HARVESTING THE SEAS

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Summary

The introduction to this article describes the basic features of fisheries as a production system, and the contribution of the fishery sector to national economies as a source of food, income, employment and leisure. The second section gives an overview of the historical development of fisheries that has resulted, in recent decades, in the full exploitation of world resources. The third section of the article describes the structure of fishery systems, and their four basic components: the resource, the production system, the exploitation system, and the regulatory system. The fourth section summarizes the effects of fishing on fish stocks, ecosystems and habitats. It reviews the current state of world resources and fisheries. Across the globe, overcapacity is commonplace, fisheries resources are depleted, and conflicts between fleets are exacerbated by these factors. At the start of the new millennium, the rise in fishing effort on stocks which are still underexploited just compensates the decline in yield of overexploited stocks. The average value of overall landings is declining. Fishery resources are losing their economic value. In the last section of the article, the cause, nature and consequences of overfishing are discussed. The conventional management methods which were developed before resources became depleted are insufficient to balance fleet capacities and fishing intensity to the potential yield of fish stocks. To control overcapacities, overfishing and conflicts between fleets, access to fish stocks must be limited. For that purpose, the legal status of resources has to be adjusted to their new economic state.

1. Introduction

With hunting and gathering activities, man has practiced fishing for since his origin. Although limited to catching the surplus yield of wild stocks, fishery production compares well with the output of major husbandry systems which benefit from technological intensification. A fifth of human protein intake comes from the sea and freshwaters. For a billion people, mainly in Africa, Asia and small island States, fish are the major source of animal protein. In affluent countries, fish products are appreciated for their gastronomic and nutritive properties (they are natural products with low calorie, fat and cholesterol contents). A third of world catches is reduced into meal and oil, which are essential ingredients for the production of farming feeds (notably for poultry and pig farming, and fish and shrimp culture). Fisheries and aquaculture are the main source of food and income for more than 100 million people either directly or indirectly. For many emergent countries, exports of fishery products rank highly as a source of foreign currency. Sustainable development policies attempts to integrate the promotion of welfare of small-scale fishing communities with the preservation of their cultural values and the conservation of natural resources from which they make their living. For several developed countries, preserving employment in coastal fisheries is an important social objective. In many affluent countries, recreational fishing comes close to the top of sport and leisure activities. Everywhere, the quality of marine environments and the picturesqueness of traditional fisheries contribute to the attractiveness of littoral areas.

Diversity is another feature of fisheries. Throughout the world, more than 3000 species are commercially exploited. A similar diversity is reflected in the design of fishing boats and gear, in the economic and social organization of producers, as well as in processing

methods, the final products and their uses (food, industrial, ornamental, recreate and aesthetic).

Lesser advances in the domestication of aquatic resources are the third salient feature of fisheries systems. In the spite of the recent and steady development of aquaculture, capture fisheries are still responsible for 80% of the sector overall production. In aquaculture, extensive systems, of shellfish and seaweed in particular, predominate. This lesser development of domestication in aquatic environments cannot be imputed to some technological backwardness, but to the past trend in the supply from fisheries—until the 1970s, the expansion of fishing operations throughout the oceans was sufficient to fulfill the growth in the world demand for fish products.

In recent years, however, this expansion has no longer taken place. The annual growth of world production, which reached 7% immediately after the Second World War, has been declining steadily since then, to fall to zero in the early 1990s. Very few stocks of significant potential commercial value remain unfished at present.

As a result of the increase in fishing intensity, yields from stocks which are still not fully exploited just balance the decline in yield from stocks which are already overfished. Although overfishing is not a new phenomenon, both in terms of geography and species, it has become pervasive during the last 25 years.

Conventional regulation methods elaborated before fishery resources became limiting appear ineffective for rationalizing fisheries, conserving resources and preventing conflicts between fishing fleets. Their basic drawback is that they have not been designed to adjust fishing capacities to the limited productivity of fish stocks. However, on a positive note, the adjustment of institutions to the new conditions of resource scarcity has begun.

At the international level, the extension of national jurisdictions has given coastal states the authority to manage 90% or more of world fisheries resources. However, if most states have revised their legislation to control the access of foreign fleets, only a minority have done so for the regulation of access to their own fleets. Their number, however, is slowly growing.

