SHORT COMMENTARY

Challenges and approaches to marine conservation and fisheries management

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This document discusses a selection of key concepts, relative to environmental conservation and resource management, by framing them into a unifying context. Starting from the managerial challenges, we consider the goal of executive decisions, and the tools needed to implement them, and monitor their progress.

1. The challenges

Reconciling marine conservation and fisheries management presents many challenges. Effective management intertwines with the harvest of resources, because, if the latter support food production and social welfare, their exploitation critically depends on healthy ecosystems, tenable practices, regulation compliance, and cooperation.

Management must adapt to changing spatial and temporal contexts, where geopolitical interests often clash [1], technology evolves [2], and climate change affects stock recruitment and productivity [3]. The complexity of this task requires goodwill and collaboration among stakeholders, but also far-sighted and brave decisions, often based on conflicting compromise agreements, that will unavoidably see winners and losers [4].

So, what do we base these decisions on?
*What is the **goal** of managing the marine environment and the fisheries,*
*and which **attributes** and **objectives** can we use to achieve that goal?*

2. Sustainability as a management goal

Sustainability is a common model often used in Fishery Science to identify the ultimate goal of effective management [5]. But what is sustainability exactly? The concept may embrace notions like environmental friendliness, cost-effectiveness, and maximum profits, and it likely emerged as a consequence of the staggering global catch increase, observed in 1950-1970 (8–9 % per year), which eventually led to overfishing and collapse of some stocks [6].

Despite the blurred definition of sustainable management [7], clearer *attributes*, and related operational *objectives* for its achievement do exist (Table 1).

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Table 1. Attributes and operational objectives of sustainable fisheries' management (mod. from [8]).

System	Sustainability dimension	Attributes	Management objectives
Marine ecosystem	Environmental	A1. Abundance of fish	Maximum sustainable yield
Society	Social	A2. Stakeholder inclusion	Democracy/legitimacy
Fish-processing industry	Economic	A3. Stable supplies of fish	Maintain employment
Fishing fleet	Social	A4. Accident risk	Improve safety
		A5. Employment	Maintain rural settlement
	Economic	A6. Profitability	Increase profitability
		A7. Fish meat quality	Increase quality/reduce damage and waste
	Environmental	A8. Catch capacity	Reduce overcapacity
		A9. GHG emissions/acidification	Reduce emissions

Reconciling multiple objectives, like maintaining biodiversity, employment and catch [9], are framed within four systems, including: i) the marine environment; ii) the society; iii) the fish-processing industry; iv) the fishing-fleet.

Broadly based on the attributes from Table 1, an arbitrary selection of concepts commonly discussed in Fisheries Science, will now be examined.

2.1 Attributes: abundance of fish and profitability

Fish abundance explained by the Gordon–Schaefer bioeconomic model [10] relates catch, stock, and effort (Fig. 1). Once a valid model is built, several qualitative and quantitative indicators of performance and status can be used for management purposes [11].

For instance, two key points along the yield/effort curve are the maximum sustainable yield (MSY; "Emsy" in Fig. 1), and maximum economic yield (MEY; "Emey" in Fig. 1) [12, 13]. These quantities may be used as benchmarks to avoid overcapacity, stock collapse and unprofitability, because associated with maximum revenue (MSY) or profit (MEY) (Fig. 1).

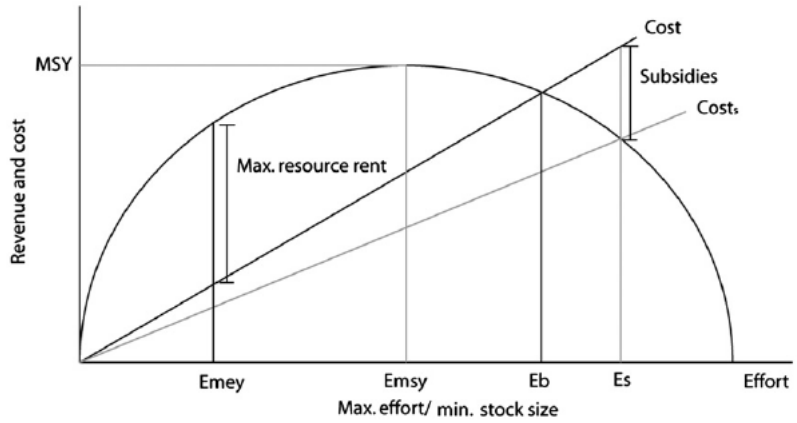

Fig. 1 The Gordon–Schaefer bioeconomic model relating catch, stock, and effort (from [14]).

