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Failing the high seas: A global evaluation of regional fisheries management organizations

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ABSTRACT

Regional fisheries management organizations (RFMOs) collectively manage the largest distinct area of the world, the high seas, but their effectiveness in conserving the fish stocks therein has been questioned lately, as many stocks have declined. This study quantitatively assesses the effectiveness of the world's 18 RFMOs, based on a two-tiered approach, concentrating first on their performance 'on paper' and secondly, in practice. The former was determined by assessing how well RFMOs scored against 26 criteria that together reflect current RFMO best practices. The latter assessment referenced the current state of the stocks RFMOs manage, through biomass and fishing mortality reference points and biomass trends through time. Results show low performance of RFMOs for both assessments, i.e., average scores of 57% and 49%, respectively. The latter result is emphasized by findings that reflect two-thirds of stocks fished on the high seas and under RFMO management are either depleted or overexploited. Findings also indicate that there is no connection between the two sets of scores, suggesting a disparity between organization intent and action.

1. Introduction

Close to 60% of the oceans are outside national jurisdiction, i.e., beyond the 200 nm mile Exclusive Economic Zones (EEZs) of coastal countries, and thus, following the United Nations Convention on the Law of the Sea [1], belong to the 'high seas' [2]. Despite covering the majority of oceans, the high seas have, until relatively recently, been inaccessible to fishers: vast, rough, and far from coasts, fishers did not have the vessels or gear to exploit these areas.

Since the mid-20th century, however, progress in fishing technology (freezers, sonar, GPS) and cheap fossil fuel have allowed fishers to exploit the high seas, from which catches have thus increased [3,4]. More dangerous and expensive than coastal fishing, fishing on the high seas is driven by its large rewards: toothfish, tuna, sharks, and certain billfish are all top predator fish of extremely high value [5–8]. In the 1950s, catch from the high seas amounted to under two million tonnes; in 2006, this had grown to over ten million tonnes [9]. As a result, the fraction of the global marine catch originating from the high seas (as opposed to within EEZs) increased from 9% in 1950 to 15% in 2003 (see www.seaaroundus.org; catch decreases within EEZs also contributed to this, but to a lesser extent).

But who manages the high seas? Steeped in the antiquated dogma of Hugo Grotius' '*The Free Sea*' from the early 17th century, fishers have long considered the high seas as open-access, meaning anyone and everyone had rights to fish there. This perception, however, is obsolete today: regional fisheries management organizations (RFMOs) are currently the only legally mandated fisheries management bodies on the high seas, and countries' commercial fishing fleets must abide by RFMO regulations in order to fish in these areas, as decreed by the 1995 Straddling Fish Stocks Agreement [10]. In other words, '*The Free Sea*' is no more [11].

Almost all of the global high seas are now covered by at least one RFMO (Fig. 1). While more RFMOs are slated to come into existence soon, the effectiveness of current RFMOs has never been comprehensively assessed, despite indications that the decline of many high seas fish stocks [12] may be attributed to weaknesses within RFMOs themselves [13]. Indeed, the "ability of RFOs to be 'vehicles of good governance' to secure sustainable management has to be proven" [14]. This contribution addresses these concerns.

Here, the global evaluation on the effectiveness of RFMOs is based on a two-tiered system [15]: (1) in theory (or 'on paper'), i.e., how well RFMOs meet standards as set by Lodge et al. [16] and as measured by the comprehensiveness of available information; and (2) in practice, i.e., how well the stocks under RFMO management do, as measured by current abundance (biomass) trends of managed stocks, and supported by trends through time.

