Annexe 5

Workshop on World Fisheries

Management and Development

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Seattle (USA)

Tidemag

7 - 11 July, 1985

THE MUTATION OF WORLD FISHERIES :

ITS EFFECTS ON MANAGEMENT PRIORITIES AND PRACTICES

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"On manipule les mêmes faits qu'auparavant,
mais en les plaçant l'un par rapport à l'autre dans un
système de relations qui est nouveau parce qu'on leur
a donné un cadre différent".
H. Butterfield, The origins of Modern Science,
1300-1800 - London 1947

1 - INTRODUCTION

I have been asked to address to the following question : "Can we expect to do better by trying harder what we have done so far or by doing differently ?"

From the considerations upon which I shall be developing my answer, I tend to think that such a discussion is of little originality and use. Most of the facts - eg. on the past evolution of world fisheries - and aspects - eg. the mobility of many fish stocks or the open access nature of fisheries-I am recalling are truisms for any fishery expert. However, there is obviously a certain gap between the picture one can draw by confronting such facts and aspects and the current fishery management practices and fishery research priorities. This gap is the justification of this rapid overview.

Obviously, scientists do not master alone the management function as the latter involves economic, political and societal forces. Consequently, they cannot decide on how fisheries should be managed. However, the following discussion indicates how fishery research, namely its priorities and concerns, is influenced by the political context of world fisheries. It shows also lags between such priorities and concerns and the political context. Thus, one should wonder whether the fishery science community should not pay more attention to the reduction of such gaps and the dissemination of timely-suited concepts among the fishing industry, the fishery

administrations and domestic societies as a whole in order to speed up their adoption and implementation.

Owing to the broad scope covered by this note, I took deliberately the decision not to cite any example or bibliographic reference. As the issues discussed are of world wide concern, the quotations I would have been able to provide would have been biased towards the regions, fisheries and scientific disciplines I am familiar. In addition, with the time I could devote to this paper and the volume whithin which it should remain, it was difficult to do otherwise. I realize this decision makes the paper somewhat abstract and doctrinal. However, I am confident that participants to the workshop will be able to feed it with examples and references of their own. I only expect that the reading of this note generates some thoughts which, added to many others, will contribute to the appreciation of the present needs for efficient fishery management.

2 - HISTORICAL TRENDS IN WORLD FISHERIES

In the early 1970's, the average rate of increase of world fisheries production dropped from an average of 6,5 % annually to about 1 %. After a period of rapid expansion, particularly favourable for long range fleets, world fisheries entered a period where conventional fish resources have become fully or overexploited. This drop in the average rate of increase was anticipated with the estimations, made by Gulland and Moiseev in the late 1960's, of the world fishery potential yield : according to their assessments, this potential is

under the current economic and technological conditions around 100 millions tons. At the time their works were published, this ceiling of 100 millions tons would have been reached in slightly more than a decade at the rate of expansion then prevailing.

This decline in expansion was not the only evidence indicating that world fisheries were entering in a crisis. The collapse of the Peruvian anchovy fishery in 1972 gave public demonstration of the limited nature of fish yield ; it showed also that certain fish stocks can be highly unstable, especially when heavily fished.

In 1973, the economic crisis characterized by a sudden rise in the cost of energy and money added to the constraints world fisheries were already facing with the exhaustion of virgin conventional fishery resources.

Finally, in 1974, at the first LOS Conference in Caracas, the principle of free access to fishery resources on which long range fleets have based their expansion was challenged openly in a world forum. International allocation of marine resources was advocated and geographical location of such resources opposed to historical rights and advantages derived from technological progress as criteria for apportionning marine resources. The position taken on that occasion by developing countries in favour of this new regime is in this context worth noting : despite the fact that fish resources are in average more abundant in high and medium latitudes

than in tropical waters, a majority of them took position in favor of the extension of national jurisdictions.

The impact of the economic crisis on world fisheries and the extension of national jurisdiction over marine fisheries resources also showed that fisheries management cannot be restricted to its biological component. Economic and political factors are no less important, especially when the exploitation of the resources has reached or exceeded the limit of their natural production. Indeed no sector of economic activity can be optimized if its economic and social dimensions are disregarded.

