Impact Factor (SJIF): 6.092 E-ISSN: 2583-1615

International Journal of Research in Academic World

Received: 15/June/2023 IJRAW: 2023; 2(7):155-161 Accepted: 10/July/2023

Navigating the Depths: Balancing Fisheries Science and Management for Sustainable Development

[*1]Sachin Dadarao Jadhav

[*1]Department of Zoology, Shri Pundlik Maharaj Mahavidyalaya, Nandura, Buldana, Maharashtra, India.

Abstract

Fisheries science and fisheries management are interconnected fields that play crucial roles in understanding and regulating fish populations and their exploitation. Fisheries science integrates various disciplines to study fish populations and their responses to fishing mortality, while fisheries management applies scientific knowledge to regulate fishing activities and achieve specific objectives. The objectives of fisheries management have evolved to include biological, economic, recreational, and social aspects, recognizing the need for a multidimensional approach. The institutionalization of fisheries science has faced challenges in bridging the gap between scientists and the fishing industry, necessitating the inclusion of economic and social expertise. The question of resource ownership and management arises, with perspectives ranging from the fishers, society, and conservationists. Uncertainty poses a significant problem in fisheries management, highlighting the importance of addressing and incorporating uncertainty into decision-making processes. The pursuit of economic efficiency in fisheries should be balanced with the goal of expanding people's real freedoms and considering the human dimension of development. Achieving sustainable development in fisheries requires balancing environmental, social, and economic considerations, preserving biodiversity, and ensuring the well-being of present and future generations. The economic perspective should account for the interconnectedness of ecosystems and the importance of biodiversity in supporting sustainable development.

Keywords: Fisheries science, fisheries management, fish populations, fishing mortality, sustainable development, objectives of fisheries management, institutionalization of fisheries science

Introduction

Fisheries science and fisheries management are separate yet interconnected fields. Fisheries science encompasses multiple disciplines like animal behavior, ecology, population dynamics, and environmental processes to investigate and comprehend fish populations and their reactions to fishing pressure. It involves research, data collection, and analysis of the interactions between fish populations and their surroundings.

On the other hand, fisheries management is the practical application of scientific knowledge and principles to regulate and control fishing activities in order to achieve specific objectives it encompasses the creation and execution of policies, regulations, and strategies to guarantee the sustainable and ethical utilization of fishery resources. Fisheries management uses the insights and findings from fisheries science to inform decision-making processes and set policies that consider the interests of various stakeholders, including fishers, consumers, and conservationists.

Fisheries science serves as the foundation by providing the scientific understanding of fish populations and their dynamics, while fisheries management utilizes this knowledge to create and enforce regulations and policies for sustainable fishery practices.

The Origins of Fisheries Science: Tracing Back To Early Beginnings

Biologists, specifically zoologists, were the first to bring attention to the issue of overfishing. In the late 19th century, fisheries science emerged as a discipline combining zoology and statistics. The goal was to utilize knowledge and guidance to optimize the use of fish stocks. Early fisheries management aimed to adjust fishing activity to achieve the greatest sustained yield, meaning the highest long-term catch that could be maintained. Many biologists believed that as long as the fish supply was sustained, the commercial aspect would take care of itself. This perspective reflects the current views of some fisheries biologists regarding biodiversity, where maintaining the fish supply is seen as minimizing the risk of extinction. The dominance of the search for a single, biologically-based objective for fisheries management has shaped the field of fisheries science.

The Objectives of Fisheries Management: Beyond Maximizing Catch

Our understanding of fisheries management has advanced, acknowledging that there are multiple reasons for managing fisheries beyond simply maximizing the catch. The objectives of fisheries management are crucial, and the traditional

***Corresponding Author:** Sachin Dadarao Jadhav

emphasis on sustaining the highest yield is no longer enough. This approach lacks precautionary measures and neglects other important goals. Hilborn and Walters (1992) categorized the objectives into four main categories:

i). Biological,
ii). Economic,
iii). Recreational, and
iv). Social.