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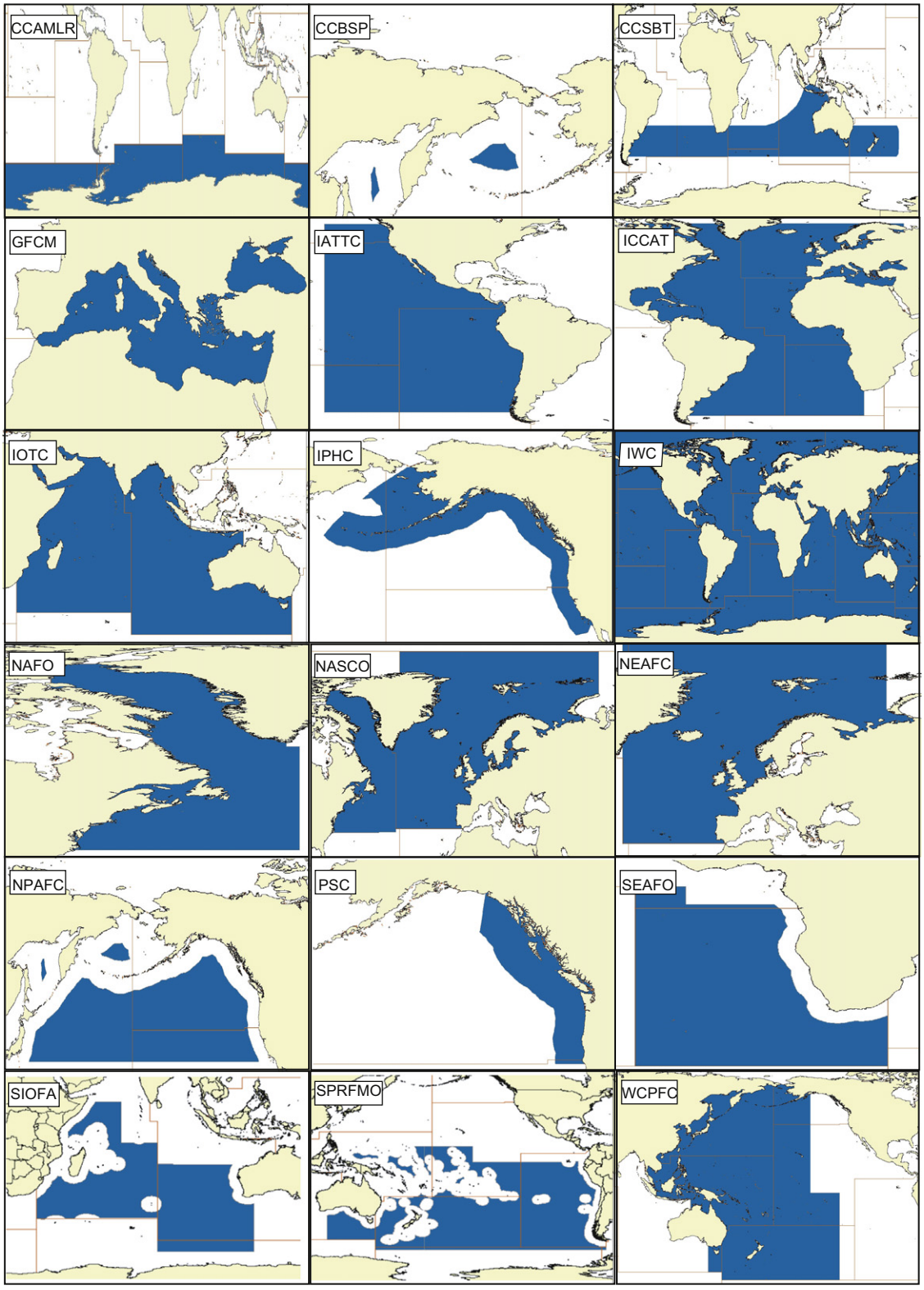

Fig. 1. Global coverage of RFMOs: each box represents the area under management of one of the 18 current RFMOs.

2. Materials and methods

2.1. Theoretical performance: 'P' scores

For this part of the study, the 18 current global RFMOs were analyzed, as characterized by FAO (see www.fao.org; and Zino [15]), i.e., all current regional fisheries organizations with management power. Also included are two 'outgroups' to test the scoring criteria: the National Marine Fisheries Service (NMFS), the national fisheries management agency of the USA, and the World Wildlife Fund (WWF), an international, environmental NGO involved in fisheries conservation issues (Table 1).

Here, the methodology for evaluating RFMO performance was largely based on Alder et al. [17], which focused on countries'

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Table 1
The 20 organizations included in this study. All 18 RFMOs were included in the theoretical performance assessment; '# of stocks' refers to the number of stocks assessed in the practical performance assessment.