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Alas, indicators' usefulness vary, and scientists, regulators, and stakeholders often disagree about which one (or combinations teherof) to use [15, 16]. Defining thresholds to unambiguously define the optimal levels of operation is also fundamental, but requires proper stock assessments to set management tools' targets (cf. TAC, ITQ, TAE, ITE etc.) [17].

Therefore, managing fish abundance requires improved monitoring [18], stock-specific data [19], thresholded indicators [7], plus consideration of transboundary dynamics [20] and multiple interests (e.g., recreational vs. commercial fishers) [21].

2.2 Attribute: stakeholder inclusion

Fair allocations of catch quotas among legitimate stakeholders [14] is paramount to marine conservation and fisheries management [21]. However, many additional parties have interests in the fisheries, like local communities, governments, banks, NGOs, and the entire production chain (suppliers, manufacturers, retailers, wholesalers etc.).

Globally, there is a growing awareness about the importance of an inclusive decision-making process, where all stakeholders participate, and are duly considered. This is driven by public awareness of social equity issues [22, 23], illegality [24], habitat destruction [25], greenhouse gas emissions and pollution [26]. However, an inclusive decision-making process is also required by current subsidies policies. A seminal 2010 paper [27], showed that the global community is disbursing billions of dollars yearly, to maintain the economic viability of the fishing industry, and directly financing marine resources' over-exploitation [27] (Fig 2).

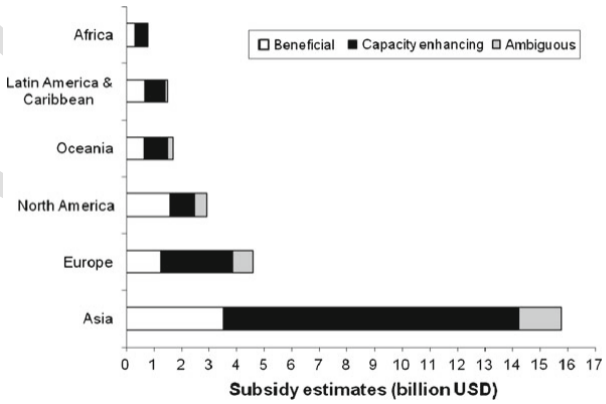

Fig. 2. Subsidy estimates by geographic region, for the year 2003 (from [27]).

2.3 Attributes: fish meat quality and ecolabeling

Increasing fish meat quality, while reducing waste, by-catch, and damage, may support the sustainable management of the marine environment and the fishing industry (Table 1).

Fish meat quality depends on several factors including gear type, harvesting regime, and product handling, storage, and conservation prior to landing (on board the vessels), and during processing and distribution. Although sometimes difficult to implement, monitoring regulation compliance to ensure quality can improve the sustainability of the industry [28].

Consumers preferences should be examined, not only to enhance market penetration, but also to understand whether consumer beliefs can hinder the potential development of more sustainable (e.g., non-extractive) practices [29].

Stated-preference discrete choice experiments have revealed that environmental concerns, rather than meat quality, are the main explanatory factors for market segmentation [29]. This strongly suggests that, if properly administered, ecolabels like the Marine Stewardship Council (MSC) may support the sustainable management of the marine environment and the fisheries [30].

A quantitative systematic search of the peer-reviewed literature [30], for instance, examined the proportion of times each outcome category is described in selected articles (Fig. 3). According to this study, the MSC program seems to have had mainly economic effects (50% of papers published), environmental effects (32.5%), effects on governance (17.5%), and negligeable social effects (0%).

