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The Precautionary Principle: its Implications in Capture Fisheries Management

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'Conservation and management both stem from value judgements made by society, not science.'

R. L. Edwards (1988)*

ABSTRACT

The paper attempts to clarify the research, management and legal implications of a potential application of the Precautionary Principle to capture fisheries, particularly in the international context. In the process, the paper also looks at related issues such as the burden of proof, the use of best available scientific evidence and technology, the reliance on prior scientific consensus, assimilative capacity and acceptable levels of impacts, etc., in the fishery context. It is argued that, if narrowly interpreted, the precautionary principle could lead to socio-economic havoc. If reasonably interpreted, however, the Principle offers a golden opportunity to progress towards sustainable fisheries development and suggestions are made for the implementation of precautionary approaches in fisheries management.

1 INTRODUCTION

Fisheries management practice has evolved slowly during the last half century, constantly lagging behind theory. Progress achieved since the first FAO Technical Committee on Fisheries in 1945 has been

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insufficient largely due to competition and expansion in an open access context as well as inadequate research and institutions.[1] While traditional management practice has still to improve, new aspects related to environmental conservation are emerging which may require an acceleration of the process of evolution of fisheries management and a broadening of its scope to take non-fishery users concerns into account.

Part XII of UNCLOS 'Protection and preservation of the marine environment' does not contain detailed instruments for implementation of the conservation of the marine ecosystem, but it stresses that States have the 'duty to protect and preserve the environment' from pollution. Burke[2] stresses, however, that if ecosystem conservation requires measures for the fisheries sector, under Article 192, States will have to apply such measures as provided by the fisheries provisions of UNCLOS and to strike a balance between the environmental and fisheries provisions to ensure sustainable exploitation.

Environmental concern has increased drastically in fisheries, with the World Conference on Human Environment, Stockholm, 1972, the work of the 'Brundtland' Commission from 1984 to 1987[3] and the preparations for the UN Conference on Environment and Development, Rio de Janeiro, 1992. This concern, which was already apparent in the FAO Technical Conference on Fishery Development and Management, Vancouver, 1973, and the FAO World Conference on Fisheries Management and Development, Rome, 1984, was exacerbated by the international conflict on large-scale pelagic driftnet fishing in the high seas at the end of the 1980s and the related Resolution 44/225 of the UN General Assembly in December 1989.

There is a worldwide trend towards preventive approaches to management of renewable resources (cf. IUCN[4]) and such approaches have been advocated in the past for fishery management,[5] but rarely implemented. As the global concern for the environment is gaining momentum in fisheries, one can expect that the principles adopted at international level for environmental protection, such as the Precautionary Principle, may be progressively forced on the fisheries systems. The wide adoption of the Principle could change drastically the state of affairs in marine living resources conservation and could offer an opportunity to improve fisheries management and ensure sustainable fisheries development. Its careless generalization to fisheries could, however, lead to economic and social chaos in the fishing industry.

The purpose of this paper is, therefore, to review the available information on the Precautionary Principle, to clarify the implication of its potential application to fisheries and its relationships with conventional management approaches. The paper addresses this issue mainly

in the context of international fora but many of the implications are also relevant at national level. The following sections will; (1) describe the Precautionary Principle; (2) analyse its scientific, technical and legal implications for fisheries; and (3) propose elements for precautionary fisheries management strategies.

2 THE PRECAUTIONARY PRINCIPLE

The Precautionary Principle seems to have existed for a long time in national laws related to human health and, for instance, in the regulations of pharmaceutical industries. It seems to have been then progressively invoked in relation to pollution and its impact on human health and, later, its impact on the environment. As environmental concern and conscience grew, preoccupation for human safety has been progressively extended to human environment and to other animal species and from a national to an international context. This has led to a growing reference to the Principle, often without much analysis of the practical implications.

In international environmental softlaw, the Precautionary Principle emerged as a recognition of the uncertainty involved in impact assessments and management and in particular, in the determination of the future consequences (and associated costs) of present decisions. It is related to the central issues of inter-generational equity—our responsibility towards future generations—and long-term discount rates and is particularly relevant when uncertainty is high and potential consequences of decisions could affect the survival of humanity.[6] By comparison, traditional fisheries management deals with intra-generational equity—and allocation of resources between the present users. The Principle was apparently referred to in relation to pollution prevention in the early 1980s in Germany ('Vorsorgeprinzip'[7], and applied to issues related to the ozone layer, the greenhouse effect and the conservation of nature. It has touched indirectly on fisheries through the International Conventions on dumping at sea (Paris and Oslo Convention, Marpol) in relation to pollution by fishing vessels.

It has been recently addressed for fisheries in relation to the actual or suspected impacts of the activity on coastal habitats and ecosystems, endangered species, genetics and biodiversity. In most cases this was done only implicitly. Of particular relevance is the implicit emergence

of this Principle in the discussions of the Preparatory Commissions of the UN Conference on Environment and Development on Oceans and particularly in the three Action Programmes on coastal areas, high seas and marine living resources. The International Conference for the Protection of the North Sea (London, November 1987; The Hague, March 1990) used it explicitly in decisions regarding coastal States jurisdiction, habitats, species and fisheries, including pollution from ships.