Along with this mutation in the state and prospects of world fisheries, the limitations of conventional fisheries management practices developed during the phase of expansion and open access became equally obvious. The effects of a dynamic driven by open access to naturally limited resources are well documented in fisheries ; they are still worth recalling :

- economic overexploitation characterized by the dissipation of the potential economic rent attached to the resource and the increase in the rate of subsidy resulting from the inertia of the fishery system and its tendency to go beyond the equilibrium where the economic rent is just dissipated,

- losses in employment resulting from the loss of the rent (1) as well as from an excessive recourse to equipment and innovations resulting in an excessive substitution of labour by capital generated by the pressure to maintain competitivity in a context of excessive competition,

- biological overfishing characterized by :

  . a possible decline in total average yield,

  . an excessive reduction in catch rate and average size of fish, both reducing the economic value of yields ;

  . a boosting of natural unstability of fish stocks and landings resulting in an increased risk of stock collapse and temporary disappearance of fisheries,

- intensification of conflicts within and among fisheries as well as with other uses of marine resources,

- poor enforcement of regulatory measures owing to the relative inadequacy of regulatory measures and a coercitive approach of management associated to a lack of fishermen support for enforcing the management schemes, and

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(1) if economic profit can be generated by reducing labour, increase in employment depends on investments

- an excessive cost of resource monitoring and fisheries management resulting from the unsuitability of the regulatory measures (eg. catch quotas which requires annual readjustments and implies a time lag before enforcement which weakens their effectiveness) and approaches (eg. coercitive approach not backed by fishermen and the fishing industry) as well as from the higher variability of fish stocks generated by overexploitation.

3 - NATURE OF THE PROBLEM

The dynamics of the exploitation of open access, renewable and limited resources are well known : in the absence, prior to harvesting, of explicit decisions regarding resource and wealth allocation, users are lead to increase continuously their fishing capacities to maintain their share of the resource and of the rent attached to it. Such dynamic can be acceptable as long as there are resources to sustain expansion. However, when opportunities for expansion are exhausted, competition for the economic rent through the acquisition of excess fishing capacities leads to the economic and social losses as well as to the biological overfishing described in the previous section.

What may be less well appreciated is the hierarchy between the biological, economic and political dimensions of fishery management. Classically, the basic cause of biological overfishing lays in the competition for the acquisition of the economic rent. This is

achieved largely through the acquisition of fishing capacities. As long as political decisions regarding the allocation of exclusive rights of use for given fisheries are not made, the competition for open access resources prevents fishing capacities from being optimized. Optimally, fishery management should be approached along the following sequence :

(i) political decisions for the allocation of exclusive use rights,
(ii) socio-economic optimization of unit fisheries, and
(iii) resource conservation.

With the conditions of open access prevailing under the past ocean regime, this could not be done and fishery management had to be restricted to its last step, i.e. the resource conservation. As a consequence, only the effect, but not the cause of overfishing could be considered. The poor performance of current fishery management practices should, therefore, be no surprise.

In principle, the new ocean regime should enable to approach the management issue comprehensively. However, in many cases, the allocation decisions are not yet taken at the space scale required : they remain to be made for domestic fisheries. As a consequence, present practices of fishery management often do not differ from what they were under the previous ocean regime and the period of expansion of world fisheries.

Moreover, it should be recalled that, most economic and social objectives - including most probably maximization of employment in the fishery sector taken as a whole, - are achieved on the left limb of the yield curve, i.e. before conservation of the resource at high levels of productivity raises special concern (i.e. growth and recruitment overfishing). In other terms, a large part of the resource conservation requirements will be satisfied, should the rate of fishing be maintained within limits where most economic and social goals are achieved.

Variability in stock abundance generated through fluctuations of recruitment (1) in relation to climatic interannual variations worsens the perverse effects of overfishing. Effects of overfishing on stock abundance variability through the reduction in the number of year classes making up the exploited stock are well documented.

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(1) Recruitment variability is not the only cause of unstability in fisheries : costs of energy and money can vary widely and unexpectedly. However, the amplitude and time scale of their variations are such that they often do not disturb fisheries to the same extent ; recruitment of certain fish stocks - notably pelagic or shellfish bivalve can vary considerably, up to one or two orders of magnitude. Effects of such variability on stock abundance is boosted by the reduction of year classes lead by excessive fishing.