In many cases, fisheries management involves a combination of these objectives. For example, the Norwegian government provides subsidies to support small communities in the north that rely heavily on fishing for their livelihoods. However, it is essential to manage fisheries sustainably to prevent resource depletion. This situation requires parallel objectives of supporting communities and maintaining sustainable fishing practices. Some management systems have seemingly straightforward goals, such as separating different fishing gear types to protect specific species or habitats. However, these objectives have broader consequences that impact both the fishing community and the biological community. For instance, closing certain areas to mobile gear in the waters around Start Point off the south coast of Devon, UK, not only safeguards the gear of crab potters but also fosters a more diverse benthic community, contributing to biodiversity conservation as an unintended positive outcome. In the past, the focus on maximizing sustainable yield prevailed, despite economists and experts recognizing that fisheries management involves more than just biology and necessitates consideration of fishers' behavior, economics, and social structure. The failure to fully embrace these broader issues resulted in an incomplete understanding of fisheries management and its objectives.

The Development of Fisheries Science Institutions

The excerpt discusses the institutionalization of fisheries science and its evolution over time. Initially, individuals like Thomas Henry Huxley and Walter Garstang, who were primarily employed in other fields, drew attention to the issues of overfishing in Great Britain. Their efforts eventually led to the establishment of institutions like the Marine Biological Association of the UK (MBA), which aimed to conduct accurate research on zoological and botanical science, as well as the food, life-conditions, and habits of British food-fishes and molluscs. However, as these institutions grew larger and employed more people, their focus and objectives shifted. For example, the MBA became more academically focused on zoological and botanical science, while fisheries-related functions were taken over by the Fisheries Laboratory at Lowestoft, now known as the Centre for Environment, Fisheries and Aquaculture Science (CEFAS).

The development of government-operated fisheries laboratories, tasked with stock assessments and providing advice to policymakers, created a divide between scientists and the fishing industry. This divide made it difficult for each side to understand and appreciate the other's perspective on the issues. Efforts to bridge this gap have become crucial in the development of effective management measures.

Initially, the significance of economic considerations in fisheries was acknowledged by early workers, but it took time for institutions to integrate experts in economics and sociology. Even today, organizations like the International Council for the Exploration of the Sea (ICES) have limited involvement of economists and sociologists in their fish stock assessments. It is recommended that fisheries institutions should engage professionals who can evaluate the economic and social benefits of proposed management policies, alongside assessing biological productivity.

In fisheries laboratories, scientific research often takes precedence, while assessment work is perceived as routine and not conducive to career advancement. However, institutions responsible for stock assessments should establish evaluation criteria that recognize and reward individuals for conducting thorough stock assessments and providing sound advice. The passage also draws an analogy with engineering, highlighting the importance of selecting the correct equations and practical considerations in bridge design. Similarly, fisheries science should place value on the practical aspects of stock assessment and management, not just theoretical research.

Overall, the excerpt explores the institutionalization of fisheries science, the challenges of bridging the gap between scientists and the fishing industry, the need for multidisciplinary expertise, and the importance of recognizing and rewarding good stock assessments and practical contributions in fisheries institutions.

Fishery Ownership and Management Details

The division of fishery scientists and managers into separate institutions, as well as their detachment from the fishing industry, has resulted in divergent objectives between the two groups. While fishery scientists seek to control and regulate the industry, fishers aim to generate enough income to cover their expenses and make a livelihood. This difference in objectives raises the question of who fisheries scientists ultimately serve. While one might expect their perspectives to align with those of fishers if they were working directly for them, this is often unrealistic due to the competitive nature of the fishing industry. Fishers compete with each other, and scientists are frequently asked to provide advice that can be used to mediate this competition, which can foster nationalistic sentiments. For instance, fishers may question why they should face reduced quotas while fishers from another country continue to exploit the same fishery resources.