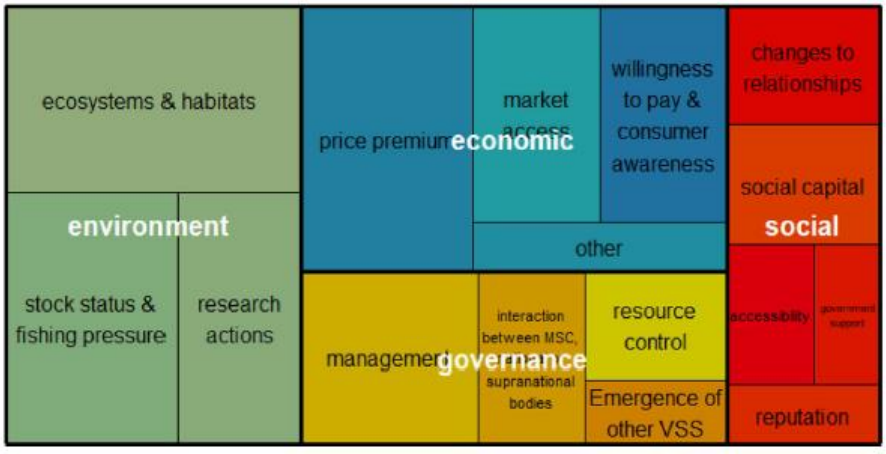

Fig. 3. Topics covered by the articles selected for a quantitative systematic analysis of the peer-reviewed literature, on the effects of MSC certification (from: [30]).

Quantitative analyses like this are important to fully assess the changes induced about this program, and improve our ability to comprehend its ultimate contribution to a sustainable management of the industry and the environment.

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3. Conclusion and way forward

In the ocean, fish, fishers, and the environment interact in an extremely complex scenario. However, marine conservation and fisheries management are clearly two sides of the same coin, demanding complementary approaches.

Nationally and/or internationally, there is often poor cooperation, regulation, and monitoring, which has led to unsustainable practices in many parts of the world. Despite the complexity of the system and the many uncertainties, scientific evidence is strong for some topics. Consumers, governments, and stakeholders may be persuaded to sustainable practices by targeted, accessible, and evidence-based education/information. However, in many cases prejudices, conflict of interests, and lack of goodwill will prevent the implementation of these changes.

In these cases, unsustainable practices must be challenged and solved once for all, with drastic, brave, and far-sighted resolutions. Radical changes of the authority and the currently fragmented structure of regulatory bodies are urgent.

Problems in one oceanic region, may reverberate globally, like in the case of highly mobile commercial stocks that are overexploited in international waters, but do not find sufficient protection within the EEZs. To this end, a club approach to create widespread international consensus around sustainable management, and isolate non-compliant countries may be considered. Support of parties negatively affected by the implemented changes should be contemplated.

After ensuring their credibility and reliability, the adoption of sustainability certifications (e.g., MSC) is critical, and the market/consumers are pushing in this direction. Similarly, strengthening the transparency and accountability of the certification process is fundamental. Many improvements have been suggested [28], including a more centralised process that avoids multiple certifying parties, tiered approaches, certification of fishers rather than fisheries, governmental facilitation, and greater engagement.

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References

1. Croxall, J.P. and S. Nicol, *Management of Southern Ocean fisheries: global forces and future sustainability.* Antarctic Science, 2004. **16**(4): p. 569-584.
2. Marchal, P., et al., *Impact of technological creep on fishing effort and fishing mortality, for a selection of European fleets.* ICES Journal of Marine Science, 2007. **64**(1): p. 192-209.
3. Britten, G.L., M. Dowd, and B. Worm, *Changing recruitment capacity in global fish stocks.* Proceedings of the National Academy of Sciences, 2016. **113**(1): p. 134-139.
4. Sumaila, U.R., et al., *Winners and losers in a world where the high seas is closed to fishing.* Scientific Reports, 2015. **5**: p. 8481.
5. United Nations, *Report of the World Summit on Sustainable Development, Johannesburg, South Africa, 26, August-4 September 2002.* 2002.
6. Lindegren, M., et al., *Preventing the collapse of the Baltic cod stock through an ecosystem-based management approach.* Proceedings of the National Academy of Sciences of the United States of America, 2009. **106**(34): p. 14722-14727.
7. Angel, E., et al., *An indicator framework to support comprehensive approaches to sustainable fisheries management.* Ecology and Society, 2019. **24**(4): p. 34.
8. Utne, I.B., *System evaluation of sustainability in the Norwegian cod-fisheries.* Marine Policy, 2007. **31**(4): p. 390-401.
9. Worm, B., et al., *Rebuilding Global Fisheries.* Science, 2009. **325**(5940): p. 578-585.
10. Schaefer, M.B., *Some considerations of population dynamics and economics in relation to the management of the commercial marine fisheries.* Journal of the Fisheries Board of Canada, 1957. **14**(5): p. 669-681.
11. Garcia, S., D. Staples, and J. Chesson, *The FAO guidelines for the development and use of indicators for sustainable development of marine capture fisheries and an Australian example of their application.* Ocean & Coastal Management, 2000. **43**(7): p. 537-556.
12. www.balticeye.org. *Understanding MSY*. 2019 [accessed: 12/09/20]; Available from: https://balticeye.org/en/fisheries/understanding-msy/].
13. www.pewtrusts.org. *MSY - Maximum sustainable yield*. 2012 [accessed: 12/09/2020]; Available from: https://www.pewtrusts.org/-/media/assets/2015/03/turning_the_tide_msy_explained.pdf].