Acronym	Full name	# of stocks
CCAMLR	Commission for the Conserv. of Antarctic Marine Living Resources	1
CCBSP	Conv. on the Conserv. & Mgmt. of the Pollock Resources in the Centr. Bering Sea	1
CCSBT	Commission for the Conserv. of Southern Bluefin Tuna	1
GFCM	General Fisheries Commission for the Mediterranean	2
IATTC	Inter-American Tropical Tuna Commission	3
ICCAT	International Commission for the Conserv. of Atlantic Tunas	8
IOTC	Indian Ocean Tuna Commission	3
IPHC	International Pacific Halibut Commission	1
IWC	International Whaling Commission	9
NAFO	Northwest Atlantic Fisheries Organization	5
NASCO	North Atlantic Salmon Conserv. Organization	1
NEAFC	North East Atlantic Fisheries Commission	6
NMFS	National Marine Fisheries Service	Outgroup
NPAFC	North Pacific Anadromous Fish Commission	3
PSC[a]	Pacific Salmon Commission	–
SEAFO[b]	South East Atlantic Fisheries Organization	–
SIOFA[b]	South Indian Ocean Fisheries Agreement	–
SPRFMO[b]	South Pacific Regional Fisheries Management Organization	–
WCPFC	Western and Central Pacific Fisheries Commission	4
WWF	World Wildlife Fund	Outgroup

[a] Constraints on fish stock data: RFMO not assessed.
[b] Adequate fish stock data not yet available for these RFMOs.

compliance to various fisheries and related instruments in the North Atlantic area. In their study, a scoring system was used to determine countries' level of compliance with these instruments. In contrast, the goal here was to evaluate the effectiveness of RFMOs as determined by how their Conventions and other written texts scored against a set of criteria. These criteria were based on the report 'Recommended Best Practices for Regional Fisheries Management Organizations' [16], from which 26 criteria were identified, jointly representing the core components of a competent RFMO.

Scoring was performed, as Sydnes [14] describes, based on descriptions from RFMOs' mandates, stock assessments, and other reports (available mainly from their websites). A score, which could range from 1 and 10, was given to each of the 20 organizations (i.e., including the outgroups) for each of the 26 criteria, creating a matrix of 520 data scores. While other studies assessing various aspects of RFMOs employ much smaller scoring ranges (see Alder et al. [17]; Mooney-Seus and Rosenberg [18]; Small [19]), this larger range allowed more nuanced scoring. The scores were obtained by asking up to ten different questions for each criterion, each yielding a 'yes' or 'no' answer, and moving up (i.e., to the next question within the criterion) if the answer was 'yes', or allocating a corresponding score if the answer was 'no' (see Zino [15], for the rationale behind this 'question' methodology, see Table 2 for an example, and www.seaaroundus.org for all questions under each criteria included in this assessment). Occasionally, when the questions did not necessarily 'chain' (e.g., when an RFMO could not meet the requirement expressed by a lower ranked question, but could meet that of a higher ranked question), a point system was implemented, where each question answered positively was given a 'point'. Points were then added up to form a final '*P*' score. Finally, if no information was available on a criterion, it was assumed to be ignored by the RFMO under evaluation, and a low score was allocated for that criterion (as in Alder et al. [17]).

Scores were not weighted for this assessment, as the number of criteria would make such a process difficult. Furthermore, determining which criterion should be given more weight than others could be subjective, depending on the evaluator and the focus of the research. This was the same in other studies using a similar methodology (i.e., quantitatively answering questions by way of a scoring system), which also did not weight their scores (see Caddy [20]; Pitcher et al. [21]). After the final *P* scores were computed for each RFMO, an average score was computed, and the initial data matrix was then divided up into five general categories (see www.seaaroundus.org). These categories were based on the principal themes presented in Lodge et al. [16], and describe RFMO performance in broad areas.

Ordination and correlation tests were then run, and a hierarchical cluster analysis was employed to detect patterns in data by grouping RFMOs according to their similarity; a dendrogram was then derived from the similarity matrix.

