



On the importance of clarity in scientific advice for fisheries management



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ABSTRACT

Fisheries management is a difficult process that requires policymakers and scientists to work in concert with one another to set quotas or other management actions that conserve fisheries resources for long-term use. Policymakers take such actions based on advice from their scientists, who serve as independent knowledge providers. There are many examples, however, of policymakers allowing short-term financial or political objectives to drive their decision making rather than strictly adhering to the advice of their scientists. Throughout the histories of the International Commission for Conservation of Atlantic Tunas and the Western and Central Pacific Fisheries Commission, policymakers have followed the advice of their scientists only 39% and 17% of the time, respectively. There are also a number of cases where a lack of clarity in the scientific advice leads to undesirable management actions, either a result of simple misinterpretation by policymakers or imprecision in the advice allowing for a range of actions not intended by the scientists. To improve the likelihood that managers and scientists interpret language in the same way, it is important that scientists provide advice that is explicit and precise and clearly states the appropriate management measures to be applied. Here, a set of guidelines that may help scientists to achieve the necessary clarity is presented. Following these steps would allow scientists to clearly describe stock assessment results and other complex scientific processes and provide their expert advice in a manner that is most useful for policymakers but without sacrificing their reputation of independent knowledge provision.

1. Introduction

Most marine governance decisions are made only after policymakers consider (and ideally follow) the advice of their government scientists or scientific organizations contracted to provide such advice, a process intended to prevent politically motivated decision making so that adopted management options are grounded in good science [1,2]. This is particularly true for the management of highly migratory fishes, which typically fall within the jurisdiction of one or more regional fisheries management organizations (RFMOs). RFMOs are groups of governments, usually founded by treaty or other international agreement, charged with managing transboundary stocks through multi-government cooperation. In an idealized system, the member governments of each RFMO represent all stakeholders in their constituency (i.e., fishing, trade, and conservation interests), allowing RFMOs to address issues associated with the high seas commons and with multi-national conservation and resource management.

Most RFMOs have subsidiary bodies for science and/or research that provide regular advice to the organization's annual plenary meeting. The subsidiary bodies typically comprise government scientists, along

with academic researchers, representatives of industry and environmental nongovernmental organizations with relevant expertise, and invited or contracted external individuals. This is the case for all of the five RFMOs that manage fisheries for tuna and tuna-like species around the world (tRFMOs; Table 1). These five organizations manage major commercial tuna fisheries worth approximately US\$10 billion per year, dockside, and more than US\$42 billion at the final point of sale [3], along with highly migratory stocks of small tunas, billfishes, swordfish, and pelagic sharks whose fisheries values have not been estimated. Many of the stocks under tRFMO jurisdiction are overfished or severely depleted [4–9]. The RFMO model was originally derived, in the 1940s–50s, to address fisheries allocation and economic gain [10], with little intention that science would play a role in actively reducing catches. As fisheries stocks have been depleted, the advice provided by scientists has become the focus of intensifying examination. Given the financial and conservation stakes, and the reality that tRFMO policymakers are rarely technical experts in the intricacies of stock assessment [11], it is essential that the scientific advice be both clear and explicit, to reduce the likelihood that the advice could be misinterpreted – willfully or otherwise – in a way that threatens the sustainability of

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Table 1

The regional fisheries management organizations that manage fisheries for tuna and tuna-like species (tRFMOs) and their subsidiary bodies charged with producing scientific advice.

Organization	Scientific subsidiary body	Stock assessment body
Commission for the Conservation of Southern Bluefin Tuna [13]	Scientific Committee	Internal working group
Indian Ocean Tuna Commission [14]	Scientific Committee	Internal working groups
Inter-American Tropical Tuna Commission [16]	Scientific Advisory Committee	Secretariat scientists/International Scientific Committee for Tuna and Tuna-like Species in the North Pacific
International Commission for the Conservation of Atlantic Tunas [15]	Standing Committee for Research and Statistics	Internal working groups
Western and Central Pacific Fisheries Commission [17]	Scientific Committee	Secretariat of the Pacific Community/International Scientific Committee for Tuna and Tuna-like Species in the North Pacific

stocks or fisheries.