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14. Standal, D. and I.B. Utne, *The hard choices of sustainability.* Marine Policy, 2011. **35**(4): p. 519-527.
15. Christensen, V., *MEY = MSY.* Fish and Fisheries, 2010. **11**(1): p. 105-110.
16. Piet, G.J. and N.T. Hintzen, *Indicators of fishing pressure and seafloor integrity.* ICES Journal of Marine Science, 2012. **69**(10): p. 1850-1858.
17. Arrizabalaga, H., et al., *Using stock assessment information to assess fishing capacity of tuna fisheries.* ICES Journal of Marine Science, 2009. **66**(9): p. 1959-1966.
18. Pauly, D. and D. Zeller, *Catch reconstructions reveal that global marine fisheries catches are higher than reported and declining.* Nature Communications, 2016. **7**: p. 10244.
19. Walters, C. and P.H. Pearse, *Stock information requirements for quota management systems in commercial fisheries.* Reviews in Fish Biology and Fisheries, 1996. **6**: p. 21-42.
20. Shackell, N.L., et al., *A transboundary dilemma: Dichotomous designations of Atlantic halibut status in the Northwest Atlantic.* ICES Journal of Marine Science, 2016. **73**: p. 1798-1805.
21. Cooke, S.J. and I.G. Cowx, *Contrasting recreational and commercial fishing: Searching for common issues to promote unified conservation of fisheries resources and aquatic environments.* Biological Conservation, 2006. **128**(1): p. 93-108.
22. Stringer, C., D.H. Whittaker, and G. Simmons, *New Zealand's turbulent waters: the use of forced labour in the fishing industry.* Global Networks, 2016. **16**(1): p. 3-24.
23. Tickler, D., et al., *Modern slavery and the race to fish.* Nature Communications, 2018. **9**(1): p. 4643.
24. Theilen, J.T., *What's in a name? the illegality of illegal, unreported and unregulated fishing.* International Journal of Marine and Coastal Law, 2013. **28**(3): p. 533-550.
25. White, A.T., H.P. Vogt, and T. Arin, *Philippine coral reefs under threat: The economic losses caused by reef destruction.* Marine Pollution Bulletin, 2000. **40**(7): p. 598-605.
26. Chen, C.L. and T.K. Liu, *Fill the gap: Developing management strategies to control garbage pollution from fishing vessels.* Marine Policy, 2013. **40**: p. 34-40.
27. Sumaila, U.R., et al., *A bottom-up re-estimation of global fisheries subsidies.* Journal of Bioeconomics, 2010. **12**(3): p. 201-225.

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28. Kaiser, M.J. and G. Edwards-Jones, *The role of ecolabeling in fisheries management and conservation.* Conservation Biology, 2006. **20**(2): p. 392-398.
29. Bronnmann, J. and F. Asche, *Sustainable Seafood From Aquaculture and Wild Fisheries: Insights From a Discrete Choice Experiment in Germany.* Ecological Economics, 2017. **142**: p. 113-119.
30. Arton, A., et al., *What do we know about the impacts of the Marine Stewardship Council seafood ecolabelling program? A systematic map.* Environmental Evidence, 2020. **7**: p. 29.