2.2. Performance in practice: 'Q' scores

For this second part of the study, a total of 48 stocks across 14 RFMOs were assessed (see Table 1). *Q* scores of stocks managed by RFMOs were determined by graphing, for each, F/Fmsy against B/Bmsy, where F is current fishing mortality rate, Fmsy is the fishing mortality rate which maintains MSY, B is current biomass, and Bmsy the biomass that produces MSY. Optimal fisheries management should maintain both ratios (i.e., F/Fmsy and B/Bmsy) near unity. On the other hand, if $F/Fmsy > 1$, then the stock is overfished; similarly, if $B/Bmsy < 1$, then biomass is depleted. Hence, a point falling within quadrant I of Fig. 2 receives the lowest score of zero, quadrant IV, the highest score of three, and quadrants II and III receive scores of one. The phase plot methodology is used in ICCAT stock assessment reports (see ICCAT [22]), and is illustrated in Langley et al. [23], and in Worm et al. [24].

In addition, time series of abundance (biomass) of the (major) stocks managed by RFMOs were collected; such data

Table 2
Example of scoring (Criterion # 26: assessments and performance reviews).

Score	Question
1	No mention at all?
2	Does the RFMO mention performance reviews as necessary?
3	Is the RFMO in the process of reviewing/planning on a review?
4	Has the RFMO had meetings with other RFMOs to discuss performance reviews?
5	Has a performance review been created (at least one)?
6	Has a performance review been executed?
7	Are the details of the review available?
8	7+Does RFMO guarantee implementation of relevant changes pending results of review?
9	Has the review led to any changes in the RFMO?
10	Has the review led to the implementation of tangible, positive changes in that RFMO?

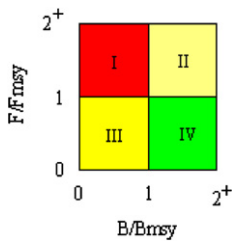

Fig. 2. Example of a phase plot.

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were available for 15 of the 18 current RFMOs (see www.seaaroundus.org).

2.3. Comparing P and Q scores

Unweighted and weighted regressions were both carried out to compare the results from the first assessment with the results from the second; a multiple regression analysis was also performed to test which criterion accounted for the highest between-score variance.

3. Results

3.1. Theoretical performance

Final *P* scores varied from 43% (PSC) to 74% (WCPFC), with an average score of 57% (0% being worst possible performance, and 100% being perfect performance; see www.seaaroundus.org for data matrix of all results and Table 3 for final *P* scores).

Table 3
Final *P* scores.

RFMO	*P* score (%)	RFMO	*P* score (%)
WCPFC	74	ICCAT	57
GFCM	64	SPRFMO	57
IWC	63	NPAFC	55
NAFO	63	IPHC	52
NEAFC	63	NASCO	52
SEAFO	63	SIOFA	47
IATTC	60	CCBSP	46
IOTC	58	CCSBT	44
CCAMLR	58	PSC	43
Average			57

The overall highest scoring category across all RFMOs was by far 'General Information and Organization,' with a 70% average score. The overall lowest scores across RFMOs were those in the 'Allocation' category, which had an average score of 43%. The overall highest single score in a category belonged to CCAMLR, which scored an 83% in the category of 'Conservation and Management'. WCPFC was the most consistently high scoring RFMO across all categories, and thus received the highest overall score, too. The variance amongst scores was greatest for the 'IUU fishing prevention' criterion, and smallest for 'Science'. From the correlation analysis, certain variables were highly significant (i.e., $p < 0.01$) and highly correlated (i.e., $r > 0.65$); see www.seaaroundus.org for details.

The results from the PRIMER 5 analysis are shown in dendrogram format in Fig. 3, which depicts, as expected, that the outgroups (NMFS and WWF), fall outside the range for RFMOs. This confirmed that the questions, as hypothesized, served to characterize RFMOs. Beyond this, clusters, though small, do occur, and are identified in boxes in Fig. 3. SIOFA appears the least similar to other RFMOs, while GFCM, NAFO and SEAFO are the most similar, and jointly form the tightest cluster.

3.2. Performance in practice

Final *Q* scores of RFMOs were all relatively low, averaging 49% across RFMOs. CCSBT had the lowest score at 0%, while CCAMLR had the highest at 100% (Table 4).

Of the 48 stocks assessed, 32 are currently depleted or being overfished, amounting to 67% of all stocks assessed.