Constraints on long-distance fishing operations as a result of the establishment of EEZs have triggered drastic changes in the volume and structure of world trade for fishery products. During the last decade (the 1990s), the value of world exports rose from US$17 billion to 47 billion. Exports from developing countries tripled. Currently, affluent countries such as Japan, the EU and the US import 85% of the total value of world exports. From first producers, they have become net importers.

Like agriculture and other uses of natural resources, fisheries are taking part in a historical change, characterized by excessive pressures on natural renewable resources, transformation of the economic and social organization of small producer rural communities, and the growth of transnational fluxes of people, capital, information, pollution and cultures'.

2. Historical Development

2.1 Overview

For thousands of years, fishing operations have been restricted to inshore waters. In Western Europe, offshore stocks such as herring in the North Sea, or whale in the Bay of Biscay, started to be exploited commercially in the Middle Ages. As early as the fourteenth century, English fishermen went to Iceland to fish cod during the summer months. At the beginning of the sixteenth century, fleets from Western Europe crossed the Atlantic on the basis of information on the abundance of cod stocks around the Great Banks, brought back by Giovanni Cabotto from his first trip to North America. In 1609, following a request by the Dutch Government to access certain fishing grounds in the North Sea that were claimed by the British, Hugo Grotius wrote "Mare Liberum." With the exception of a narrow inshore belt, the principle of open access henceforth ruled the exploitation of world marine resources for almost four centuries.

The expansion of offshore fisheries accelerated during the second half of the nineteenth century following the Industrial Revolution. Trawling benefited from the combination of technological innovations (the introduction of the steam engine and improvement of the Vigneron-Dahl trawl), the use of ice for preserving fish catch, the development of railway networks, and the rapid expansion of markets in industrial centers. At the end of the century, stimulated by the introduction of canning methods for the preservation of fish (pilchard in the North-East Atlantic, salmon in the North-East Pacific), similar advances took place in inshore pelagic fisheries.

In 1954, the development in Great Britain of a revolutionary type of trawler again accelerated the expansion of long-distance fishing. The combination of a stern ramp for hauling the trawl, which enabled fishing under almost any weather conditions, with the use of a diesel engine, filleting machines, multiplate freezing, and fish meal plant to save weight and room, made long-distant trawlers largely autonomous of their home ports.

Their autonomy was furthered by refueling, catch transshipment and crew replacement at sea. In coastal pelagic fisheries, the adoption of acoustic equipment (echo-sounder and sonar) for detecting fish shoals, the introduction of the power block, the use of synthetic twine for net making, and the utilization of fish meal in chicken and pig farming had similar effects on fishing efficiency and demand. Finally, thanks to the improvement of fishing techniques (pole and line, purse seine, and finally pelagic entangling nets) and the expansion of markets in affluent countries, tuna fleets from Japan, the US and Southwest Europe gradually extended their operations throughout the whole tropical belt.

After decolonization, governments in emergent countries realized the potential contribution of the fishery sector to economic development. In some countries, the growth of local fisheries was facilitated by transfers of capital, equipment and expertise from countries in higher latitudes. In the 1950s, for example, after the collapse of the Californian sardine resource, US fishing companies transferred processing plants, purse seiners and skippers to Namibia, Peru and South Africa. Fifteen years later, the Peruvian

fishery landed 12 million tonnes of fish, representing a fifth of the world production. Finally, national governments and international organizations realized that small-scale fisheries, hitherto considered primarily as a source of skilled manpower for military and merchant navies and large-scale fisheries, was an economic segment with its own assets and constraints.

Despite national efforts to develop domestic fisheries, long-distance fleets continued to dominate production in the most productive fishing areas. In the early 1970s, for instance, the share of long-distance fleets amounted to almost 80% in the Eastern Central Atlantic, 70% in the North-East Pacific, and 50% in the North-West Pacific (these regions refer to the FAO classification that divides the world ocean into 16 statistical areas).

Considering the finite nature of fisheries resources, the conflict between long-distance and local fleets was unavoidable. Confronted with stock depletion, a growing number of coastal countries, both affluent and emergent, undertook to extend unilaterally their areas of jurisdiction.

