allocations [45].

The Central American regional Group, integrated by Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua and Panama, constitutes the "Organización del Sector Pesquero y Acuícola del Istmo Centroamericano" (OSPESCA). Although not a member of this

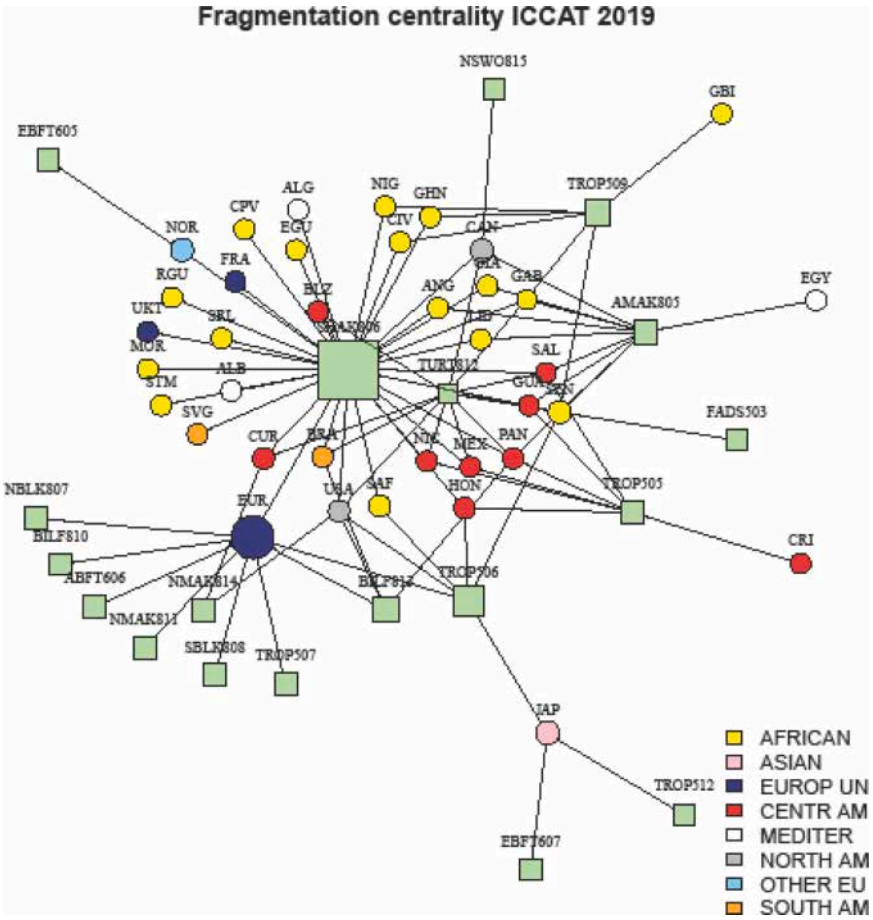

Fig. 7. Total fragmentation centrality for CPCs (circles) and for management proposals (squares) of social network to the 2019 ICCAT Commission. The size of the nodes is proportional to their total fragmentation centrality score. CPCs have been classified according to their geographical location. The CPC and proposal codes are shown in Table 1 and Table A.1 in the Appendix, respectively.

organisation, Curacao shares the same interests as its members, and for the sake of simplicity has been assimilated to the Central American group in this study. As with the African CPC group, the Central American CPC group is undoubtedly based on a combination of socio-cultural and economical homophily. In addition to the linguistic link for most of them, they all have economic links with the EU-Spain (tuna seiners and canneries). Despite different situations, as some of these CPCs have little or no tuna catches in the ICCAT area of competence (Honduras, Nicaragua, Costa Rica), while others have several active purse seiners (Guatemala, El Salvador, Curacao) or even purse seiners and longliners (Belize, Panama), they regularly co-sponsor tropical tuna and turtle proposals with other CPCs. Although it is reasonable to assume that the PA1-505–18 proposal on tropical tuna submitted by Guatemala was already based on a consensus within this group, the joint proposals PA1-505–19 and PA1-511–21 (Figs. 7 and 5, respectively) highlight the growing cohesion of co-sponsorship between the Central American CPCs which, like the African CPCs, will form a co-sponsorship community; a co-sponsoring community is defined as a group of states that support proposals in a coherent way as a group, due to the network structure of this community [34]. Generally speaking, the OSPESCA group stresses the socio-economic importance of tuna seine fishing for the CPCs of this region and is opposed, among other things, to reducing the number of FADs/buoys per seiner and increasing the moratorium period on FADs.