This is not the only source of variability for high levels of exploitation. In France, for example, where shellfish cultivation is highly developed, there is evidence that, in closed and semi-closed littoral basins, competition for the limited carrying capacity (plankton fodder) of the ecosystem leads to overstocking. The resulting weakening of oysters physiological condition increases their susceptibility to diseases as well as to mass mortalities when, seasonnally, climatic conditions become hard. Production statistics for the past century show that epizooties which decimated oyster stocks on several occasions occurred a few years after total production has passed through a maximum. Moreover, usually more than one disease appeared on such occasions. These observations support the hypothesis that overstocking enhances stock susceptibility to diseases and to sudden collapses.

Vulnerability of fisheries to natural fluctuations of stocks and yield is increased by the lack of flexibility of the various segments of the industry (harvesting, processing, market) as well as of the management machinery. Often those show an inertia such that their adjustment lags a few years behind stock fluctuations. In certain fisheries, such time lags have actually boosted natural stock size variability. This happens for example when, on the basis on information on stock abundance for the past years, catch quotas are increased whereas the stock has already started to decline for natural causes, and conversely, when it is decided after a stock decline to maintain reduced catches whereas stock has started already to recover.

The combinaison of open access, resource variability and lack of mobility and flexibility of the industry can only increase the susceptibility to overexploitation. When good and bad years come in cycles, fisheries can attract labour and capital which create gluts when recruitment declines for a few years in succession.

The multispecies nature of many fisheries makes the management task even more complex. Single species stocks are partly interrelated through complex trophic relationships which are difficult to quantify ; as a consequence effects, on the species composition of fishery ecosystems, of changes in fishing patterns are hard to forecast. Furthermore, several stocks are usually exploited by the same fleets during the same fishing operations. Those stocks require different patterns of fishing for optimum exploitation. Several fleets using different gear and manned by different fishermen communities are often operating in the same areas. They are not the only users of the marine resources. The objectives of these various users differ often drastically : eg. pollution and shellfish farming. This overlapping of resources and users raises an additionnal degree of complexity (whatever the management objectives may be). Exploitation of individual stocks cannot be optimized. Management has to depart from the stock by stock approach and to consider management units encompassing not only several stocks, but also the various fleets and fishing communities exploiting them within a given space and time matrix.

These pecularities and complexities are not specific to fisheries They are common in the exploitation of natural ecosystems : eg. hunting, natural forests, ranching, extensive agriculture, environment conservation, etc. where natural productivity cannot be increased, at least sufficiently rapidly, through technological innovations to damp down the effects of climatic fluctuations and where resource mobility and environment fluidity also make resource allocation difficult. In such circumstances, climatic fluctuations generate gluts in overcrowded exploitations : unwise recourse to technological solutions for exploiting already fully used resources (eg. outboard engines in scale fisheries, wells in the Sahel, etc.). affects resource productivity negatively or reduces overall incomes or employment. Examples of similar dynamics are many in the exploitation of natural ecosystems : the potatoe disease and the emigration from Ireland ; the Dust Bowl in the USA ; the development of Virgin Lands in Soviet Union ; the desertification, drought and hunger in the Sahel, etc. In front of such a complex situations, with biological, economic, social, societal and political dimensions, the classical approach limited to the maximization of the biological output is clearly insufficient and self-defeating.

4 - LIMITATIONS OF CURRENT APPROACHES AND PRACTICES OF FISHERIES MANAGEMENT

The difficulties in properly managing the exploitation of natural ecosystems being recognized, examination of current concepts and

practices of fisheries management shows that they are still largely influenced by the conditions prevailing under the expansion phase of world fisheries and, as such, partly inadequate to the present conditions of full exploitation. Furthermore, they are insufficient to grasp the opportunities offered to the new ocean regime and the possibility it offers to relax the excessive competition attached to open access.