Another viewpoint is that fishery resources are owned by society, and fishers are granted permission to utilize these resources. Legally, fish in coastal waters are typically considered the property of the state. This perspective suggests that fishers do not possess inherent rights and that exploitation should only occur if it benefits society as a whole. Similar arguments arise in other resource industries, such as forestry, when conservationists challenge the rights of loggers to exploit shared resources. When contrasting this societal viewpoint with the perspective of fishers, it becomes evident that many conventional management measures are prone to failure. Fishers often need to borrow money to finance their operations, and strict regulations can have negative impacts on their economic viability. Purchase boats and must catch enough fish to repay their loans and support their families. To effectively consider the fishers' perspective Management measures should manipulate the costs and benefits that influence the actions of fishers. Regulations that solely focus on total allowable catches and minimum landing sizes may be problematic because they require fishers to discard valuable resources (dead fish) for the perceived benefit of society or their competitors. This expectation can lead to dissatisfaction among fishers who are unwilling to discard their catch.

Moreover, when considering the broader concept of society, different individuals have diverse views and priorities. Consumers, especially in developing countries with limited alternatives, desire access to fish for consumption. Additionally, there is growing concern among society about biodiversity, ecosystem structure in aquatic habitats, and the sustainable use of resources. The involvement of conservationists in the discourse on sustainable use has introduced new demands on fisheries science and management, challenging traditional perspectives. Conservationists argue that fishers' right to make a living should not come at the expense of decimating populations for profit. According to this viewpoint, if fishers cannot meet conservation objectives, they should cease fishing.

In summary, the separation between fishery scientists/managers and fishers has led to divergent objectives. While fishery scientists focus on control and regulation, fishers prioritize earning a livelihood. The question of who fisheries scientists are working for arises, and different perspectives emerge. Fishers often view themselves as working on behalf of society but may have competing perspectives due to nationalistic fervor and competition among fishers. Society, as a whole, may claim ownership of fishery resources, and fishers are granted permission to exploit them. However, conservationists argue that exploitation should only occur if it benefits society and does not lead to the depletion of populations. To achieve effective management, it is crucial to consider the perspectives and interests of all stakeholders involved in the fishing industry.