Iceland, for example, proceeded in four steps (4, 12, 50 and 200 miles), entering at each of its initiatives (1952, 1958–1961, 1971–1973 and 1975–1976) into political and even physical struggles with European fleets that had been fishing around the island for decades or centuries.

After two decades of disputes at sea and debates in international forums, the position of coastal states prevailed ultimately. In the 1970s, long-distance fishing fleets and their governments accepted to offer compensations in kind or in cash to developing countries in exchange for fishing rights.

In 1982, the extension of national jurisdictions to 200 miles was adopted at the UNCLOS at Montego Bay (Jamaica), and formally ratified in 1994.

2.2 Intensification, Diversification and Geographical Expansion

This historical overview shows that the development of fisheries resulted from three distinct processes:

- the intensification of fishing on the most valuable stocks closest to the initial centers of economic development—as exploitation intensifies on the stocks, the average catch rate declines, and total catches level off before declining more or less markedly (Figure 1);
- the species diversification of the resource basis, with the exploitation of new species located on the same grounds that have been neglected so far as a result of their lower value; and
- the geographical deployment of operations on more distant areas where the previous two processes start again (Figure 2).

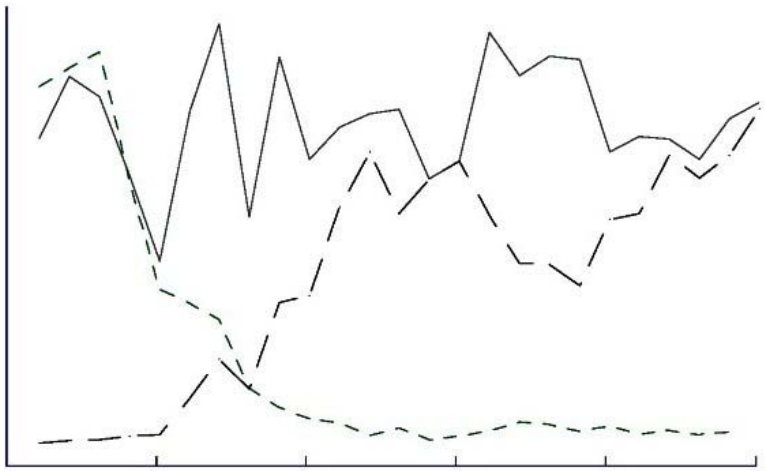

Figure 1. Moroccan cephalopod fishery: trends in annual catch, exploitation rate and catch rate
(data from INRH, Casablanca, Morocco).