The principle of open access to fishery resources could be justified, in part, by the resource mobility and the environment fluidity which make allocation difficult. However, there are many stocks, notably in littoral areas, which are sedentary (seaweeds, bivalves, etc.) or slightly mobile (crustaceans, coral reef fish, etc...). In many countries, coastal and inland fisheries were regulated traditionnally through the allocation of exclusive territorial rights of use among fishing communities, complemented by the limitation of fishing capacities and the regulation of the distribution of their operations. Such systems considered explicitly issues such as exclusion of foreign effort and labour, geographical distribution of fishing operations, reduction of disputes, distribution of wealth, etc., even if they paid comparatively less attention to resource conservation and optimization of fishing patterns. In most countries, such customary systems have fallen into disuse under the combined effects of the intrusion of technological innovations and of the encroachement of offshore fleets (eg. trawlers in developing countries). Moreover, even if long range fisheries developed initially their operations on unexploited

offshore stocks, the principle of open access was germane to the expansion of long range fishing operations. The recent expansion of national jurisdictions over most marine fishery resources and the reference to geographical criteria as opposed to historical rights and advantages derived from technological innovations are in line with the exhaustion of opportunities for physical expansion.

Biologists and economists have analyzed the limitations of MSY as a management objective. If its biological and economic limitations have been well analyzed, the weight that the political context has exerted on its selection is also worth noting. This concept was adequate during the expansion phase when biologists were asked to make inventory of latent resources and to assess the potential yield they offered for expansion. The fact that it disregards the cost of fishing and the desirability to optimize the net profits - in whatever terms those are expressed - which can be derived from fisheries cannot be accounted for the unability of biologists to consider economic aspects of fisheries management. During the phase of expansion of world fisheries, it could be expected that catches and revenues would remain greater than current costs of fishing or would eventually catch up with them. In that situation, if the need to preserve the resource and maintain its productivity at maximum level was recognized, no decision was required immediately regarding cost minimization and resource allocation. Later, when conservation became a matter of concern, the lack of formal decision on resource allocation prevailing in international fisheries prevented countries to devote a proper attention to the cost of fishing. They had first

to ascertain their fishing rights and could do it only through the development of their fishing capacities. No progress could be achieved even in domestic fisheries, for international fisheries provided possibilities for expansion, if only through more intensive competition. This explained the gap between the formal recognition of the need for resource conservation and "rational" management, on the one hand, and the continuous development of fishing capacities which continued to be the rule, on the other hand.

At the same time, the working hypothesis made - to facilitate the investigation of the effects of fishing effort on stock abundance and yield - on environment average stability, as well as the lack of historical series on stock abundance lead to seriously understimate the natural variability of certain fish stocks (small pelagics, bivalves) : explanation of recruitment failures was looked for essentially in the excessive reduction of parental stock by overfishing. The role of hydroclimatic conditions on medium and long term trends as well as on sudden collapses or explosions in recruitment and, then, in stock abundance was largely disregarded.

These concepts had negative repercussions on the practices used for conserving and managing certain particularly unstable fish stocks, notably :

(i) the vaine attemps to maintain fish stocks at stable levels and their yields as closed as possible to a mythic MSY ;

(ii) for such stocks, management objectives such as $F_{0,1}$, F_{max}, were of limited relevance not only for economic reasons : forecasts based on past time series and, thus, the height of the yield curve itself were likely to be of little significance on the medium term.

(iii) misinterpretations of stock collapses disregarding the effects of environment on recruitment and, thus, on stock declines have necessarily lead to overestimating the impact of the management measures then recommended, notably the protection of the spawning stock, in the forthcoming evolution of depleted stocks.

Similarly, overall and national catch quotas were the only regulatory measure which could be used in fisheries where resource productivity had to be preserved but when, owing to lack of political decision on resource allocation, fishing capacities and costs could not be adjusted to the average resource potential yield. The practical limitations of overall catch quota (need for annual readjustments to account for variations in stock abundance, need to recourse to short term (month, quarter) catch limitations to effectively limit fishing mortality in shortliving species - shrimp, cephalopods, physical impossibility to simultaneously harvest individual species catch quotas in multispecies fisheries, enforcement difficulty related to the fact that catches escape more easily to control than vessels, deliberate misreporting resulting in biases in fishery statistics, lack of regulation of fishing capacities and costs resulting in the impossibility to optimize

economic and social outputs of fisheries, consequent excessive cost of research for routine stock monitoring) are directly related to such political context.