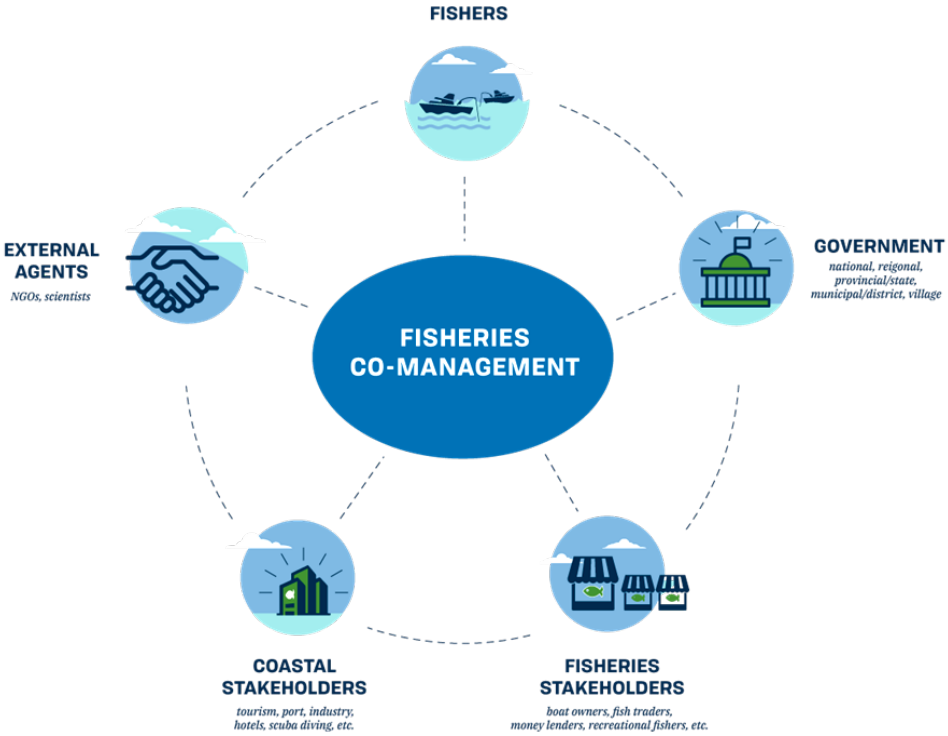

Fig 1: Graphic adapted from Fishery Co-Management: A Practical Handbook by R.S. Pomeroy and R. Rivera-Guieb

The Problem of Uncertainty

The categorization of uncertainty in fisheries science includes three main types: random fluctuations, uncertainty in parameters and states of nature, and structural uncertainty. It is crucial to acknowledge and address uncertainty in fisheries management to make informed decisions [1]. Failure to account for uncertainty can lead to the collapse of fisheries, as seen in the examples of the California sardine fishery and the cod fishery off Newfoundland.

In the case of the California sardine fishery, during the period between 1920 and 1945, the fishery experienced significant growth and overfishing due to the conversion of the whole fish into fishmeal instead of canning The California Fish and Game (CFG) Fisheries Laboratory and the US Bureau of Fisheries' Laboratory (USBF) evaluated the impact on the stock but presented different interpretations due to their uncertainty The CFG scientists argued that the stock was being overfished, while the USBF scientists claimed that environmental changes caused the decline This disagreement, influenced by uncertainty, hindered effective decision-making, and the sardine stock eventually collapsed, leading to the demise of the fishery

Similarly, the collapse of the cod fishery off Newfoundland was also affected by uncertainty in stock assessments. In the late 1980s, conflicting evidence about the state of the cod stocks was available to the Canadian Department of Fisheries and Oceans (DFO) scientist's Commercial fishery data indicated an expanded stock, while the DFO's own survey data suggested a steady level. The uncertainty in the assessments and the inadequate handling of uncertainty within the DFO's advisory framework contributed to the collapse of the cod fishery

These examples highlight the need for improved institutional systems that can effectively account for uncertainty in fisheries management decisions. Researchers have proposed approaches such as quantifying uncertainty using frequentist or Bayesian methods, incorporating uncertainty in management targets, projections, and catch limits, and adopting harvest strategies that consider multiple possible stock states and their outcomes

In conclusion, the categorization of uncertainty in fisheries science plays a significant role in the decision-making process. Ignoring or downplaying uncertainty can have detrimental effects on fisheries, leading to collapses. To

ensure sustainable fisheries, it is essential to develop institutional systems that adequately address and incorporate uncertainty in stock assessments and management decisions.

The debate surrounding resource ownership and exploitation often originates from a particular economic standpoint that prioritizes efficiency, productivity, and wealth maximization as the primary objectives of economic activity. Within this perspective, fisheries are treated as business enterprises, and the management challenge lies in structuring the industry to maximize profits. This approach has led to the industrialization of fisheries, where fishers strive to minimize costs through economies of scale. The underlying notion is that developing a fishery involves making it more efficient.

However, an alternative perspective on development, as argued by Sen (1999), emphasizes the expansion of real freedoms that individuals enjoy. This concept focuses on improving people's well-being by providing them with access to better education, healthcare, and a clean environment, regardless of the overall wealth of society. The emergence of the Nile perch fishery in Lake Victoria serves as an example of the loss of freedom experienced by artisanal fishers. The introduction of the Nile perch, which is primarily caught for export in a capital-intensive industry, has diminished the prospects of artisanal fishers who rely on cichlid species for their own consumption. Consequently, their freedom to choose how to develop their lives, improve their health and education, and escape poverty has been restricted.