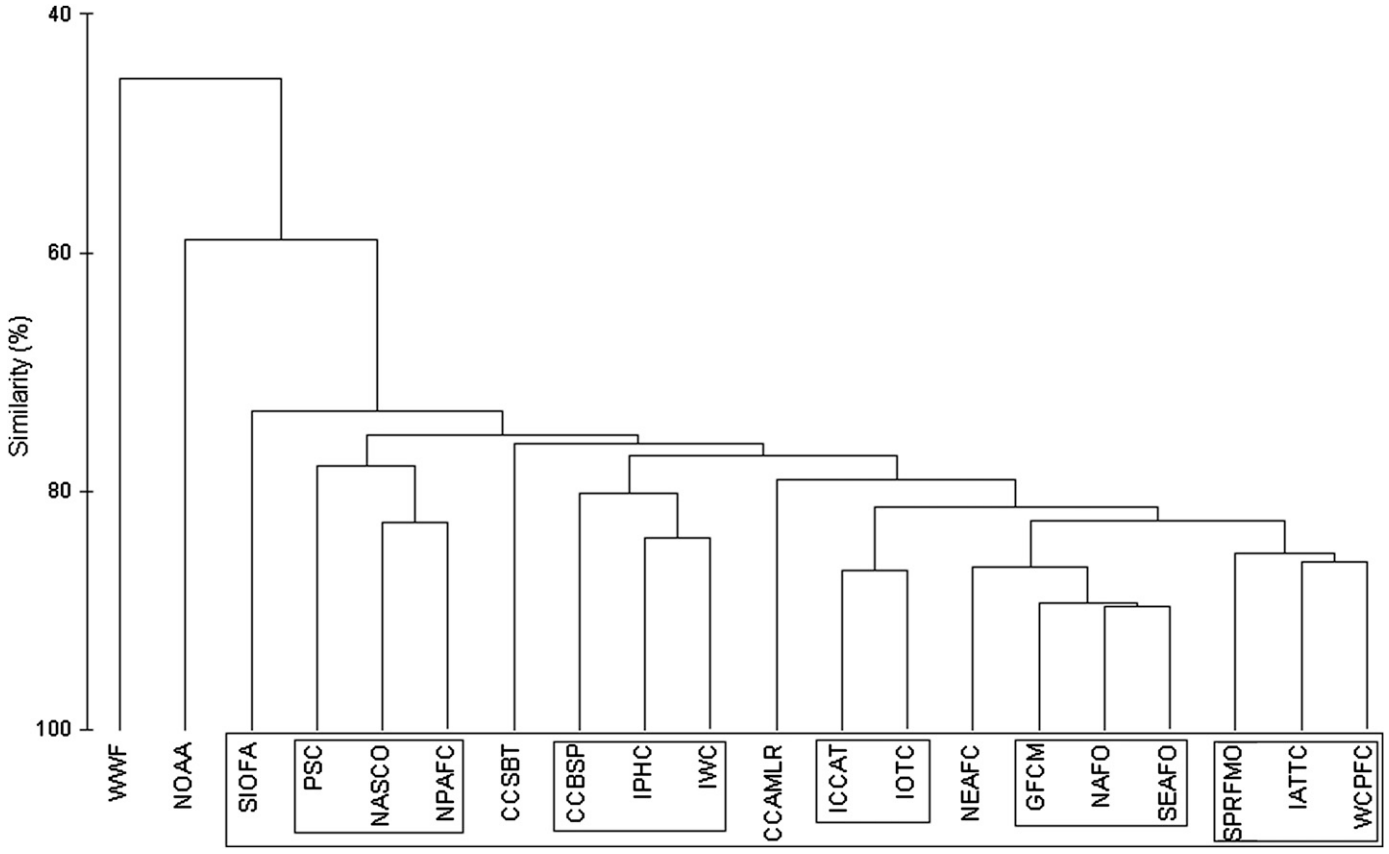

Fig. 3. Dendrogram from SIMPER analysis, depicting the clustering of RFMOs and two outgroups. Boxes denote cluster groups.