The monospecific approach of resource evaluation can be explained partly by the need to decompose the issue in elements simple enough to be efficiently tackled as well as by the relatively simpler species composition of high latitude ecosystems. However, the high selectivity of long distance fleets during the initial expansion of their activities made the species composition of their landings considerably simpler than the composition of their catches and than that of the ecosystems they were exploiting. It was with the reduction of opportunities for redirecting effort towards new fishing areas that secundary species were progressively marketted making the multispecies issue of fisheries evaluation a matter of concern in high latitude fisheries.

Fisheries science and administration concentrated their attention essentially on large scale fisheries. Small scale fisheries characterized by their diversity in terms of species, sought and caught, gear used, uses of products, etc., were implicitly considered as doomed to progressively decline and provide skilled manpower to large scale fisheries and other maritime activities. Adoption of unique mesh size regulations common to all fishing segments of a fishery implied that all those had similar capabilities with respect to range of operations, gear used, market accessibility, etc. as well as similar flexibility. Only one

objective was explicitly or implicitly considered to optimize --- fisheries, that is the maximization of total yield. Still in line with the current state of development of large scale fisheries, biological and economic models considered fishing effort as the main variable driving the state of the fisheries. Such models implied full mobility of production inputs, i.e. of resource (open access and pulse fisheries), labour and capital. No models envisaged the existence of links between manpower and fisheries resources as exist in coastal traditionnal fisheries or which are appearing with the extension of national jurisdictions and which seem necessary to facilitate the regulation of fishing capacities by promoting fishermen support for management and enforcement. Little attention was paid to the pecularities of small scale, artisanal fisheries. The stronger links which exist between labour, capital (lay wages) and resources, or the recourse to barter arrangements, frequent in traditionnal communities for example necessarily affect the dynamics of such fisheries as well as the variables which drive them and upon which management authority can act. As a consequence, the validity of conventional economic models as well as of statistical schemes currently developed for assessing traditionnal and artisanal fisheries is to be questionned. This is no negligible observation for half of the world fish production used for human consumption comes from small scale fisheries.

Thus, present practices of resources evaluation and fisheries management are still largely influenced by the situation and constraints prevailing during the phase of expansion of large scale

fisheries. This situation is now over. Inventory and assessment of world fishery potential yield have been grossly achieved in the late 1960's and early 70's. The conservation of the resource started to become a matter of concern in the early 70's with the adoption of first catch quotas. On a world basis, the last two steps of fisheries management, i.e. their socio-economic optimization and the resource allocation (at domestic level) have hardly been touched - except with respect to foreign fleets : only few countries have applied the same concepts to their own fisheries.

5 - NEED FOR ANOTHER APPROACH IN FISHERY MANAGEMENT

As discussed in section 3, the socio-economic optimization of fisheries is conditionned by the explicit adoption of allocation decisions, i.e. when satisfactory answers are given to the political dimension of fisheries management. If so decided, the task will be considerably more complex in domestic fisheries as the overlappings among resources, gear, fleets and communities become more intricated as space scale shrinks. There will be, however, a basic difference as compared to the international situation : boundaries separating fisheries can be positioned where interrelationships within resources and gear operations will be minimum, thus allowing to delineate more homogeneous and independant fisheries management units.

At the same time, it is hard to see how significant progress - both in meeting economic and social objectives and in facility of enforcement - will be achieved without a move in that direction. The analysis of the conditions facilitating a convergence between individual fishermen or industry motivations and societal objectives as well as easier and more efficient enforcement, and the evaluation of the rationale and justifications of traditionnal management schemes (territorial rights of use, delegation of management responsabilities to fishermen communities, etc.) suggest strongly that the temporary lease of well identified sets of resources to specific sectors of the industry or fishermen groups presents a potential for improvement. It should facilitate the internalisation by the group or industry sector of the management issue and the apparition of a group behaviour facilitating enforcement. The lease of sites for shellfish cultivation or for fixed gear gives an example of a concept which is largely applied to coastal fisheries in certain countries - e.g. France or Japan. To facilitate the apparition of a group behaviour, sets of resources and fishermen should be selected as small as permitted by the resource mobility, diversity and variability. Such leases should be granted for periods of time of sufficient duration as required for investments amortization and for generating fishermen concern for the longterm conservation of the resource. However, the implementation of such a concept raises serious questions of operational, legal, political and ethic nature. To acquire more practical experience on the advantages and limitations of such an approach, the concept should preferably be tested, initially on a few pilot projects.