While economic efficiency and wealth accumulation can contribute to greater freedom, they should not be pursued as end goals in themselves. Modern economic activities often prioritize efficiency and profit while neglecting the human dimension, as illustrated by the decline of small fishing communities in South Devon, UK. As the fishing industry became increasingly industrialized, these communities decayed, and individuals lost the ability to make a living on their own terms and at their own pace. Consequently, improved economic efficiency can inadvertently restrict people's freedom of action.

The argument about resource ownership and exploitation is often influenced by an economic perspective that emphasizes efficiency and wealth maximization. However, an alternative view of development focuses on expanding people's real freedoms, enabling them to lead more fulfilling lives. The industrialization of fisheries and the pursuit of economic efficiency can sometimes come at the cost of limiting individuals' freedom and disregarding the human dimension of economic activity.

Achieving Sustainable Development

The understanding of fisheries management objectives has evolved over time. Early fishery scientists primarily focused on maximizing sustainable yield, but it is now recognized that this narrow objective is insufficient. The concept of sustainable development has gained prominence in resource management, emphasizing the need to balance environmental, social, and economic considerations. Sustainable development, as advocated by the Brundtland Commission's (Brundtland 1987) report and adopted by many countries, aims to ensure that present actions do not compromise the opportunities and freedoms of future generations This includes preserving biodiversity and maintaining viable fish stocks to provide livelihoods for future generations.

From an economic perspective, the objective is to maximize utility over time, and economic analysis explores how consumption should be planned to achieve this goal. The discount rate, which represents the rate of return on investments, is a key factor in this analysis. Clark (1990) investigated the influence of the discount rate on the exploitation of fish populations and highlighted that if the interest rate exceeds the fish population's growth rate, it may be economically rational to deplete the stock and invest the earnings elsewhere. This viewpoint challenges the traditional notion of preserving the present value of future fish stocks for sustainable development. Anand and Sen (1996) argue that sustainable development can still be attained if the money obtained from exploiting the fish stock is invested in a way that ensures comparable opportunities (freedoms) for future generations, even if they may not have the exact resources as the present generation.

However, it is important to consider the assumption underlying this economic perspective. It assumes that the structure and diversity of the environment are not essential for our well-being. This anthropocentric view of life disregards the interconnectedness of ecosystems and the crucial role of biodiversity in supporting human health, well-being, and sustainable development

In summary, the management objectives of early fishery scientists, centered around maximum sustainable yield, have given way to a broader objective of sustainable development. This shift acknowledges the need to consider environmental, social, and economic factors in resource management. The economic perspective emphasizes maximizing utility over time, taking into account discount rates. However, the concept of sustainable development also recognizes the importance of preserving biodiversity and ensuring that future generations have comparable opportunities to the present generation.

Conclusion

Assessing the importance of conserving fish resources and biodiversity for the future is challenging. If we only consider food production, it might seem plausible to replace wild-caught fish with aquaculture. However, taking a broader perspective, diminished fish populations and damaged ecosystems will have far-reaching impacts on various aspects of our lives. Many fishers choose their profession based on its alignment with their lifestyle needs, and depleting fish stocks entirely would deprive future generations of similar opportunities. Moreover, other stakeholders would also suffer from the reduced diversity and altered functioning of aquatic ecosystems. Economic analysis often overlooks the intangible factors that motivate people, as highlighted by the example of assuming that people would readily switch from consuming cod to farmed salmon. Evaluating the future benefits of biodiversity, beyond ecosystem function, is challenging. Reducing biodiversity decreases the chances of discovering valuable substances for medicine or the food industry. However, the specific substances and their relationship to biodiversity remain uncertain, making it difficult to objectively quantify what we might lose if fish stocks are destroyed. Ultimately, our knowledge has limits, and the decisions we make today will have significant consequences for both the present and future generations.

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