In order to understand better its potential implications for fisheries, the terms of its declaration could be adapted to fisheries, for illustration, replacing the words 'substances' by 'fishing practices' and deleting specific reference to the North Sea. (Such 'transposition' from environmental to fisheries softlaw, which may be considered abusive to some readers is, unfortunately, what is presently happening.) This Precautionary Principle would read as follows:

> Accepting that, in order to protect a marine area from possibly damaging effects of the most dangerous fishing practices and gears, a precautionary approach is necessary which may require action to control fishing activities even before a causal link has been established by absolutely clear scientific evidence...
>
> States accept the principle of safeguarding the marine ecosystem by reducing dangerous fishing practices, by the use of the best technology available and other appropriate measures. This applies especially when there is reason to assume that certain damage or harmful effects on the living resources are likely to be caused by such fishing practices and technologies, even where there is no scientific evidence to prove a causal link between practices and effects (the principle of precautionary action).

The UN Resolution 44/225 on large-scale pelagic driftnet fishing in the high seas (December 1989) gives an example of expression of the Precautionary Principle for international fisheries. Although not as stringent as the original proposals put forward by the countries promoting it, the Resolution is a good example of the type of approach which might be internationally agreed to in the future. It is also likely that the strategy and principles behind this resolution will be used again in the future, both in the high seas and inside EEZs. After having expressed concern about the importance of the fleets, the length of the nets, their mode of operation, their potential impact on anadromous and highly migratory species, their by-catch, the concern of coastal

countries on the state of resources close to their EEZs, the Resolution recommends that:

> (a) a moratorium should be imposed on all . . . fishing . . . by 30 June 1992; (b) immediate action should be taken to reduce progressively . . . fishing activities in the South Pacific region with a view to the cessation of such activities by July 1991 and (c) further expansion . . . in the North Pacific and all other high seas areas . . . should cease immediately.
>
> . . . such a measure will not be imposed in a region or, if implemented, can be lifted, should effective conservation and management measures be taken based upon statistically sound analysis to be made jointly by concerned parties . . .

The Resolution recommended immediate action on the basis of 'concern', in the absence of convincing evidence or scientific consensus and assuming therefore that driftnets have undesirable impacts unless shown otherwise.

A major property of the Principle is that it inverses the course of action, requiring that measures are taken first and, subsequently, relaxed if research demonstrates convincingly that they are not necessary. It affects the relation between science and policy and between management and development by: (a) focusing the spotlight on scientific uncertainty and related risk in decision-making; (b) reverting the burden of proof on industry; and (c) giving priority to preventive management on crisis solving. It is a reaction to the present situation that environmentalists consider unbalanced in favour of the economic sectors and short-term socio-economic considerations. If narrowly interpreted, without reference to social and economic considerations, it could reverse the situation in favour of the environment and of non-consumptive users giving to them the benefit of the doubt and safeguarding all their interests even in the worst case assumption. The latter would imply that all risks are to be taken by economic activities.

The problem is not new to fisheries. James[8] wrote that the managers' dilemma was that 'by always leaning backwards in regulation, *giving to the resources the benefit of the doubt* (emphasis added), he might come up with reasonable assurance of protecting the resource, except that the economic survival of thousands of individuals, hundreds of communities and dozens of countries may be affeted by the administrative action taken'.

In the following sections distinction should be made between the Precautionary Principle and precautionary approaches or measures.

The 'Principle' will refer to the 'hard line' rule proposed for management of highly polluting activities. The 'approaches' will refer to the practical ways and sets of measures which are precautionary in nature but may lead to more realistic application in fisheries.

3 IMPLICATIONS OF THE PRECAUTIONARY PRINCIPLE

3.1 Implications for research

3.1.1 *Best scientific evidence*

The Kristiana Conference, in 1901, just before the creation of the International Council for the Exploration of the Sea, endorsed the principle of scientific enquiry as a basis for rational exploitation of the sea. The same principle was also agreed on at the International Conference on the Conservation of the Living Resources of the Sea, hosted by FAO in Rome in 1955. It was finally integrated in the United Nations Convention for the Law of the Sea, adopted in 1982. Prior scientific consensus (on cause–effect relationships and potential consequences of action) has been the basis for action in international fisheries management and will remain one of the most neutral and peaceful ways to reduce costs of interaction between nations and user-groups.

In modern fishery management systems, scientists are asked to: (1) determine the theoretical potential production of a stock (usually equated to MSY); (2) calculate the corresponding level of fishing effort, as a benchmark level not to be surpassed; (3) determine the appropriate size at first capture before which fish should not be caught in significant numbers; (4) recommend ways in which the above can be achieved (mesh sizes, closed areas, closed seasons) and the bio-economic and technical trade-offs involved; (5) assess the effects of fishing and forecast impacts of management options.

Despite its level of development, particularly in the northern hemisphere, fishery science has played only a limited and advisory role in the complex decision-making process of fisheries development.[1,9] The limitations of the data, models and paradigm are being progressively recognized[10] together with the uncertainty unavoidably attached to any scientific assessment. Raising the research standard further to model ecosystem behaviour under combined environmental and fishing stress and considering socio-economic effects implies data, understanding and financial and human resources which, in many instances, would be

unrealistic. However, research can contribute substantially to the reduction of management uncertainty by:

- Improving the statistical power of the methods used for assessing the biological and economic parameters, testing their sensitivity to data errors and systematically producing estimates of bias and precision in the derived parameters.[11]
- Expanding the range of available models towards multispecies and ecosystem models, taking environmental variability into account.
- Testing the sensitivity of models used for fisheries and ecosystem management to the uncertainties in their parameters and in their functional structure. In particular, testing routinely the impact of such uncertainties on the performance of management.
- Analysing a range of possible options, with a range of models, showing the likely direction and, if possible, magnitude of the biological and socio-economic consequences of these options as well as the level and direction of the uncertainty (risk assessment).
- Experimenting with management systems as advocated by Walters and Hilborn[5] many years ago.[13]
- Improving fishing gear and practices. Work must be done not only on better ways to use gears but on the development of better gear (square mesh trawls, turtle and by-catch excluder devices, biodegradable nets and pots, etc...) with better selectivity and less environmental impact.