The adjustment of fishing capacities to fishery potentials, made possible by the new ocean regime, passes through the definition of exploitation, assessment and management units : unit fisheries will have to be defined in terms of species, gear, vessels, seasons and space. Boundaries will have to be positionned where inter-relationships within resources and among gear are minimum. This passes through the mapping of the fishery components, the analysis of their interrelationships and seasonal variations and the appreciation of their flexibility.

There is no regulatory measure which applied alone will enable to implement the previously discussed comprehensive approach. In each fishery, a specific assemblage of measures (territorial rights of use, limitation of fishing capacities, catch quota) will have to be adopted, depending on the features of the resources (sedentary or mobile, short or long living, single or plurispecific, stable or variable, etc.), of fishing operations (single or multigear, scattered or concentrated landing sites, etc.) and of management objectives (maximizing economic net revenue or employment, resource conservation, etc.). However, once allocation decisions are taken, new kinds of regulatory measures - at the same time more efficient and easier to enforce - can be used. In particular, the serious limitations of overall catch quotas and of their implications on the present practices of resource monitoring and fishery management can be relaxed.

The simpler case corresponds to the mere allocation of space (e.g. exclusive territorial rights of use) as used in shellfish culture or for the exploitation of wild stocks of shellfish or of fixed gear. Obviously, such resource allocation measure is particularly well adapted to sedentary and low mobility species. When stocks do not require particular attention for their preservation (possibly seaweeds) or when farmers or fishermen individually can control adequately the resource yield (shellfish farming), the need for stock monitoring and evaluation is small. However, as noted earlier, competition for limited plankton productivity in semi-closed basins may require stock control (total biomass and its apportionment through space and among leasers). Still very little knowledge and even less experience is available on regulatory measures which would facilitate such regulation while promoting farmers support and compliance.

When fish stocks are mobile, fishing capabilities need in addition to be limited and shared. This will be achieved by controlling the physical variable(s) (gear ; boat tonnage, power ; number of fishermen) of the fishing units which make up the bulk of their fishing power and by limiting the number of fishing units in each unit fishery. Such kind of limitation presents several potential advantages :

- it regulates both inputs and outputs (catches, employment, fishing cost), and, thus, facilitates the socio-economic optimization of the fishery,

- for most demersal stocks, but generally not for schooling species whose catchability coefficient, q, may change appreciably with stock size, it keeps fishing mortality more stable with respect to variations in stock abundance ; thus, its use should reduce appreciably the cost of stock monitoring and the need of annual readjustments of regulations, as are usually required when regulation is based on catch quota,

- it should facilitate enforcement - vessels being easier to control than catches - and fishermen support -, because allocation of exclusive fishing rights relaxes competition.

However, it has also its weaknesses :

- for pelagic stocks whose catchability coefficient may change with stock size, catch quotas - with their limitations - will have probably to be added, at least at certain seasons and areas. However, limitation of fishing capacities will reduce considerably the task of resource monitoring and enforcement ;

- in multispecies fisheries, certain high valued species may have to be protected individually and excessive concentration of fishing operations upon them prevented ; similarly, excessive taking of undersized fish may have to be prevented in seasons and areas where it is more available ;

- the basic difficulty with limitation of fishing capacity will be to offset the long term gain in fishing efficiency of the licensed vessels (seepage effect) : such gains will be achieved by

  (i) maximizing the unregulated variables of the fishing unit and by

  (ii) improving the average distribution of fishing operations relative to the distribution of fish concentrations.

Individual catch quota is another way of motivating individual fishermen, fishing companies or processing enterprises to minimize their input cost for the allowed catch. However, the difficulty of effectively controlling actual catches will remain.

