

Marine Ecosystems : towards responsible and sustainable fisheries

Ocean resources are diminishing dangerously due to overfishing, pollution and global warming. This depletion is of particular concern in southern countries, where fish, a source of revenue for millions of people, takes on major importance in terms of food security.

In this context, scientific research has an essential rôle to play. For scientists, one of the main stakes is to better quantify the effects of fisheries on ecosystems. Many gaps are still to be found in this domain, for it is only recently that research efforts have focused on the functioning of ecosystems as a whole.

A billion people dependent on fish in the world

On a world-wide scale, approximately one billion people are dependent on fish as the principal source of animal protein. Since the 1960s, the availability of fish and fish by-products per inhabitant has practically doubled (with an average consumption of 16 kg of fish per person per year at the end of the 1990s), rapidly gaining on demographic growth, which also nearly doubled over the same period. In low-income food-deficit countries where the current consumption of sea products is close to half of that of the richest countries, the contribution of fish to total protein in-take is considerable, neighboring 20%. In certain insular or coastal countries of high population density, fish protein is a deciding dietary contributor, providing at least 50% of total protein intake (Bangladesh, North Korea, Ghana, Guinea, Indonesia, Japan, Senegal, etc.).

From years of “miraculous fishing” to stock collapse

Although the oceans were considered inexhaustible in the last century, many fisheries today show signs of senescence. A brief history of fisheries gives the measure of the problem. The 1950s marked the beginning of a very rapid increase in fishery activity. During the 1950s and 1960s, the enormous global expansion of fishery effort and power was coupled with ever-growing catches, at a rate so rapid that they tended to exceed population growth. In the space of two decades, world production of continental and marine catches was multiplied three-fold, from 18 million tons in 1950 to 56 million tons in 1969. During these miracle years of fishing, marine resources were thought to be inexhaustible. Then, over the 70s and 80s, average growth rates fell to 2% per year, and then to practically zero during the 90s and ever since, while the number of boats and their efficiency has continued to rise.

In the space of two decades, world production of continental and marine catches has been multiplied by three, from 18 million tons in 1950 to 56 million tons in 1969. The same conclusion has been drawn locally and globally for commercial and artisanal fisheries alike in both the northern hemisphere and in tropical waters: the world's fisheries seem to have reached their maximum potential, and given that three-quarters of all fish populations are fully exploited or overexploited, there will probably be no significant increases in total catches in the future.

An unlikely return to initial state

The problem is not the stagnation of fishing catches alone. These risk to collapse in the future because the speed and intensity of exploitation on a world scale leave little chance of ensuring the viability of the resources exploited. A major preconceived idea has long been the recovery of collapsed fish stocks. Fisheries theory postulates that reducing fishing or a moratorium on fishing would allow fish stocks to be re-established more or less rapidly, given that species have a potential for strong growth. But numerous observations contradict this idea. Only 7% of collapsed populations have recuperated their numbers after one generation.

The example of codfish in Newfoundland is renowned. Despite a moratorium on codfishing following the collapse of stocks in 1992, the biomass level remains still lower than that of 20 years ago, and no recovery has been observed. Many researchers are now in agreement concerning the weak capacity of resilience of marine populations (return to an initial state, either unperturbed or little perturbed). Overexploitation through fishing appears to be the principal cause in the past and present of the upsets observed in exploited marine ecosystems. Other factors such as pollution, the destruction of habitats, the introduction of species, and climatic changes modify ecosystems as well, and their impacts may overlap or combine with those of exploitation. A new context appears in which human activities engender upsets difficult to control.

Impacts of fisheries on the marine ecosystem as a whole

Fisheries have therefore a strong impact on targeted species. However, their direct and indirect effects on other components of the ecosystem are not to be ignored, for it is indeed the marine ecosystem as a whole which is potentially affected by fisheries.

Certain types of fisheries have direct effects on the habitat of marine species, whether or not they are exploited. Trawling, for example, contributes to the destruction of the benthic habitat. Annually, the surface covered by trawling is estimated at fifty per cent of the surface of continental shelves. This surface represents 150 times the surface of yearly terrestrial deforestation and illustrates the scope of the potential impact on numerous sedentary species.

There are also indirect effects of fisheries on non-targeted species. Fisheries generally target species of commercial interest, using selective gears and/or exploiting adapted zones and seasons. However, the selection process is far from perfect. At-sea discards of catches of incidental species (those with little or no commercial interest) are very high and represent 27 million tons out of a total world catch of 85 million tons (or approximately 30% of declared catches). The International Whaling Commission estimates that between 65,000 and 80,000 dolphins, seals and other sea mammals perish each year in this way.

Approximately 40,000 sea turtles in danger of extinction are caught in nets or other non-selective gears. Another striking yet not isolated example is that of shrimp and crab fisheries which harvest roughly three to ten times their volume in commercially undesirable fish species. For one kilogram of caught shrimp, an average of five to ten kilograms of incidental catches are discarded!! These exploitation practices of marine resources are more and more condemnable in the context of precautionary principles. The world of fisheries is striving today to correct harvesting habits and techniques which no longer seem adapted to conservation imperatives.

A worrisome reduction in fish size

An essential qualitative evolution in fish landings shows the indirect effects that may be engendered by fisheries on the ecosystem as a whole: fishes of small size and at the bottom of the food chain constitute a growing proportion of catches. More and more sardines, anchovies, herrings and other small pelagic fishes are caught, and fewer and fewer codfish, halibut, hake, etc. This phenomenon is not linked to a change in targeting by fishers, quite the contrary. Indeed, fishers most frequently target large carnivorous fishes, situated at the top of the trophic chain, because these have high commercial value.