UNCLOS requires 'the best scientific evidence' when designing and adopting management and conservation measures. It provides that in EEZs it shall *be taken into account* (emphasis added) by the coastal State (article 62) and in the high seas, *measures are designed on it* (emphasis added) (Article 119). Although the obligation seems to be less stringent for the coastal States in its area of exclusive jurisdiction than for States cooperating in the high seas, the requirement for scientific evidence is clear. The discussion by Burke[2] of the UNGA 44/225 in this respect highlights some of the problems. UNCLOS is satisfied with the 'best available evidence'. It does not define the quality of the evidence required in any quantitative manner and 'does not necessarily place a great or imposing burden that must be discharged before the necessary conservation measures can be taken... The 'best available' standard even permits the use of poor evidence to justify conservation measures, if that evidence is the best available?[2] UNCLOS, however, also does not indicate what should be done if

there is no scientific information available. One would assume that the spirit of the text is that such scientific information should be urgently collected but this does not preclude measures being taken in the meantime. UNCLOS does not provide criteria on how to decide what is 'the best' scientific information if scientific conflicting results are available, neither does it give guidance on how to operate in the absence of the scientific consensus which UNCLOS, implicitly, assumes. In such case, the Precautionary Principle would ensure that action is not deferred sine die. (In the driftnet issue, such a procedure was set-up through international scientific monitoring but the consensus on the implications of the results of the programme was never reached.)

The UNGA Resolution 44/225 on large scale pelagic driftnet fishing recognizes, in its preamble 'that any regulatory measures... should *take account of* (emphasis added) the best scientific evidence available and analysis', using for a high seas problem, the weaker wording that UNCLOS provided for EEZ resources management. The purpose of this might have been to avoid the constraint that measures would have to be *based on* (emphasis added) the evidence available.

The introduction of the Precautionary Principle in fisheries could appear, therefore, an attempt to 'fill the gaps' in UNCLOS, preventing the absence of scientific data or consensus opening a loophole leading to 'laissez-faire' management and development strategies. UNCLOS does not foresee, however, that an existing fishery could be closed if data are not available. The Precautionary Principle has been criticized by the GESAMP Steering Group on Scientifically Based Strategies for Marine Environmental Protection and Management[14] as 'the acceptance of *suspicion* rather than *scientific evidence* as sufficient to introduce controls'. Contrary to the usual rule for crime regulations, potential culprits are considered guilty pending proof to the contrary. It should be hardly debatable that, in fisheries, when scientific data are available together with a monitoring and management system, the basic requirement of UNCLOS should prevail, e.g. that decisions be taken on the basis of the best scientific evidence available.

3.1.2 *Burden of proof*

The burden of proof is traditionally on research and management with the rare exceptions where scientific work has been used to limit the development programmes on new fisheries. They have to demonstrate that harm is being done to the stock before measures can be imposed on industry. History has shown that, because of the continuous bargaining between management and industry (and related socio-economic pressures) the 'proofs' may be arguable and their impact on

decisions often far from satisfactory.[1] The adoption of the Precautionary Principle would imply a fundamental reversal of the burden of proof, placing on those actors (group of fishermen, countries) who claim that no action is required the onus of proving that what they intend to do will not lead to 'unacceptable' effects on the resources.

As an example, in relation to the conditional re-opening of the large scale pelagic driftnet fishery, it was proposed to the UN General Assembly in 1990[15] that:

> Unless joint assessments by all concerned ... of sound scientific data from a specific large scale driftnet fishery concludes that there are no unacceptable impacts by that fishery, the conditions for relief of the moratoria ... are not met (the subjective words have been underlined by the present author).

This proposal puts on the fishing nations the burden to prove that, if allowed, driftnets would not have an unacceptable impact, leaving implicitly to the other nations the right to accept or not that proof. This is in line with the Precautionary Principle which requires States to take preventive or corrective action even in the absence of sufficient scientific evidence of a causal link between a suspected factor and the adverse effects observed (or even before any effect is observed at all).

This was confirmed by UNGA Resolution 46/215 of December 1991 on large-scale pelagic driftnet fishing which called for action against this type of fishery on the basis that: 'the international community (which) have reviewed the best available data ... have failed to conclude that this practice had no adverse impact ... and that ... evidence has not demonstrated that the impact can be fully prevented'.

Another example can be found in the EEC Council Regulation 345/92 of 27/1/1992 which regulates the use and the length of driftnets (limited to 2·5 km) in EEC waters. Article 9a grants a derogation until 31/12/1993 to some vessels allowing them. It states, however, that: 'the derogation shall expire on the above date, unless the Council, acting by a qualified majority on a proposal by the Commission, decides to extend it in light of the scientific evidence showing the absence of ecological risk linked thereto'. This indicates clearly that, unless proved otherwise, driftnets of more that 2·5 km are considered harmful.

Finally, the form in which the ICES Advisory Committee on Fisheries Management (ACFM) delivers its advice gives another example of precautionary approaches:[16] for 'stocks where, at present, it is not possible to carry out any analytical assessment with an

acceptable reliability, AFCM shall indicate precautionary TACs to reduce the danger of excessive efforts being exerted on these stocks'.