4.2. Factors external to ICCAT meetings likely to affect co-sponsorship of management proposals

The networks we have analyzed in this study have the advantage of using the list of co-sponsors of each proposal from a database freely accessible at the annual meetings of the ICCAT Commission, thus enabling reproducible analyses. However, the way alliances and influences operate within ICCAT may not be revealed solely within the formal structure of the Commission. This may consist of an extension of the debates initiated during the Commission meeting, such as the organization of private meetings between CPCs during the year to align their points of view on a specific subject. It is likely, for example, that the meeting on tropical tunas organized in Rabat (Morocco) in 2022[5] between the Central American CPCs of OSPESCA, whose purse seiners have fishing agreements with several African countries, and the CPCs of the COMHAFAT group was made to seek an alliance or compromise in anticipation of the next Commission meeting. The way in which CPCs decide to form and maintain an alliance also depends on a number of social and economic factors external to tuna RFMOs. We discuss below the impact these factors may have on social capital, which measures the degree of confidence CPCs have in investing in collective actions in the knowledge that they will be reciprocated by other CPCs.

In the case of relations between CPCs that do not, a priori, appear visibly at ICCAT meetings, we can cite the investments of the Spanish tuna sector in Central America. The possibility of signing public or private fishing agreements with third countries, the use of flags of convenience and the creation of joint ventures and subsidiaries in these same places or in those with access licences to certain fishing grounds, have

[5] https://www.comhafat.org/fr/files/actualites/doc_actualite_50811142.pdf (accessed 6 November 2023)

been options frequently used to maintain the activity of the Spanish fleet whose fishing capacity far exceeds the quotas allocated to Spain, as an EU member country, by the tuna RFMOs [50]. In 2017, of the 27 purse seiners belonging to the Spanish fleet operating in the Atlantic Ocean, 16 were flying the flags of Central American CPCs and Curacao, and 1 in Cape Verde [38]. All Spanish tuna purse seiner companies have vessels flying third country flags through joint ventures with the host country, with some having all their tuna vessels registered abroad. The need to cut costs and face up to international competition has also led to a process of relocation in the processing sector, resulting in the creation of joint ventures and subsidiaries in Central American states [50]. In particular, the relocation of the Spanish canning industry to low-wage economies is linked to the increased production of tuna loins, which have high labor costs. Semi-processing loins close to where tunas are caught also enables a substantial reduction in transport costs, as loins can weigh less than half a whole piece. To give an order of magnitude, over 90 % of all tuna loins imported into Europe come from non-European suppliers, offering non-European exporters opportunities to penetrate this market. The volume of tuna loins exported to Europe has seen a steady increase of 31 % since 2015 [14]. The desire to control the entire tropical tuna production chain in order to better withstand market fluctuations is reflected in certain Spanish companies, horizontally integrated at international levels, such as Grupo Calvo [51], Appendix A1. A final factor explaining this relocation outside the EU is the introduction by ICCAT of catch limits (TACs) linked to the deteriorating state of bigeye and yellowfin tuna stocks. In such a situation, the advantage of using the quota set for the coastal state rather than, or in addition to, the one defined for the European Union means that you can have it both ways, as the manager of Nicra-7, a Spanish company that operates two vessels in Curaçao, acknowledged:

> "As the EU tuna fishing rights are limited according to the commitments acquired in ICCAT and currently this capacity is already covered with active vessels, the other countries that have tuna fishing rights recognized in the Atlantic are a valid alternative for the exploitation of the resource[6]."