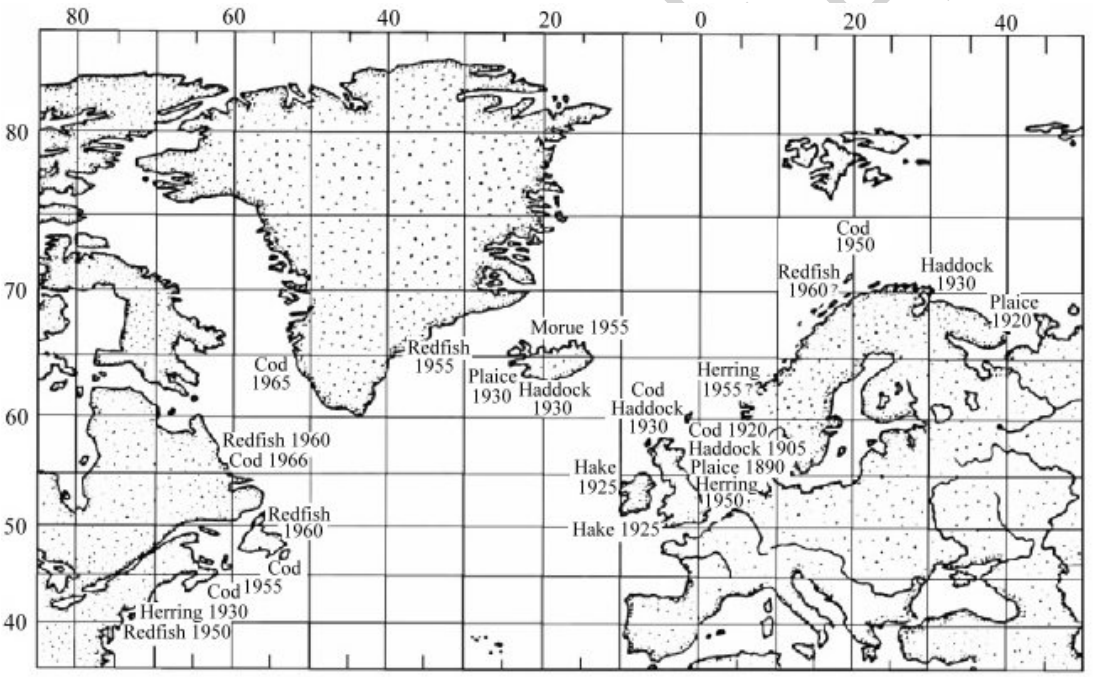

Figure 2. Extension of overfishing in the North Atlantic from the end of the nineteenth century to 1966 (years refer to the dates on which increase in the exploitation rate did not lead to significant increase in total catch).

Overfishing, however, is not a new phenomenon. By 1760, Tiphaigne de la Roche had already recorded evidence of overfishing in French inshore fisheries in the early fifteenth century. During the course of the twentieth century, local fleets of sailing boats depleted Western European oyster beds. After the Second World War, however, the phenomenon became widespread both in terms of areas and species.

2.3 Development Factors

In the historical development of fisheries, the combined existence of abundant resources and remunerative markets was more decisive than technological innovations. Fishing gear have not basically changed since the inception of fishing, although their dimensions and handling methods, as well as the material used for making them have improved.

With the exception of the power block, all innovations were borrowed from other economic sectors—mechanical propulsion, navigation and fish detection devices, synthetic twine, fish preserving methods, etc. Neither has the introduction and adaptation of innovations been particularly rapid. Mechanical propulsion, for example, was only introduced in Western European fleets 60 years after it had been adopted in the merchant navy.

While small-scale fisheries are widespread, large-scale fisheries developed initially in regions closest to large markets and abundant resources. Once established, existing infrastructures, marketing networks and specialized skills were decisive assets for the spreading of long-distance operations, when local resources became insufficient to sustain expansion.

If large-scale fishing companies are more effective than small-scale fleets in connecting latent resources to potential markets and in mobilizing investments and innovations for that purpose, artisanal fisheries can be very dynamic once these connections are established.

In developing countries, as in industrializing countries in the past, traditional fisheries have been able to enter rapidly into commercial production once market outlets have been opened.

3. Fishery Systems

3.1 Structure of Fisheries

The structure of fishery systems can be analyzed with the grids used in agricultural science for investigating farming systems. With respect to productive activities, fisheries can be subdivided into four basic components: the resource unit~~s~~, the fishing or production system, the exploitation system, and the regulatory system (Figure 3).

3.2 Resource Units

3.2.1 Nature and Composition

Most fishery resources belong to the upper level of the food web, although all species in that level cannot be exploited with profit. The economic value of fish resources depends on their abundance, the unit cost of their harvesting, and the intensity at which they are fished, since their abundance is reduced by fishing.