3.1.3 *The role of statistics*

The UNGA resolution 44/225 requires 'sound statistical analysis' and this new terminology could be considered as an attempt to clarify the concept of 'best', equating it with 'statistically sound'. Relations between statistics and the Precautionary Principle have been discussed by Gray[12] who welcomed the adoption of the Precautionary Principle for environmental law but worried about the fact that it implies that 'it is no longer necessary to have scientific facts to back up environmental legislation as one can simply "have reasons to assume" that an effect can take place' to justify a management decision. He warns on the risk for scientific objectivity if proper statistical procedures are not the basis for the assessments. He concluded that 'the Precautionary Principle should not be part of science since, by definition, it does not rely on scientific evidence'.

The advantage of referring to statistics is that it offers a way of using well-established mathematical techniques and tests to decide what information is 'best' on statistical grounds. Bringing statistics into the picture would force scientists and decision-making systems to recognize and measure explicitly the levels of uncertainty and the risks attached to the decisions.

There are, however, also problems with statistics. There are many types of them (parametric, non-parametric, geostatistics). Statistics for spatial analysis are still to be improved. Biological distributions tend to be continuous (rarely random) and stratification is usually not fully satisfactory. Under these conditions, the use of many statistical tests is questionable. Separating the 'signal' from the 'blank noise' in a data set and distinguishing fishing effects from environmental ones is, in many instances, a nightmare. Obtaining consensus on statistical analysis might therefore not always be easier than on scientific evidence. If such agreement on the sound statistical analysis would have to be obtained by consensus, one single country could easily block the process. The lack of international agreement on the results of the joint driftnet fishery research programme illustrates this difficulty.

3.2 Implications for management

Human beings are not 'prudent predators' because their intervention is disjointed, and the feedback controls that they respond to are in good part independent of the natural resource ecosystem.[9] Their activities,

not sufficiently controlled by natural signals of resources stress, can continue despite environmental degradation with potentially irreversible effects. One should recognize, however, that fishermen, whose livelihood depends on the living resources, are more sensitive to natural feedback control than most land-based activities. Notwithstanding, the hard facts demonstrate without any doubt that such feedback has been, in many instances, insufficient to avoid excessive stress on fisheries stocks, with severe ecological and economic consequences. Improvements are therefore necessary and the following sections will look at ways in which the Precautionary Principle could help.

Hey[17] states that a precautionary approach to environmental protection should be based on clean production methods and best available technology, comprehensive methods of environmental and economic assessment, scientific and economic research towards better understanding and analysis of options, appropriate legal, administrative and technical procedures. If taken out of their precautionary context, as described above, the elements of the approach look very traditional, at least to fisheries management specialists.

3.2.1 *Management under uncertainty*

It is obvious that fisheries management could certainly be improved. Many important stocks are too close or even below their MSY level, leading to instability. Many have ecologically or economically collapsed. The situation raises particular concern in the high seas[18] but is far from satisfactory in all EEZs.[10] Management failure results essentially from the common property nature of fisheries and the lack of effective will to control fishing effort levels directly in the absence of an explicit allocation of resources. In a fishery system with an efficient resources allocation scheme, both research and management would have performed better. Allocation can, however, be achieved only through lengthy and politically difficult processes of evolution of property and user rights, and the resulting deficiencies and uncertainty must be faced.

Perrings[6] notes that 'there is no consensus on what the principle means for decision-making under uncertainty'. In general, the Precautionary Principle is invoked when a negative impact on man—and, by extension, on the ecosystem—is suspected and when the options or even the survival of future human generations are at stake. It should be obvious that fisheries do not threaten the future of humanity even though their mismanagement may severely affect the livelihood of coastal communities. There can be no doubt, however, that fisheries have an impact on the ecosystem and its species, if only by reducing target species abundance, age structure and reproductive potential.

Some involuntary impacts on associated species will also occur and impacts on habitats, although limited, cannot be excluded for some mobile gears (beach seines, trawls, etc.). A major difference, however, between fisheries and pollution (for which the Principle was created) is that the survival of capture fisheries and aquaculture is directly dependent on the state of the environment (including the biodiversity) they exploit. This is not the case for, say, chemical industries dumping sewage into the coastal areas.

The aquatic resources properties, their 'fluid' nature, the quality of the fishery data and the limits of scientific understanding lead to the existence of a certain level of uncertainty on the understanding of the ecosystem and on the scientific advice. This, in turn, implies some level of risk of error in management decisions aiming at maintaining the resources and the environment. The risk cannot be totally eliminated. One can easily assume that in a complex multi-resources and multi-user system the overall level of uncertainty in the parameters and the system itself is so high that a zero-risk strategy would imply no development at all. A strategy hardly viable.

If sustainable use is the objective, in order to produce a continuous flow of goods and services from the living aquatic resources, the Precautionary Principle can only aim at reducing detrimental impacts below some acceptable threshold and not at eliminating them altogether. It follows that the judgement will have to be based on scientific evidence and advice on what levels of impacts are acceptable, taking in due consideration the short- and long-term impacts and their socio-economic as well as ecological implications.