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The population sizes of certain stocks fluctuated widely through time, particularly for anadromous fishes (see www.seaaroundus.org). Yet the general trend in biomass for most species within management under RFMOs is one of decline, with one obvious exception being NEAFC's Norwegian-spawning herring. In relation to RFMO establishment, the majority of RFMOs did not seem to have a visible positive effect on stock biomass (see Fig. 4 for ICCAT example; see www.seaaroundus.org for all others).

Table 4
Final *Q* scores.

RFMO	Q score (%)	RFMO	Q score (%)
CCAMLR	100.0	CCBSP	33.3
IOTC	77.8	GFCM	33.3
NPAFC	77.8	IATTC	33.3
NEAFC	72.2	IPHC	33.3
WCPFC	66.7	IWC	33.3
NAFO	53.3	NASCO	33.3
ICCAT	37.5	CCSBT	0.0
Average			48.9

3.3. Comparing P and Q scores

While three RFMOs scored within 10% between assessments, others had prominently different *P* and *Q* scores, e.g., CCAMLR had the overall highest *Q* score at 100%, which differed markedly from its *P* score of 58%. The bivariate plot of *Q* versus *P* scores showed a positive correlation coefficient ($r=0.45$), but was not significantly different from zero ($p > 0.05$).

4. Discussion

4.1. P scores

Of all RFMOs, PSC received the overall lowest score at 43%; as with IPHC (52%), it is limited to just two contracting parties, Canada and the USA. In addition, PSC and IPHC are also the only two RFMOs functioning primarily within national jurisdiction. These organizations probably scored poorly in part because they do not fit the typical RFMO framework.

The RFMO with the highest *P* score was WCPFC with 74%, 10% higher than the next most effective RFMO (GFCM, see Table 3). Established in 2004, WCPFC is currently the newest functioning