Not all these factors appear implicitly in the analysis of co-sponsorship of management proposals at ICCAT, but they may be at the origin of coalitions and strategies to promote or oppose all or part of a proposal. As an example, we can see a strong convergence between the proposal made by Guatemala on tropical tunas at the ICCAT Commission meeting in 2018 (PA1-505–18) and the point of view defended by the main Spanish professional organization of tuna purse seiners (OPAGAC) a few months earlier at the Standing Committee on Research and Statistics (SCRS) on a replacement of the moratorium on dFADs by a full seasonal closure of the purse seine fishery [46]. Both even consider it preferable to use input control measures (e.g. capacity limits and fishery closures) rather than output measures (TACs) to achieve catch reduction levels. This change in the nature of the closure was not included in the other proposals for tropical tuna, which, like successive EU proposals on the subject, only provided for a ban on fishing on dFADs (and therefore not on free schools) as part of the measures to be taken to reduce juvenile tuna mortality. This alliance with Central American states sometimes enables Spanish tuna fishing companies to bring back into the Commission's debate specific points on recommendations that had not been favorably received during prior discussions within the EU.

Following the signing of the United Nations Convention on the Law of the Sea (UNCLOS),[7] which recognizes the right of coastal states to control fishing harvests in their EEZs, some of the DWFNs' historic fishing grounds were closed to them unless a fishing agreement was signed with the coastal state. The fairness of these fisheries agreements between developed and developing states is a matter of debate [22,31] and is beyond the scope of this study, but it may be thought that these agreements made outside the formal ICCAT framework partly condition co-sponsoring between CPCs during the ICCAT Commission meetings.

The European Union, one of the leading DWFN operating in the Atlantic Ocean, maintains fishing agreements with African states based on a series of staggered financial payments between the EU and tuna shipowners. The terms of the European Union's fisheries agreements have evolved progressively since the late 1970s and as part of the 2013 reform of the Common Fisheries Policy (CFP), the EU introduced Sustainable Fisheries Partnership Agreements (SFPAs)[8] which, in addition to providing financial contributions and technical support, aim to contribute to scientific research, monitoring, as well as control and surveillance of fishing activities carried out in partner states' EEZs [21, 31], Appendix A2. While SFPAs offer developing states the opportunity to boost trade in fisheries-related services, at the same time, access to the European seafood market is subject to rules set by the EU, even if some of them contribute to capacity building in partner third countries in the fight against illegal, unregulated and unreported (IUU) fishing [13]. Given its exclusive control over access to European seafood markets, the EU obliges all exporting states to ensure value chain transparency through the introduction of a Community Catch Certification Scheme (CCS). Non-compliance with the EU traceability system, or poor cooperation in the fight against IUU fishing on the part of African CPCs, can result in sanctions affecting their seafood exports to the EU, or suspend any negotiations on new fisheries partnership agreements [13,48], Appendix A3. The EU's willingness to translate normative environmental values into the regulations of developing states may be perceived by these partners as a manifestation of power asymmetries during the negotiation process of fisheries agreements [33]. Consequently, it is possible that the EU's external governance of fisheries has gradually led African CPCs to reconsider co-sponsoring management measures with the EU, at the risk of turning to partnerships with other DWFNs that are less constraining in terms of seafood markets and environmental sustainability.

The other long-distance fleets operating in the Atlantic Ocean are those of Asian longliners. Japan' fisheries agreements with the coastal CPCs are negotiated by industry associations such as Nikkatsu – Japan Tuna Fisheries Cooperative Association and are coupled with government support loans to Japanese firms to operate in third countries [21], Appendix A4. The presence of Japanese longliners in coastal EEZs is the result of fishing agreements, as in Cape Verde [1], or through the intermediary of local companies that lease the vessels, as in Brazil [42]. Failler [20] suggested that some longliners continued to operate off the coast of Gabon and São Tomé and Principe. As shown in Fig. 1, Japan usually submits the majority of its proposals alone. However, there are a few proposals made with other CPCs operating in the South Atlantic (e.g., Brazil, Namibia and South Africa, Figs. 4 and 5), and also with Morocco (for example, in 2021). Although a fisheries agreement does not mean automatic co-sponsorship of management proposals, it may explain Morocco's support for the positions defended by Japan at meetings of the ICCAT Commission and the International Whaling Commission (IWC). As Tanabe [47] pointed out, in the case of this cooperation with Morocco:

[6] Iñigo Uribe, interviewed by the Spanish newspaper "La Vangardia"(15/11/2018) https://www.lavanguardia.com/economia/20181115/452926425259/artimanas-empresas-atuneras-burlar-cuotas-pesca-golfo-guinea.html (accessed 16 October 2023)

[7] Among ICCAT's CPCs, the USA, Turkey and Venezuela have not ratified the Law of the Sea Convention.

[8] The list and type of Sustainable fisheries partnership agreements (SFPA) with non-EU states is freely available at: https://oceans-and-fisheries.ec.europa.eu/fisheries/international-agreements/sustainable-fisheries-partnership-agreements-sfpas_en#list-of-fisheries-agreements (accessed 15 December 2023)

"Japanese fisheries diplomacy in Morocco has had three main objectives: 1) securing food import for the Japanese nation; 2) acquiring rights for their vessels to fish off the Moroccan Atlantic shores; 3) acquiring political allies to defend their position on whaling and tuna fishing in the global context".

To date the two states have built a mutually beneficial relationship, in terms of strengthening their political and economic influences on the African continent and beyond. Morocco now plays the role of mediator in the transfer of technical knowledge from Japan to sub-Saharan African states, within the framework of "south-south cooperation".

South Korea has also concluded tuna agreements with several African states. Most of the tuna South Korean fishing companies operating out of Tema (Ghana) are joint ventures between Ghanaian companies and South Korean companies, which are themselves a subsidiary of groups such as Thai Union Europe or Sylla Group [16,20,25], Appendix A5. South Korea is also active in Senegal through the SCASA cannery, which is controlled by the Dongwon group [18]. However, South Korea is not very active at ICCAT in submitting proposals or in co-sponsoring with CPCs, with which its industry is very involved.

In recent decades, the People's Republic of China (PRC) has evolved into the world's leading fishing country with the largest industrial distant-water fishing fleet. As many of China's distant-water fishing companies engage in joint ventures or private agreements in foreign states, there is a lack of transparency over the ownership of vessels [2], Appendix A6. In a global way, through the Belt and Road Initiative (BRI), the PRC and Chinese companies have provided significant investments and loans to West African states (e.g., Ghana, Cote d'Ivoire, Sierra Leone), that traditional lenders have avoided [25]. Chinese companies have also developed "fishing bases" in Mauritania, Ghana, Guinea-Bissau and Angola. These bases are designed as "one-stop shops" for the Chinese fishing industry, and include ports, processing facilities and PRC-owned fishing and support vessels developed under the African Development Cooperation Initiative. However, functioning as private ports, bases are not subject to the same level of inspection or oversight as public landing sites [25]. The lack of transparency in the fight against IUU fishing has often been highlighted by several ICCAT CPCs, and could be one of the reasons why the PRC only participates orally in debates within the ICCAT Commission, without itself drawing up management proposals with its African partners. Beyond access to tuna resources, it has been suggested that the strong Chinese influence in coastal states that have benefited from loans or have joint ventures could lead these CPCs to shift their political alignment from Chinese Taipei to mainland China [2]. The aim would be to isolate Chinese Taipei diplomatically in international forums. As for Chinese Taipei (which has the status of cooperating non-contracting party within ICCAT), its longliners very often operate under chartering agreements with coastal states, as is the case with Namibia [21]. Because of its status, Chinese Taipei is not very involved in co-sponsoring management proposals.