Whatever measure is used for regulating fisheries, appropriate mechanisms have to be adopted for allocating and transfering rights of use. The objective will be to keep the size of the fishery inputs close to the objective set, while preventing apparition of monopolies. Theoretically, fishery resources can be either state or privately owned. Practically, owing to their mobility and variability as well as to the overlapping and intrication of marine resources, public intervention in fisheries management can be expected to remain appreciable irrespective of the desirability to transfer part of the management duty to fishermen and the industry.

Schematically limited fishing rights can be allocated and transferred :

- either arbitrarily on the basis of criteria such as the belonging to certain socio-economic groups (eg.fishermen) ; one could note that the issue will reappear when the groups become too large as compared to the resource potential ;

- or through economic mecanisms based, at least in part, on the rent value of the fishing right or lease.

Adoption of efficient allocation and transfer mechanisms will be difficult and take time for the existence of an economic rent and its use as a basis for transacting fishing rights is far from being recognized for marine resources. The reasons are :

(i) a certain confusion between the concepts of public domain, open access and free (zero value) resource,

(ii) the need to agree on the signification of the resource economic rent, particularly when it has been created by those who have developed a culture industry or a fishery in a previously unexploited sea area, and

(iii) that of agreeing on its sharing among capital, manpower and resource.

As long as adequate transfer mechanisms are not adopted, rigidities are likely to prevent optimum use of sites and fishery resources. The development of more efficient systems of exploitation (eg. new

cultivated species) will be slowed down if traditional users do not enjoy the same accessibility to innovations and cannot draw benefit from the disposal of the sites they enjoy.

The evolution of management practices will also affect considerably the priorities for fishery research. As long as world fisheries where expanding, the basic question posed to fishery science was to elucidate the response of fish stocks to exploitation. With the full exploitation of world fish resources which appeared more than a decade ago, the constraints affecting fisheries management as well as the opportunities offered for fisheries betterment have changed profoundly. Basically fishery science is still approaching fishery management with the same concepts and tools it developed during the phase of expansion. Its concern is largely limited to the effects and not the causes of overfishing. Those are economic and political in nature. Improving the precision and sophistication of answers to traditionnal questions (eg. maximizing physical yield from a given cohort) will not provide adequate answers to the new questions. Even if answers will have still to be tailored to the peculiarities of the fish stocks response to exploitation, economic and political dimensions of fisheries management have to be apprehended. This is particularly important owing to the hierarchy which prevails between the political , economic and biological dimensions of fisheries management. This requires the broadening of the fishery science matters of concern.

There are two new areas where biological and ecological research should be developped :

(i) the definition - in terms of species, gear, fleet, areas, seasons - of unit fisheries, i.e. of units of exploitation, assessment and management ; this requires :

- the mapping of the resources (species, sizes) and of their seasonal movements,

- that of the fleets and gear and their seasonal movements as well as the estimation of their flexibility to modify their time and space distribution patterns and

- the analysis of the interrelationships within the resources and among the gear and fleets, notably through the resources (gauntlet fisheries), in order to define the boundaries of the fishery units and the patterns of their interrelationships

(ii) the variability and causality of recruitment : the new ocean regime has considerably reduced fleet mobility ; the desirability to strenghten bounds between resources and fleets in order to facilitate the socio-economic optimization of fisheries and to promote fishermen support for the enforcement of regulatory schemes will reduce even further the possibility to use space to damp down stock fluctuations ; this increases the need for extending the span of stock forecasts and for

better appreciating their average variability over the time span of investiments (fishing fleets, processing capacities, etc.).

At the same time, the dynamics of multispecies ecosystems, in response to changes in fishing patterns and pressure need to be better understood. This passes also through the development of research on the determinism of recruitment as most marine populations concentrate their regulatory mechanisms on early stages. It is clear that the application to fisheries of a better understanding of the relationships between recruitment and environment variability will essentially depend on man ability to assess probabilities on the medium and long term climatic trends. The development of such ability will take time but, may be, not more than of understanding the recruitment processes. Immediately, a better appreciation of the respective role of environment variability and of spawning stock size will improve scientific concepts and advise for stock conservation and fisheries management.