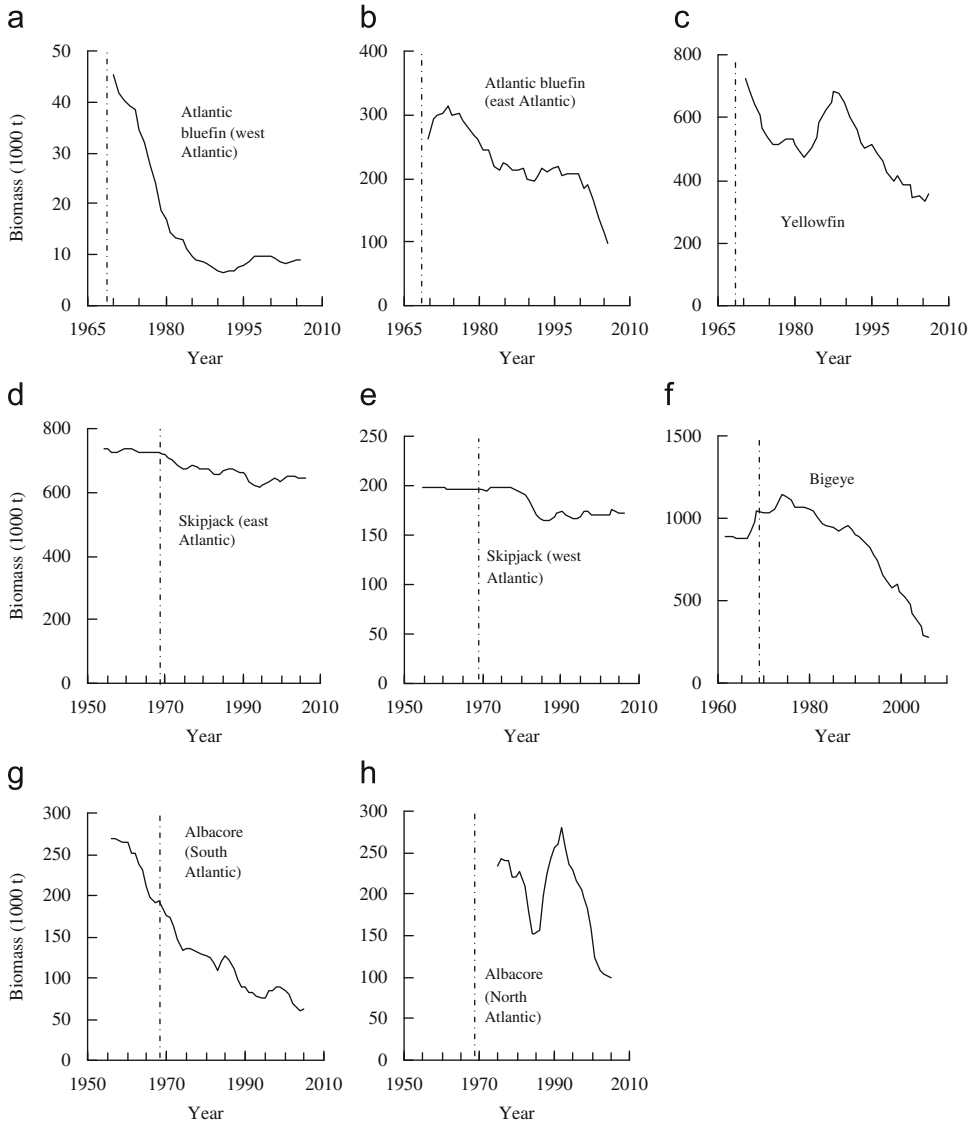

Fig. 4. Example of historical biomass results for eight tuna stocks under ICCAT management; dashed lines denote year of RFMO establishment, 1969.

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RFMO. It suggests that newer RFMOs conform better to newer trends, particularly those pertaining to conservation measures, which have changed significantly through the years and which affected many of the criteria in this study. Still, SEAFO scored lower (63%), although it was established recently, in 2003.

CCAMLR had the highest category score (in 'Conservation and Management'); this is unsurprising given that CCAMLR has been lauded as one of the better-managed RFMOs [25], with a good record in implementing conservation measures [26,19].

The 'Allocation' category generally yielded the lowest scores. This was attributable to both criteria therein, i.e., 'New members', and 'Provisions for developing states'. The lack of framework for defining a legitimate membership process for countries to join an RFMO (termed the 'new entrant problem') has been criticized as a real impediment to successful fisheries management [27–29]; low scores in this category clearly reflect the absence of such a framework. In contrast, while a tentative framework does exist for supporting the participation and contributions of developing countries to the RFMO of which they are members [10], many RFMOs did not even mention the subject of developing states, or if they did, only casually, despite the fact that all but two RFMOs have developing countries among their members. Exceptions were ICCAT and IWC, both by far the largest RFMOs in terms of number of member states (48 and 88, respectively); they are also the two organizations with the largest number of developing countries, likely explaining their well-documented framework and provisions on this subject.

The high variance amongst scores relating to the 'IUU fishing prevention' criterion reveals the lack of consistency among RFMOs in addressing the issue. In contrast, the low variance amongst scores relating to the 'Science' criterion is encouraging as the scores were mostly high, suggesting a widespread understanding of the importance of science in RFMO management, as well as a consistent scientific methodology across RFMOs.

Further, some of the correlations have implications for RFMO management. For example, the correlation between the two criteria 'Flag state duties' and 'Schemes to promote compliance' implies that if duties are well-defined, RFMO compliance may increase (the converse, while possible, is unlikely). Another example shows that if frequent assessments and performance reviews are carried out, approaches to deal with IUU fishing may emerge. Finally, strong mandates could produce better provisions for developing states. Such results indicate that 'influential' criteria, i.e., criteria that potentially affect others, should be of primary interest in RFMO management.

Finally, the cluster analysis reveals that although these 18 RFMOs differ in size, organization and scope, they are mostly similar with regards to the core components of an operational RFMO. While certain individual criteria might differ markedly between RFMOs, no one RFMO is exceptionally different from the rest. Essentially, they all fall within one cluster, with an average similarity of about 78%, and the most dissimilar RFMO still having about 73% similarity (Fig. 3). This is in contrast with WWF and NMFS, suggesting that, as a minimum, RFMOs have some fundamental, unifying structures in place, despite their seemingly differing backgrounds and mandates.

4.2. Q scores

The main conclusion based on these results is that RFMO management on the high seas is inadequate. Findings indicate that 67% of stocks under RFMO management are either depleted, overfished, or both (see www.seaaroundus.org for details). This is in line with FAO [9], which states that: "In the case of straddling stocks and of other high seas fishery resources, nearly two-thirds of the stocks for which the state of exploitation can be determined were classified as overexploited or depleted. These high seas fishery resources constitute only a small fraction of the world fishery resources, but they can be considered key indicators of the state of a major part of the ocean ecosystem."