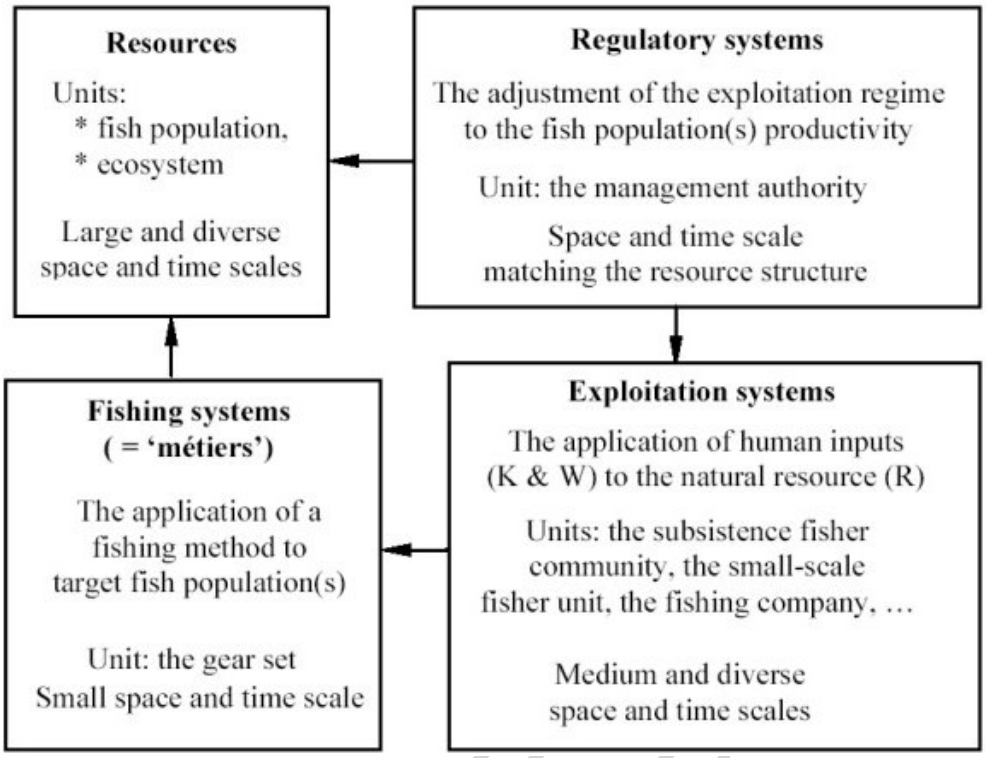

Figure 3. Schematic presentation of the fishery structure (sea-based operations).

Aquatic species are structured in discrete populations, distinct by their reproduction, migration and distribution patterns, and the genetic and demographic characteristics which result from their genetic and ecological isolation. Populations are parts of complex ecosystems, or sets of populations or microorganisms, plants and animals, interconnected in biological communities which interact with each other and with their physical and chemical environments, with adjacent ecosystems, and with the atmosphere.

Fish populations are seldom harvested separately. In general, several species of the same community and several populations of the same species are found on the same grounds. Fishing gear and methods are seldom selective enough to catch exclusively the species that fishermen seek. Varying quantities of other species are caught accessorily or incidentally with target species. In addition to these technological interactions, species belonging to the same community are also trophically linked. Owing to these trophic relationships, the exploitation of a species affects the abundance of its preys and predators. In general, technological interactions are stronger than biological relationships.

On account of these technological and biological interactions, fishing operations can seldom be regulated at the level of the population, but at the scale of larger sets, the fish stocks. The number of species that fishermen hunt while on a fishing trip, as well as the number of secondary species that they may catch during the same gear set, fishing trip or fishing season, vary from one fishery to another. This species diversity is an important parameter for the assessment of fish stocks, as well as for the regulation of their exploitation.

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determinism of their recruitment, the adjustment of shellfish production to the carrying capacity of shellfish basins, the regulation of access and the allocation of fishing rights in fisheries, etc.]

Biographical Sketch

Jean-Paul Troadec was involved in the 1960s in surveys and assessments of fishery resources conducted by the French Institute of Research for Development (IRD) in the Gulf of Guinea. He, then, joined the FAO Department of Fisheries, where he participated in the Department programs in the fields of fishery statistics, stock assessment, and fisheries management, before being in charge of the Fisheries Development Planning Service. In FAO, his work focused on the conditions of fishery development in developing countries, and on the change in fishery management approaches resulting from the full exploitation of world resources. In the 1980s, he became Director of the French Scientific and Technological Institute of Maritime Fisheries (ISTPM), and then, Director for Living Resources in the French Research Institute for the Exploitation of the Sea (IFREMER). His research interests concern the changes of marine production systems—including the uses and conservation of marine environments, the institutional aspects of their management, and the related changes in research priorities resulting from the full exploitation of fishery resources. He has presented a Ph.D thesis on the biology and population dynamics of West African croakers at the University of Marseilles (France), and edited a book on fisheries management.