3.2.2 *Assimilative capacity and acceptable levels of impact*

The concept of assimilative capacity of the environment has generated heated debate in environmental protection. This concept implies that nature can absorb a certain quantity of pollution without significant effect. For some industries it is important to estimate the assimilative capacity of the ocean and use it as a resource (i.e. for dumping wastes). According to Hey,[17] the concept also implies that science can determine the assimilative capacity and that management will be efficient enough to prevent negative effects and abuse. She states that this concept depends too much on short-term economic considerations and is not precautionary. One can easily see the concern when the assimilative capacity is defined in terms of radioactive wastes, heavy metals and other non-reversible impacts.

The problem is significantly different with fisheries. Their purpose is to impact the resource and capture part of the natural productivity in

order to extract food and revenues. The resources do have an 'assimilative capacity' in terms of the fishing mortality they can stand. In a way, the Maximum Sustainable Yield could be considered a measure of the maximum assimilative capacity of a stock. The same concept can apply to a multispecies resource and to an ecosystem even though defining and measuring such 'capacity' is not a trivial issue.

As the cause–effect relationship between fishing and the resources is obviously not questioned, the problem lies in (a) the degree of impact that could be allowed (e.g. the assimilative capacity) and (b) the discrimination of fishing impacts from environmental impacts whether natural (normal year-to-year climate fluctuations) or resulting from human activities (degradation and global climate change).

3.2.3 *Standards and criteria*

The Precautionary Principle is not formulated in absolute terms and it offers little guidance on how to apply it in practice. Better quantification and qualification are required and words such as: detrimental, substantial, significant, harmful, unacceptable, which are generally used in the various expressions of the Principle, need a more accurate definition. There is a whole range of degrees in each of these and other terms currently used and one of the major tasks for research and management will be to develop the agreement on standards, criteria and critical thresholds on which to base decisions. Criteria will be needed to face the requirements of management of the diversity of existing ecosystems and resources. Clarification is required, for example, on the concepts of sustainability (in a naturally variable context) and reversibility (for multi-equilibrium systems). Measures of ecological stress will also have to be agreed. The following examples illustrate the difficulty of establishing a set of coherent and credible criteria.

With reference to the issue of by-catch, for example, Miles[15] stressed the danger of setting criteria at excessively high levels, with the risk of crippling national industries beyond what is required to ensure long-term resources conservation, recalling that criteria established for high seas will tend to be proposed also for EEZs. This author cites a paper on driftnets, presented to the United Nations in 1991, and in which an 'efficient harvest' is defined as the one which:

> (a) will ensure as far as practicable that human activities do not result in the decrease of any population of marine species below a level close to what ensures the greatest net annual increment or
> (b) will not catch numbers of either target or non–target species that will result in significant changes in the relationship among any of the key components of the marine ecosystem of which they are part.

The first criterion implies that populations are not decreased beyond their MSY abundance level where their natural turnover is the highest. This is in line with the original UNCLOS requirements and it has been shown, since then, that it is not biologically and economically advisable, in most cases, to extract the Maximum Sustainable Yield. For multi-species fisheries, however, it would require that all species be exploited below their MSY abundance and therefore that the overall level of exploitation be fixed at the lowest level required by the species with the lowest resilience. In a typical Mediterranean multispecies trawl fishery, where long-lived bottom species (e.g. seabreams and red mullets) are targeted together with short-lived pelagic (e.g. sardines), this would imply fishing sardines well below the possible level of harvest in order to meet the criterion for seabreams and mullets. The problem has been recognized in the report of the FAO Expert Consultation on Large Scale Pelagic Driftnet Fishing (FAO[19] para. 74).

The second criterion implies that fishing does not disturb significantly the food chain. There are two problems there. First, the word 'significantly' is subjective and the criterion gives no guidance on the basis of which a food chain disturbance is to be considered 'significant' or not. Second, applying fully the first criterion leads, in practice, to differential fishing, to a change in relative abundances of species and may very well affect the food chain. As a consequence, the second criterion is difficult to use in practice for many fisheries and may not even be coherent with the first one.

It has been proposed respectively to the United Nations General Assembly (cited by Miles[15]) and in the Report on Ecologically Sustainable Development of Fisheries (Australia[20]) that:

> The mortality inflicted on any target or non-target species... is unacceptable if it exceeds the level that would, when combined with other sources of mortality, result in a total level that is not sustainable by the population in the long term.
> As data permits, fish management authorities set target species catch levels in accordance with the requirement that fishing does not exceed ecologically sustainable levels for both target and non-target species...

Taking into account mortalities from all sources when assessing fisheries impacts is a prerequisite (including natural mortality, indirect fishing mortality as by-catch, direct fishing mortality as target, etc.). Estimating drop-out mortality is a very demanding task but assuming it is feasible, a problem remains with the term 'sustainable' in both proposals.

The production model theory says that resources are sustainable (in the sense of being able to regenerate themselves) *at various levels of abundance* depending on the level of harvest. In other words, a stock can reproduce itself, for a long period of time, and be considered therefore sustainable, at high (virgin state), medium (MSY level) and even low level of abundance. As stocks are fished down, their variability and the risk of collapse increases. But, in theory, and in practice, stocks can be said to be sustainable even at fairly low levels. It has been agreed in UNCLOS that stocks should not be exploited beyond their MSY level of abundance and this could be considered a bottom line criterion for stock 'sustainability', remembering, however, that stocks' MSY vary with environment and that, even when abundance is above the MSY level, the risk of collapse is not nil (Laurec[21]).

From an ecosystem point of view, if balance between ecosystem components must be maintained, minimizing by-catch or using extremely selective gears might not be necessarily the best solution (with the proviso that discards be limited to a strict minimum). Garrod[22] suggested that in multispecies management, a reasonable strategy would be to exploit all species proportionally to their abundance in order to maintain the overall structure. More work is certainly required on this matter before objective guidance can be given.