In Canada, where the codfish seems to have in fact disappeared, the ecosystem today is dominated by pelagic fishes and other species located lower down the trophic chain, in particular shrimps and crabs. Several decades ago, it was still possible to catch three-meter long halibut and two-meter long codfishes. Today, their size rarely exceeds one meter. This reduction in fish size found in catches is a clear symptom of the generalized overexploitation of fish stocks, especially of the larger species. Scientists are beginning to take the measure of the problem. Knowledge of the functioning of the marine milieu, even if incomplete, allows us to foresee that the massive reduction of these predatory species will have important effects on marine ecosystems as a whole, upsetting their structure and functioning. Dominated by species of small size and short life expectancies, ecosystems will become more and more affected by environmental and climatic variations.

Dynamics of exploitation systems

Fisheries are exploitation systems of renewable resources with a global dynamic resulting from the interactions between human, social and natural components.

Exploitation dynamics can be studied conjointly with those of exploited resources. These studies are indispensable to the development of fisheries co-management models. They are most particularly important in the case of tropical fisheries, especially artisanal ones, whose fishing units can adapt their activities to the highly variable conditions of access to the diverse components of the exploited ecosystems. In this case, in fact, the impact of fisheries activities is affected by variability 'decided' by the fishers. This variability must be well-evaluated and taken into account when evaluating the resource. But most importantly, this variability must also be studied because it depends upon the adaptability of fishers and may hence be a source of viability of exploitation systems. This leads to the study of halieutic exploitation governance. The term governance indicates that the activity and the rules to which it conforms are the result of the interactions of an important number of involved parties (fishers, consumers, governmental authorities, non-governmental organisations, research organisms ...).

Research in these fields is conducted in an interdisciplinary context, linking social sciences, natural sciences and modeling sciences.

Towards responsible and sustainable fisheries

It is urgent to implement management measures which take into account the impacts of fisheries on the functioning of ecosystems. Current fisheries practices, too often based on a short-term view of economic profitability, are signing away not only the future of marine populations and ecosystems but the fisheries sector in the middle term.

With the objective of encouraging a precautionary approach in a true effort to construct the fisheries industry of tomorrow, the FAO (Food and Agriculture Organization of the United Nations) has laid down the bases of an “Ecosystem Approach to Fisheries Management”. By establishing a code of conduct for responsible fisheries in 1995, a new dimension has appeared with the principle of precaution applied to fisheries, resulting in a concerted effort to reconcile conservation and exploitation. This does not mean rejecting fishery activity as such but rather making fishers and decision-making bodies aware of their responsibilities in the exploitation of renewable marine resources. Exploitation activities are no longer considered independently of their very context, the ecosystem. The Reykjavik Declaration on Responsible Fisheries in the Marine Ecosystem in 2001, adopted by the World Summit on Sustainable Development held in Johannesburg in 2002, asks States to establish policy on the exploitation of marine resources.

An international framework and agenda have been fixed for the goals of conservation and exploitation.

For scientists, one of the stakes is to better quantify the effects of fisheries on ecosystems. Many gaps persist still in this domain, for only recently has research turned to the functioning of ecosystems as a whole.

One possible line of research is the elaboration and proposal of ecosystem indicators with the goal of establishing a veritable bill of health of marine ecosystems so as to better communicate scientific knowledge to the decision-making spheres of fisheries management. The use of these indicators was discussed at an international symposium held at UNESCO in Paris, assembling 250 researchers from 53 countries. This conference took stock of existing knowledge on the subject and laid down future research bases to be undertaken in order to refine the health diagnosis of marine ecosystems. It remains to be seen whether governments will integrate the responsibility of fisheries within legislation, as recommended by the FAO, at this point in time where responsible and precautionary fisheries management is a minimum requirement for ensuring viability of resources and their exploitation. If maritime fisheries do not wish to become a recreational activity due to depleted resources and undergo the fate of hunting, the number of vessels and their activity must be limited, the numerous depleted stocks must be replenished, and conservation and exploitation reconciled by rendering fisheries more respectful of their environment.

The *Centre de Recherche Halieutique Méditerranéenne et Tropicale* (Mediterranean and Tropical Halieutic Research Center)

Created in 2001, the *Centre de Recherche Halieutique Méditerranéenne et Tropicale* (CRHMT) in Sète is a joint research structure partnered by Ifremer, IRD and the University of Montpellier II. Specialized in tropical and Mediterranean marine milieux and their halieutic resources, the CRHMT develops multidisciplinary integrated research for an ecosystem approach to fisheries, within the context of global climatic change and overexploitation. Research themes and areas of competency include marine ecology, coupled physical/biogeochemical/halieutic resource models, trophic interactions, the dynamics of exploited populations and fisheries, stock evaluation, fisheries technologies, information systems, indicators and stable isotopes.

A pilot project of the CRHMT, the Ecoscope is a knowledge center on exploited marine ecosystems. Its mission is to capitalize, articulate and disseminate the knowledge obtained in diverse past, present and future research programs on tropical and Mediterranean ecosystems. In this way, access is given to data, tools, methods and know-how concerning each ecosystem in order to answer questions raised by the ecosystem approach to fisheries. The Ecoscope is not only destined for researchers and CRHMT partners, but for the dissemination of information to the profession and young people.

Philippe Cury [philippe.cury@ird.fr] and **Yunne Shin** [shin@ird.fr]