The fishing mortality corresponding to MSY has been criticized as being too high a target reference point [30–32], and indeed, "should be regarded as a minimum standard for limit reference points" [10]. Hence, had a more precautionary (and likely, more appropriate) reference point such as Maximum Economic Yield (MEY) been employed, RFMO scores would be even lower (because MEY is achieved at a higher stock biomass and lower fishing mortality). However, only MSY-based estimates are available for most RFMOs.

In addition, while a stock that placed within quadrant I of the phase-plot is deemed to be in poor shape, it must be noted that a stock that scored within quadrants II or III also implies inadequate management. A score within quadrant II suggests that current high fishing pressure may lead to a low biomass in the future, while a score within quadrant III suggests overfishing has occurred in the past. While in the latter case, the potential to rebuild a depleted stock exists, decreases in fishing pressure rarely lead to actual biomass increases [24]. It is therefore not surprising that the historical global trend in high seas biomass across species is overwhelmingly one of decrease, one major exception being anadromous stocks, of which some exhibit very fluctuating biomasses (see www.seaaroundus.org). [It must also be noted that while CCAMLR scored 100% in this assessment, only one stock was evaluated for this RFMO, due to data availability].

Finally, as the establishment of some RFMOs preceded severe stock declines, this calls into question the very existence of these organizations. Equally worrying, is the lack of change in species biomass trends after RFMO implementation: by far the main pattern across species, it implies that the effect of RFMO management on the stocks they control has, so far, been negligible.

4.3. Comparing P and Q scores

One way of identifying whether or not an organization is based on "dead letter provisions" – essentially terms that the organization supposedly abides by but are in fact, never put to use [14] – is to compare their written commitment with the state of the stocks they manage. The question is then: do they match up? Or: does the score of an RFMO in relation to best practices guidelines determine the state of their stocks?

Both the *P* and *Q* scores of RFMOs were relatively low, particularly the *Q* scores. While there was no significant correlation between the two scores (i.e., the *P* score of an RFMO does not necessarily determine its *Q* score), the difference between the final averages of these two scores was 8%, illustrating a gap between RFMO intent and practice. This is very close to the 9% difference in scores between stated intentions and actual compliance of countries regarding the UN Code of Conduct for Responsible Fisheries [33].

5. Conclusion

In order to gauge the effectiveness of an RFMO, one must consider whether or not it has met its main goals. Objectives appear quite uniform across RFMOs (see www.seaaroundus.org), each emphasizing a commitment to the conservation of their stock(s) of interest, e.g., "…to contribute through consultation and cooperation to the optimum utilization, rational management and conservation of the fishery resources of the Convention Area"

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[34]. In this regard, RFMOs have failed. It is evident from the results here that the priority of RFMOs – or at least of their member countries – has been first and foremost to guide the exploitation of fish stocks. While conservation is part of nearly all of their mandates, they have yet to demonstrate a genuine commitment to it on the water. Individual and organizational problems can account in part for the RFMOs' low scores, but the larger concern is that most RFMOs score low overall. The focus therefore shifts from individual criteria or individual stocks to the bigger picture: taken as a whole, why have RFMOs failed?

A fundamental breakdown of fisheries management on the high seas lies in the principle, '*The Free Sea*', for it exists no longer: "First, the principle of freedom of fishing could be retired from the pantheon of fundamental principles. Indeed, the continued articulation of the principle is both inaccurate and misleading, if not downright disingenuous" [11]. Still a global commons to most, the high seas undergo widespread and rampant illegal fishing with next to no consequence, a crisis further compounded by the immensity and unmonitored state of the area.

The management of historic coastal fisheries is widely seen as having failed throughout the world, with strong impacts on coastal ecosystems [35,3]. The high seas, on the other hand, are still relatively pristine [36], and thus offer a momentary opportunity for RFMOs, if they reform themselves soon, to help turn around some very worrying trends. However, this can only happen if RFMOs actually act as stewards of the high seas, and become accountable for their actions.

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