New criteria, not foreseen in UNCLOS, are required if species sustainability is to be ensured at low risk of collapse. They would have to refer to, for example, minimum reproductive biomass, safe biological limits, optimum recruitment levels, maximum statistical probability of ecological or economical collapse, especially in areas of high environmental variability (upwellings) or for particularly low resilience species.

New criteria are also needed for precautionary ecosystem management, related to global stress indicators, resilience factors, habitat conditions, etc. Some of the required principles can be found in the management charter of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) and in the IUCN Strategy for Sustainability:[4]

—minimize conversion of critical ecosystems to 'lower' conditions,
—balance habitat conversion with restoration (not net loss),[23]
—maintain ecological relationships,
—maintain populations at greatest net annual increment,
—restore depleted populations,
—minimize risk of irreversible change in the marine ecosystem, etc.

Genetic conservation criteria, when introduced, will make things

even more complicated as management will have to face conservation requirements at both ecosystem/biodiversity, species and genetic level.

3.2.4 *Improving decision-making process*

In international management, the best principles are useless if the decision-making process leading to their practical implementation is flawed and inefficient. The quality of the decision-making process is also important when criteria and standards have to be agreed on. The following section therefore briefly analyses the issue looking at potential solutions for improvement.

In general, fisheries management agreements implicitly accept that fishing activities which are not explicitly prohibited or subject to regulations may be undertaken freely. Their regulation (including prohibition) requires a particular action to be taken. The necessary decisions are usually taken by consensus between all parties and voting procedures are rarely used, even when they are foreseen by the basic texts. In international fora, the consensus procedure allows agreement only on the 'lowest common denominator' between all parties, gives a de-facto right of veto to the minority and has led to the 'too little, too late' fisheries management. The problem has been stressed by various scholars as a weakness in international fora and the introduction of majority voting procedures would correct this situation.[10,17,24,25]

When the agreement reached is legally binding, parties are given time to object, and if they do so, to opt-out of the procedure because 'no State can be expected to accept limitations on its sovereignty without its consent' even though the opting-out party puts at risk the interests that the others have in virtue of their own sovereignty.[17] The country which does not accept the resulting legal obligation may find it convenient to leave the agreement while continuing to fish in the Convention area. (Alternatively, vessels from a party to the Convention may move under a flag of convenience of a State not party to the Convention in order to avoid the obligation contained in the Convention.) Attempts to make the right to fish in the high seas subject to complying with UNCLOS provisions or to increase flag States liability have, for the moment, met with little success. The idea is progressing slowly, however, and the issue will be specifically addressed during the forthcoming UN Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks (New York, July 1993) recommended by UNCED in June 1992.

The concept of 'people's participation' in national resources management is being voiced and increasingly recognized in international fora and we can safely assume that the public will be more and more associated with and involved in the decision-making process on

environment and development issues. In parallel, it is being proposed that management agencies, research and industry should be explicitly and directly accountable to the public for the state of the resources on which they have been given user-rights.[20,26] In addition, public opinion has been used by environmental protection lobbies for decision-forcing and as a test-board for 'acceptability' of measures, norms or criteria. Actively alerted public opinion has been instrumental, for instance, to force an international moratorium on whaling, an international ban on large-scale pelagic driftnet and a ban on coastal gillnets in California.

3.2.5 *The concept of 'best available technology'*

One requirement of precautionary management or development is to use the 'best available technology' (a parallel to the concept of 'best scientific evidence available'). This requirement has been made in a number of international instruments related to environmental policy.[7,25] This simply means that all that is technologically feasible must be done to prevent the harmful effect and little more can be done to make this requirement more precautionary.[7] The application of the concept usually implies the establishment of 'black' and 'grey' or 'red', 'orange' and 'green' lists of fishing practices.[27] Poison and dynamite (and probably large-scale pelagic driftnets) would be in such a black or red list. As an example, the Convention on the Conservation of European Wildlife and Natural Habitats, Berne, 1979, gives in its annex IV, the list of non-selective gears to be banned, which includes nets in general. (Although relevant in principle for migratory birds, the Berne Convention has been used in Italy in reference to the large-scale pelagic driftnet fishery.)

The potential problem in classifying fishing technologies in such lists is illustrated in Thorne-Miller and Catena[28] (p. 84) who mentions that examples of methods that are contributing to depleting marine living resources include fishing the deep ocean with huge driftnets, operating large vessels able to process huge catches at sea, using aerial spotters and acoustic fish finders to process huge catches at sea, using aerial spotters and acoustic fish finders to locate schools of target fish and using more and more efficient fishing equipment without restrictions on size or location of catch. This shows a total confusion and unjustified amalgamate between the lack of selectivity of some gears and the large catches which are possible on abundant small pelagic species, as well as between fishing efficiency and fishing mortality, forgetting that total effort is what is to be controlled.

The 'best management methodology' would be, following the same rationale, a concept of value. It is unlikely that any management

method would be the best in absolute terms but techniques particularly robust and well-adapted to fragile species or communities, in a particular socio-economic and cultural context, could be given a status as standard.