2. Production of advice

Fisheries management decisions, including the setting of catch limits, implementation of size limits, and designation of spatiotemporal closures, are generally made after a group of scientists has assessed the status of the stock in question and developed estimates of how many individuals can be safely removed from the population and by what means [12]. Though each RFMO has subtle differences in the way it goes about running the actual stock assessment models, they all follow a general pattern. Fisheries scientists run one or often several assessment models and agree on a best estimate of the current stock status, along with an approximation of the uncertainty associated with the estimate. Three of the five tRFMOs have internal working groups that conduct this science directly [13–15], while the Inter-American Tropical Tuna Commission (IATTC [16]) tasks either its own Secretariat scientists or asks the members of the International Scientific Committee for Tuna and Tuna-like Species in the North Pacific (ISC) to run its stock assessment models and the Western and Central Pacific Fisheries Commission (WCPFC [17]) contracts with the Secretariat of the Pacific Community (SPC) or works with the ISC to run its models (Table 1). The practice of working with external bodies to conduct stock assessments is not unique to tRFMOs. The North-East Atlantic Fisheries Commission has a formal working relationship with the International Council for the Exploration of the Seas, which conducts many of their assessments.

The results of the stock assessments are passed on to the RFMO's full subsidiary science body, where they are used to develop official scientific advice about the catch limit and any other aspects of the management process that require scientific input. This advice is not completely free of influence from policymakers and other stakeholders. In fact, management objectives are often required to frame the advice that the technical experts provide, and those objectives are defined with input from the fishing industry and other interested parties (e.g., [18]). If a stock meets the RFMO's definition of being overfished, then the advice should reflect catch limits that adhere to the policymakers' objectives, including preferred timelines and probabilities of success for recovery. If a stock does not meet the RFMO's definition of being overfished, then the advice should reflect the policymakers' preferred probability of maintaining stock levels above those that are considered overfished. Other management objectives beyond those tied to reference stock levels can be defined and also help scientists know how to provide advice [19]. Without pre-agreed objectives or definitions of how management should proceed, scientists do not have clear guidance on which to develop their advice.

Scientists also often have the difficult task of incorporating the scientific uncertainty inherent in stock assessments into the management advice that they provide to policymakers [20,21]. Running multiple assessment models or incorporating different sets of assumptions and data inputs can provide a range of stock size estimates and targets and therefore a range of catch levels that would meet the management objectives [22]. Scientists are also often asked to assess the likelihood

that management measures outside of a simple catch limit system (e.g., closed areas, gear modification, etc.) will shorten (or lengthen) time-limits to recovery, increase (or decrease) the probability of successfully recovering overfished stocks within those timelines, or increase (or decrease) the probability of preventing currently healthy stocks from becoming overfished [23,24]. This can be difficult. The language used by scientists to communicate the uncertainty inherent in stock assessment models and to describe the interactions among several management options has serious implications for the decisions taken by the RFMOs. Oftentimes this process results in the scientific advice including a wide range of “acceptable” catch limits, without a clear picture of the risks associated with following the upper and lower bounds of the range and no clear path forward for the policymakers. Similarly, the additive benefit of applying more than one of the management options is typically not quantified and thus creates a situation where the policymakers may guess or gamble with options outside of the advice.

3. When managers fail to follow the advice

Policymakers can and sometimes do purposefully choose to not follow the available scientific advice. They may take no management action despite advice to do so, or they may adopt management actions that only partially implement the advice. To explore the prevalence and consequences of these two practices, the entire history of scientific advice and management decisions for the International Commission for the Conservation of Atlantic Tunas (ICCAT) and for the WCPFC was examined and the frequency with which the actions adopted by the policymakers were exactly aligned with the scientists' recommendations was determined (methods provided in [Supplementary information](#)). Since ICCAT's scientific subsidiary body began providing scientific advice in 1970, the policymakers have chosen to take no management actions 40.4% of the time and have adopted management actions that do not adhere to the advice another 20.6% of the time. This leaves only 39.0% of the time that the policymakers have followed through and implemented regulations in line with the advice.

Since WCPFC's scientific subsidiary body began providing management advice in 2005, policymakers have chosen to take no management action more often than not (59.6% of the times scientists provided advice). When WCPFC has adopted measures, more than half of those measures are not fully in line with the scientific advice. WCPFC managers follow the advice of their scientists only 17.0% of the time (excluding north Pacific stocks; see [Supplementary information](#)).

In some of the reviewed cases, policymakers and scientists seemingly interpreted the language provided in the advice differently, risking the fate of multi-billion dollar fisheries and the health of marine populations, due to misunderstandings or vagueness in the provided advice. In other instances, implicit advice led to a situation where a broad range of potential policy decisions, and an equally broad set of impacts on the managed stock, could be reasonably determined to be in line with the advice. While these two categories of actions were scored as such, it became clear that the advice could be improved in order to increase the likelihood that policymakers and scientists interpret the

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