RATIONAL EXPLOITATION AND CONSERVATION OF MARINE ECOSYSTEMS

Jean-Paul Troadec
Menez Perroz, Plouguerneau, France

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Contents

Summary

The introduction to this article recalls the state of fisheries at the beginning of the new millennium. The massive overcapacities, severe and pervasive resource depletion, and recurrent conflicts which characterize the exploitation of renewable resources—these can be traced back to the deficiencies of classic governance institutions used for regulating access. The second section reviews the changes in the relationships between production systems and natural ecosystems that take place in the process of technological intensification. Fisheries are taken as a model to illustrate how rationalization and resource conservation, together with conflict minimization, all depend on the application of technical measures to maintain the productive, reproductive and assimilative capacities of fish stocks and ecosystems, as well as on the adjustment of use capacities to the limited capacities of natural resources. The third section examines how, by acting upon the economic forces causing overcapacities, the extraction of resource scarcity rents can minimize their effects. These rents can also provide revenues for financing the regulation of uses. However, if the objectives of economic efficiency and resource conservation are fully compatible, the short-term reduction of employment implied by the initial reduction of use capacities remains the major obstacle to institutional reforms. The fourth section investigates the effects on

wealth distribution of various regulation instruments. If the choice of resource property regimes and mechanisms of use rights allocation has important distributive effects, the allocation of exclusive rights reduces the uncertainty and risk affecting fishing activities and other uses under current access conditions. Finally, the conclusion points out that use rationalization and resource conservation are directly conditioned to the adoption of suitable institutions for limiting access. Such adjustment is equally important for the development of new activities—aquaculture in particular. Some of the factors that facilitate or impede the emergence of institutions that are adapted to the new conditions of resource scarcity are identified.

1. Introduction

The survey of world fisheries in the chapter *Harvesting the seas* (Sections *State of World Resources* and *The Dynamics of Overfishing*) gives evidence of the pervasive extension of overcapacities and resource depletion. Most fisheries currently manifest problems of economic inefficiency. These problems are summarized below:

- physical yields, and even more, the unit economic value of landings, decline while stock variability is amplified,
- fisheries are economically inefficient—fish stocks are losing their economic value,
- fleet and use conflicts are recurrent,
- technical measures aiming at preserving stock productivity are more difficult to enforce, and
- scientific knowledge and information on fish stocks and fisheries are under-utilized.

These types of problems are not restricted to fisheries. When expansion opportunities are exhausted, all uses of natural resources are subject to similar unbalances. In semi-closed basins, shellfish farming is affected by overstocking resulting in longer growing cycles and higher mortalities which curtail the profit of farming activities. In intensive farming systems, organic matter, pharmaceuticals and chemicals that are released, as well as fish escapes, have to be adjusted to the assimilative capacity of ecosystems. In coastal areas, cultivated water bodies have to be preserved against pollution from industries, agriculture and urban centers.

The underlying causes of overexploitation are economic. However, the adjustment of use capacities to the productive, reproductive and assimilative capacities of ecosystems rests in the governance institutions that are currently used for regulating access. The regulatory systems designed by self-governing customary communities, or at a higher level, by central administrations during the expanding phase of fisheries, were primarily intended to preserve the productivity of fish stocks rather than to adjust fishing capacities to their productivity (see *Harvesting the seas*, sub-section *Regulatory Systems*). It is, therefore, understandable why regulation of access to fisheries to date has been ineffective.

The adjustment of institutions to the new conditions of resource scarcity has already started. The adoption of the new Law of the Sea has been the first step. The new Ocean

Regime gives coastal States the necessary authority to revise legislation regarding use rationalization and resource conservation within their EEZs. Most countries have already adopted legislation for controlling the fishing activities of foreign fleets. Few, however, have done so for the limitation of fishing capacities in their own fleets.

The regulation of access has no standard solution. The natural characteristics of renewable resources—and notably the mobility of fish stocks and the fluidity of ecosystems—the technical features of fishing and farming systems, and the socioeconomic organization of user groups, impose particular constraints that require specific arrangements. In addition, the emergence of new institutional schemes depends on the conditions prevailing in each country and on the decisions taken by national authorities.

2. The Exploitation and Conservation of Natural Resources

2.1. Technological Intensification and Production Systems

With technological intensification, physical controls are extended over new physiological functions of selected species and certain components of their environment. Domestication proceeds step by step, each step characterized by a specific production function, or assimilation function with respect to pollution (see *Harvesting the seas*, sub-section *Fishing or Production Systems*). The relationships between production systems and ecosystems can be analyzed on the basis of their level of technological intensification. For this purpose, six sets of fishing and farming systems can be distinguished. These are:

- Fishing, in which the surplus production of wild populations is harvested.
- Attraction-retention of fish concentrations: in such systems, man interferes, primarily with the distribution, and accessorily with the growth, of concentrations of wild stocks, by closing their migratory routes (valiculture), by providing shelters (artificial reefs), or by enhancing forage production through simple cultural practices (such as acadjas in Benin). Investigations on the reproductive strategies of aquatic populations indicate that their abundance is determined primarily by the success of their recruitment, i.e. by the number of fishes which survive at the end of the early stages (eggs, larvae and fry) and which compensate for population losses by natural and fishing mortalities. The level of recruitment depends primarily on the hydrodynamic conditions prevailing during the early stages, and secondarily on the biomass of the parental stock. Population abundance and production are much less influenced by the environmental conditions prevailing during the exploited phase of year classes. Thus, from a domestication viewpoint, attraction-retention systems differ from fishing essentially by the limited effects of simple cultural practices on the growth of fish concentrations. If local yields can be enhanced significantly, it is probably more by the attraction and retention of fish concentrations, than by a direct effect on the recruitment of populations.
- Extensive farming systems: in these systems, man exerts certain controls on the reproduction of cultivated stocks, either indirectly by providing artificial substratum for the settlement of larvae (e.g. by catching and stocking natural

spat in shellfish culture), or directly by releasing in the open sea fry that is raised in hatcheries (ranching).

- Semi-intensive farming systems: in addition to controls on reproduction, man can stimulate forage production by fertilizing the environment in which the stock grows (e.g. fish culture in ponds, lagoons or small lakes).
- Intensive farming systems: in addition to controls on reproduction, cultivated stocks are artificially fed (e.g. fish culture in ponds, pens and raceways).
- Fully-controlled farming systems: by recycling the waste products of cultivation, these systems become autonomous from the environment—examples include the culture of African cat fish (*Clarias gariepinus*) in the Netherlands, the culture of tilapias in heated waters in Belgium, or pond culture in which water is recycled in Israel.

2.2. Relationships between Production Systems and Ecosystems

The relationships between fishing/farming systems and ecosystems include direct and indirect impacts of the former on the latter, as well as exogenous pollution which can modify the quality and carrying capacity of ecosystems.

2.2.1 Direct Impacts

Fishing and attraction/retention systems rest on the exploitation of wild populations. Most of them occupy a high level in the food web.

Stock productivity can be preserved, first by preventing the premature capture of juvenile fishes, and second, by maintaining the spawning stock above a level below which recruitment may be reduced.

All other farming systems include some control of reproduction.

In addition, in all those that have reached the stage of commercial production (extensive culture of sedentary species such as seaweeds and shellfishes, and semi-intensive and intensive systems), the cultivated stocks are collectively or individually owned.

With domestication and appropriation, cultivated stocks lose their status of natural resources. They can be assimilated as capital assets, in a similar way to fishing boats or farming infrastructures.

In semi-intensive and intensive systems, the constraint resulting from the limited trophic capacity of ecosystems is relaxed by the enhancement of forage production, or removed by the supply of artificial feeds.

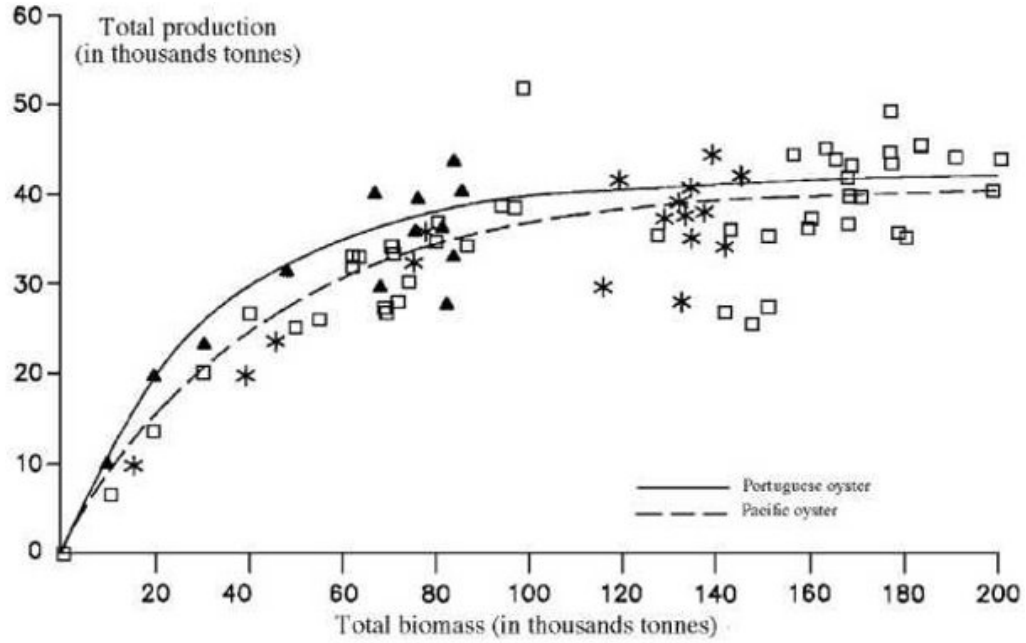

Figure 1. Annual production and stock biomass in the basin of Marennes-Oléron (France):
Portuguese oyster (□), Japanese oyster (Δ), and Japanese oyster in Portuguese oyster assimilation equivalent (*). Source: Héral *et al*, 1986.

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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's 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.