Obviously, improvement in effective fisheries management will not depend on the progress in the fishery biology paradigm only. Parallel moves are required in the industry, administration and political circles. In this evolution, the industry and fishermen associations may be readier to apprehend the opportunities - both economic and social - offered by the new regime and to take a leading role for promoting the required changes. Analyses of opportunities for social and economic betterment of fisheries, or pilot projects for testing different equilibria and for comparing

the respective net economic and social advantages of new management approaches should contribute to the better appreciation or opportunities and appropriate ways to achieve them.

6 - CONCLUSIONS

Schematically, the management function has three major components :

(i) resource conservation,

(ii) socio-economic optimization of the fishery,

(iii) allocation of exclusive rights of use,

their hierarchy going from the last to the first.

During the expansion of world fisheries, none of these components had the critical importance it has acquired with the full exploitation of the resources.

In the absence of allocation decisions, prior to fishing, economic and social optimization of fisheries is hardly possible and resource conservation is made more difficult by the existence of overcapacities and the resistence it generates among fishing countries, companies and fishermen against an effective enforcement of management schemes. Independanly of its distributional effects, allocation decisions have been taken at international level and substantial progress has been made locally in the national control of foreing fleets previously operating in international fisheries. In such fisheries, economic and social benefits have been derived,

thus demonstrating the validity of the above discussed concepts. However, implementation of such concepts to domestic fisheries is still an exception on a world basis. As a consequence, most of them still suffer the well known deficiencies of mismanagement : dissipation of economic rent, loss of employment, biological overfishing, lack of enforcement, misreporting of fishery statistics, etc. This is the case even when fish stocks are properly assessed and monitored. Moreover, progress in performances is slow despite the fact that the constraints and limitations of current practises have been identified a decade or two ago.

Can we, thus, expect to do better by trying harder what we have done so far or by doing differently ?

From the above discussion, the answer seems relatively clear. Progress requires basic changes in approach. The new Ocean Regime has had fundamental effects on world fisheries. It can be interpreted as a decolonization of international fisheries. The concepts on which it is based, notably the extension of national jurisdictions, lead towards a certain sedentarization of fishing operations. Parallel changes are required in the management concepts and approaches. Among those, one can mention :

- the extension to domestic fisheries, whence they are fully exploited, of the principles - especially exclusive use privileges - on which the new Regime is based,

- the need to depart from the stock by stock monitoring to assess fishery units with their resource, gear and fleet components in order to determine the trade offs in their socio-economic optimization and, more generally, those between mobility and stability,

- the medium and long term variability of fish stocks, the effects of climatic changes and their consequences on the economic and social optimization of investments.

Fisheries are not the only economic activity susceptible to benefit from similar developments in research and management : the coherent use and conservation of marine environments, notably in littoral areas, are likely to gain from such progress as most utilizations of natural ecosystems show the same dynamics and involve a similar rationale.

At the same time, one should recognize that the task will be difficult and progress slow. The history of mismanagements in the use of wild ecosystems is long and not always cheerful.

This rapid review of the mutation in which world fisheries entered in the early 1970's and its consequence on needs and prospects for fishery management raise two more basic questions :

(i) what could be the adequate balance between competition and stabilisation ?

(ii) is such balance likely to change with the level development of fisheries and, notably, the rate of exploitation and the amount of natural resources available for expansion ? In other words, are the mobility of production inputs and the desirable degree of freedom in the resource accessibility not likely to go down as the potential for expansion declines ?

Answers to those questions go beyond the scope of this paper and the field of fisheries but will remain relevant for the betterment of domestic fisheries.

The discussion of the present weaknesses and prospects of fishery management has been restricted, on purpose, to the capture phase of fisheries where resources productivity is the limiting factor. There are obviously areas where fisheries, in the broad sense, can be expanded : locally, foreign fishing effort can be substituted by domestic fishing capacities ; certain fish stocks - e.g. small pelagics - are still locally underexploited for technological and economic reasons ; different mariculture systems which offer varying prospects for overcoming natural constraints limiting wild stock productivity are to be developed ; food technology offers good prospects for utilizing better a limited raw material ; etc. These opportunities for expansion do not lessen those which can be derived from the development and implentation of better suited management concepts and approaches wherever the natural resource is the binding factor.