A criticism of the 'best available fishing technology' concept is that (a) 'best' is defined neither in qualitative nor quantitative terms and (b) the accumulation of 'best technologies' could be the worst thing happening to fish if the total effort is not controlled. The wording assumes a universal value judgement on what is 'best' without providing guidance on the basis for such judgement and the best gear from an extreme ecological point of view may be one that catches nothing. The General Assembly Resolution 44/228 on UNCED refers to 'environmentally sound' technology in a document which, however, stresses abundantly the necessity to take also into account socio-economic values as required by the FAO definition on sustainable development.

3.3 Legal implications

Although General Assembly resolutions are not legally binding, they can have enormous political significance. The consequences of the General Assembly resolutions on large-scale pelagic driftnets gave an example of the potential impact. Although its legal status is that of a recommendation, a UNGA resolution may have an effect wider than that in revealing indirectly what State practice is, or pointing to what States might be willing to accept. The UN Convention on the Law of the Sea is in a similar category pending its entry into force (although it is considered that parts of the Convention (including the fisheries provisions) already constitute customary law even before the entry into force of the Convention), though an obligation to act in accordance with its provisions can be linked to the need for those States which have signed it not to act in a manner contrary to its objects and purposes (Vienna Convention on the Law of Treaties, Art. 18).

These points do not, however, elevate the Precautionary Principle to a legal requirement in its own right and Nollkaemper[7] indicates that, for the time being, the Precautionary Principle is no more than a non-binding norm, operating within the framework of particular agreements. Hey,[17] however, argues that the Principle 'may be on its way to becoming part of customary international law'.

The Precautionary Principle might, however, be invoked in fisheries conservation issues as a factor, indeed a very important factor, in negotiations between States to establish conservation measures in circumstances where there is an obligation to negotiate in good faith to

reach agreement, e.g. with respect to straddling stocks under UNCLOS or with respect to high seas fishing under article 119. Given the wide support of the Principle in the world community, a State or a party which refers objectively to it, directly or indirectly, most probably hopes that it cannot be accused of bad faith. The above discussions on the Principle show, however, that it may easily lead to abuse.

4 IMPLEMENTATION OF PRECAUTIONARY APPROACHES

4.1 Existing precautionary approaches

Precautionary approaches for fisheries management have long been advocated even though they have rarely been applied in practice. Preventive (proactive) management has been recommended in order to avoid crisis and higher costs in the future.

This included: (1) step-wise development with impact monitoring as opposed to massive development with no accompanying research; (2) early effort limitations instead of laissez-faire investment strategies which lead to overfishing; (3) design of institutional or financial 'brakes' to avoid 'explosive' development; (4) prior authorization for ordering new vessels or borrowing money for them; (5) precautionary quotas for species for which proper assessments are not available; (6) using 'pessimistic models' (e.g. the Schaefer production model instead of the Fox model or yield-per-recruit models) for stocks where low resilience is suspected; (7) recommendations for multispecies management; (8) recommendations for 'experimental management' to test systems response;[5] (9) recommendations of development targets below the Maximum Sustainable Yield (MSY) e.g. $F_{0.1}$, $F_{2/3}$, F_{MSY}; (10) adoption of the concept of 'safe biological limits'; (11) modelling systems response across the whole uncertainty range;[29] (12) agreement on cautious management thresholds (e.g. minimum spawning biomass) and course of action before crisis occurs.[30]

The poor state of the fisheries resources in many areas indicate that despite their potential availability, such measures have not been adopted widely or successfully implemented. Ways must therefore be found to strengthen existing precautionary approaches.

In case of doubt as to the effect on the marine environment and resources, preventive or remedial action would have to be taken, decision erring on the safe side. For example, the General Assembly

Resolution 44/225 on large-scale pelagic driftnet fishing recommended immediate action in the absence of scientific consensus. The generalization of the approach would imply that 'the prohibition of a disputed fishing technique is in order even in the absence of scientific information demonstrating its harmfulness until its harmlessness has been demonstrated' (freely translated from the original, in French)[31] (p. 637). Although the usefulness of this approach can be easily seen in case of very high risk, its ordinary application for everyday fisheries management could very quickly discredit the Principle itself.

Paying lip service to the Principle will not satisfy the growing international pressure for more environmentally-friendly technologies and development. As Hey[25] rightly stresses, what is new in the Precautionary Principle is not so much the implied measures themselves but the way in which such measures are to be implemented (i.e. stringently) and the time at which they are implemented ('as soon as a detrimental effect... becomes plausible'). A precautionary fisheries management policy may combine a variety of approaches and regulatory tools as follows:

—*Adopting the sustainable development principle* as defined by the FAO Conference. Specific and shorter-term objectives would have to be broadly compatible with it. Hey[17] argues that not linking explicitly environment and development would be contrary to the precautionary approach.

—*Adopting the principle of precautionary management.* This would entail adopting a preventive management approach and the measures listed below. The degree of 'precaution' (e.g. the amount of constraint and the degree of stringency) would be negotiated on a case-by-case basis, for each agreement or convention.

—*Using the 'best scientific evidence available'*. In most cases fisheries impacts are progressive and reversible leading to small risk. There should therefore be time available to collect data and build up scientific consensus at least on the level of uncertainty. All fisheries should be covered by an information system, the complexity and cost of which should be commensurate with the level of risk, e.g. higher for long-lived species (mammals, sharks, etc.) and in highly unstable resources systems, e.g. small pelagic stocks in upwelling areas.

—*Adopting a broader range of management benchmarks* and reference points more directly related to reproduction capacity (safe biological limits, minimum spawning biomass, etc.). In particular, using such reproductive capacity as the system status indicator and explicit management target.