The USA is not considered a DWFN in the Atlantic Ocean, as its fleets operate mainly in the Northwest Atlantic area. We have already seen that in terms of the number of proposals, the USA is a key player comparable to the EU. To combat IUU fishing and reduce bycatch in protected living marine resources (PLMR),[9] the US Congress has introduced a series of laws (e.g., the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006) that allow the US Secretary of Commerce to identify states with regulatory measures deemed comparable to those of the USA [44]. In the event of negative certification, the United States may take actions against a foreign country, which may include trade sanctions, such as denial of US port privileges for its flag vessels, or potential prohibitions on certain seafood products exported to the USA. It is therefore reasonable to assume that historical disputes, such as the shrimp/turtle and tuna/dolphin affairs, are taken into account by delegates from CPCs exporting seafood to the USA when they give, or withhold, their support to US proposals at the annual meetings of the ICCAT Commission. With regard to the first of these two affairs, several Central American CPCs have been forced to use turtle excluder devices (TEDs) in their shrimp fisheries to avoid the imposition of sanctions by the USA, and year-on-year co-sponsoring of the US proposal to use circle hooks to reduce turtle mortality could be a sign of goodwill on the part of these CPCs. Whatever the tacit reasons for this support, the proposal on the use of circle hooks was finally adopted in 2022 (Rec 12_2022), and the USA saw this as the culmination of a long process of consultation between CPCs:

"The adoption of Rec. 22–12 is the result of years of negotiations and NMFS recognizes the important role all ICCAT Contracting Parties and Cooperating Non-Contracting Party, Entity or Fishing Entity (CPCs) had in securing the final measure" [36].

Several economic, normative and diplomatic factors, which are not implicit in the co-sponsoring of management proposals at the annual meetings of the ICCAT Commission, condition relations between developing and industrialised CPCs (Fig. 8). Consequently, it is difficult to predict what impact these social and economic factors might have on the future evolution of centrality indicators. However, the attraction of developing CPCs to collaborative arrangements with certain industrialized CPCs, both in terms of economic benefits and reduced interest in normative aspects, could increase the fragmentation of the ICCAT social network into sub-groups, thus limiting the ability to reach consensus. For this reason, it is important for the proper functioning of ICCAT that industrialised CPCs, which act as a bridge between the different subgroups of CPCs, are willing to co-sponsor management proposals with developing CPCs, including on stocks or issues that are less of a priority for them, in order to interact in a mutually beneficial way. In practical terms, this would mean an increase in the value of the social network's nestedness, reflecting a better intermingling of collaboration between the different subgroups of CPCs.

5. Conclusion

The study shows that the process of co-sponsorship between CPCs to establish management rules for tuna and tuna-like species in the Atlantic Ocean is based on common interests in resource management expressed during the annual meetings of the ICCAT Commission, but also on relationships between CPCs established outside the network organization that is the ICCAT Commission. The visual representation of the bipartite network at the node level showed that the most influential CPCs - literally the key players - were the European Union, the USA and, to a lesser extent, Japan, Canada or the United Kingdom, while general shark proposals (e.g., ban finning at sea) largely dominated the second mode. These key players are CPCs from developed states, some with long-distance fleets, who sponsor several proposals each year and can be described as generalists, as opposed to CPCs, often from developing states, who submit few proposals and are regarded as specialists. It has been suggested that a successful management strategy in governing natural resources is one where actors, during periods of stability, develop new relational ties with various other actors which can be drawn upon in times of change to strengthen the governance of the social network [7]. The evolution of the social network formed by CPCs and management proposals at the annual meetings of the ICCAT Commission does not seem to be moving in this direction, since the decrease in nestedness suggests, on the contrary, that specialist CPCs are interacting less and less with generalists.

Although the overall modularity of the network over the period studied shows no clear fragmentation into small, isolated groups, we do observe the emergence of two regional co-sponsoring communities, each

[9] PLMRs consist mainly of cetaceans, pinnipeds, sea turtles and sharks. These species are protected by US law or international agreements and, with the exception of sharks, are not regulated by international fisheries management organizations.

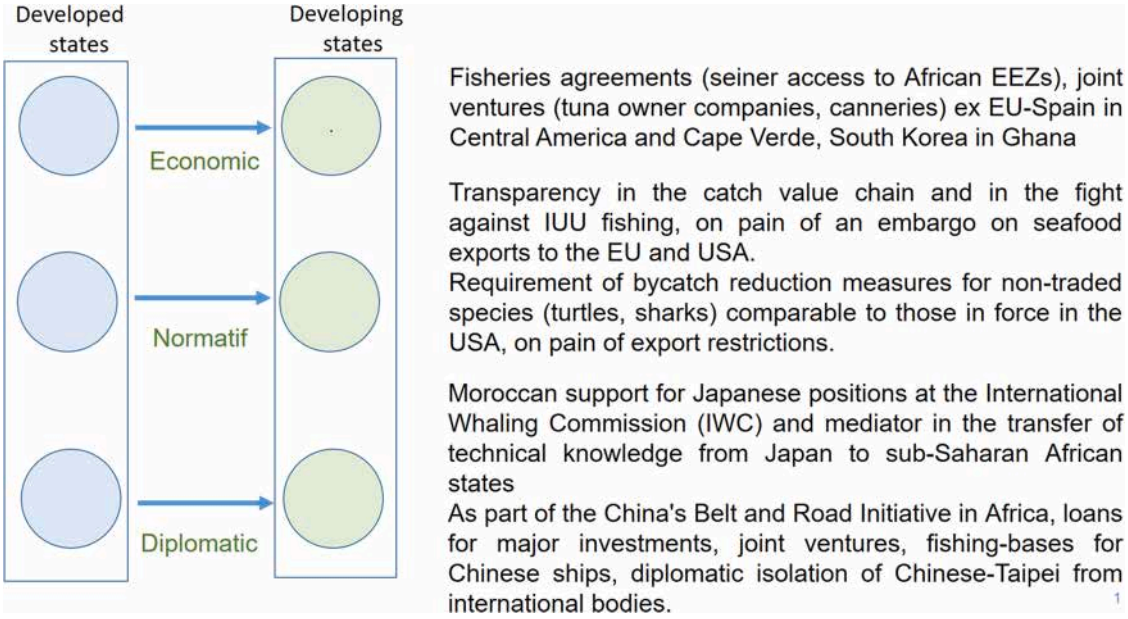

Fig. 8. Non-implicit factors likely to influence the degree of cooperation between industrialised and developing CPCs when submitting co-sponsored management proposals to the ICCAT Commission.

bringing together specialized CPCs that share common socio-cultural, economic or geographical characteristics (i.e., the COMHAFAT and OPESCA groups). In general, the social ties foster trust, reciprocity and thus cohesion within social networks, which is beneficial for consensus-building and conflict resolution, two important prerequisites for natural resource governance [7,41]. The existence of sub-groups can pose problems for joint action to govern a common natural resource, due to the risk of "us versus them" attitudes, which contribute to locking players into fixed political positions and limit their joint ability to act and seek consensus [6,37]. In conceptual terms, political fragmentation occurs in a social network when during debates participants begin to converse more with other ideologically similar people than with other ideologically different people [23]. In some cases, fragmentation can worsen to the point where conversations begin to resemble what have been called "echo chambers", where people simply hear their own point of view repeated back to them. It may be objected that ICCAT's situation is probably not comparable to that of other tuna RFMOs such as IOTC, where disagreements between coastal states (namely a group of Indian Ocean coastal states known as the G16) and DWFNs prevent decision-making on stock management, but the risk for the future of ICCAT is obvious. It is logical to think that the effectiveness of an RFMO's social network, which can be measured by the number of management measures it produces, depends more on collegial action than on the action of isolated groups of CPCs. The legitimacy of these groups' demands for more effective distributive justice is indisputable, but this evolution towards CPC sub-groups closed to discussions with other CPCs could penalize the overall functioning of ICCAT and therefore the adoption of management measures ensuring the sustainability of the exploitation of the species concerned.

CRediT authorship contribution statement

Daniel Gaertner: Writing – review & editing, Funding acquisition, Formal analysis, Writing – original draft, Software, Conceptualization. **Nastassia Reyes:** Investigation, Writing – review & editing, Project administration, Conceptualization, Funding acquisition.

Declaration of Competing Interest

None.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.marpol.2025.106831.

Data availability

as explained in the text information was in free access during ICCAT Commission meetings

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