—*Developing a set of criteria* to be used when assessing present or

potential impacts of developments. These criteria would take into account, *inter alia*, the potential degree of impact on the reproduction capacity of the target and non-target species, the level of risk to the stock and associated species caused by the combination of fishing and environment variability, the degree of reversibility of the observed or forecasted impacts. In particular, criteria will be needed for ecosystem management and acceptable degrees of ecosystem disturbance for the various types of ecosystems presently exploited.

—*Taking a risk-averse stand*: assessing the degree of risk created by ongoing fishing activities; establishing maximum rates of exploitation, based on acceptable levels of impacts; requiring an environmental impact assessment before authorizing any increase of fishing intensity beyond such rates; requiring prior environmental assessment before opening a new fishery (as required by some pressure groups) implies that all resources are put under a management scheme of various degrees of stringency and sophistication, without exception. Such risk can, in theory, be assessed by simulation of management systems as already done for the management of whales[29] but the degree of complexity will increase drastically for multispecies and ecosystem management and with the inclusion of socio-economic considerations.

—*Agreeing on acceptable levels of impacts* (and risk). They will never be nil and their 'acceptability' will be influenced by cultural, historical and socio-economic conditions. Different pressure groups, with different interests, will disagree on the degree of risk which is 'acceptable'. Negotiations between interest groups, and within an appropriate institutional and legislative framework will be necessary. Without them, the degree of compliance will be low, raising the related costs of enforcement beyond acceptable levels. The bargaining that characterized past management practices will therefore still be necessary. The difference and strength of the new approach is that the process would be more formalized and trade-offs more explicit and transparent to public opinion.

—*Basing management decisions on combined stresses* on resources and environment. This implies that effort reductions or special measures affecting fisheries will be taken when the stock will face unusually unfavourable environmental conditions. One implication that would prevent fishermen from being penalized by environmental degradation from other human activities is to insert fisheries in the context of coastal integrated management.

—*Improving management response time* by adopting 'action-triggering levels' for status variables (e.g. reproductive capacity, risk level) at which action will immediately be taken by management in

pre-defined directions agreed beforehand. This would particularly be required for highly variable resources such as small pelagic species in upwelling systems and for depleted resources in a process of rebuilding and confronted with environmental variability.

—*Improving participation of 'non-fishery users'* in fisheries management bodies as a way to open a more constructive dialogue and take all interests into account when developing and managing fisheries. This requires more 'transparency' in fisheries management and better reporting procedures on status of stocks to the public.

—*Improving decision-making procedures* by introducing voting procedures or using them when they already exist.

—*Introducing prior consultation procedures* for fishing activities listed in the 'grey' or 'orange' list. This would require that States proposing to introduce such activity present a report, comparable to an EIA report for comments. Hey[25] warns, however, of the paperwork that might be involved if such procedures are used too often and suggests limiting the procedure to activities for which phasing out has been decided and to request an annual report during the phasing out period.

—*Strengthening monitoring, control and surveillance* and raising penalties to deterrent levels.

The type of action and the degree of urgency required must be a function of the probability of occurrence of a certain type of impact of a certain magnitude. Decisions are comparatively easy when risks are extremely high. Proposing to prohibit, even without any scientific background, the use of explosives to fish in the high seas would probably not meet with much international opposition as harmful fisheries techniques (dynamite, poison) are normally banned in all national fisheries legislation. However, deciding whether a 5% by-catch of sharks in a longline tuna fishery is acceptable or not will require more careful consideration.

More stringent measures could and would probably be advocated by extremists as necessary for the implementation of a precautionary approach but that would probably be considered unrealistic from both the technical, socio-economic and political points of view. Nollkaemper[7] states that a strict interpretation of the Principle would render it meaningless in practice. In fisheries, extreme measures would include, for instance:

—banning of all activities which affect negatively the environment (implying the closing down of all fisheries),
—requiring proof of harmlessness before starting any fishery, a requirement obviously impossible to meet,

—requesting that the most advanced techniques be systematically applied by all member States.

5 CONCLUSION AND DISCUSSION

Many environmentalists are beginning to understand 'and stress the need for managing the combination of natural and socio-economic systems, but it is not clear that they have reached the point of cost-benefit analysis or widely adopted a problem-solving approach in a social milieu'.[33] On the other hand, industry must also start to understand that the spiral of short-term economic and social problems created by a lack of control, the rates of harvest and the pursuit of short-term economic goals cannot continue to justify the erosion of the resources and the environment at the expense of the present and future generations.

The Precautionary Principle appears both as a golden opportunity for better management and a threat to fisheries industries; as part of a safeguard of the opportunities of future generations and as a potential source of inequity for those of today. It is therefore important that misunderstanding and extremism are avoided. The problem should not be expressed in terms of a drastic choice between a standpoint of extreme ecological conservationism and one of total liberalism (terminology taken and freely translated from Savin[31]). Between these two unrealistic extremes lies an area of possibilities and opportunities for mankind, requiring balance, dialogue and mutual understanding, as well as significant changes in decision-making and legal frameworks.

UNCLOS already imposed the concepts of MSY and optimum utilization and referred to the need to take into account the reproductive needs of species associated with or dependent upon harvested species. It did not impose on coastal States the heavy burden of proof before action could be taken even if it did not give much guidance on how to build consensus (apart from broadly referring to cooperation) and how to act if consensus could not be reached. This and the fact that precautionary techniques have always been available in the fisheries management tool-box lead us to conclude, with Nollkaemper[7] and Hey,[25] that the direction of the methods required under the Precautionary Principle is not a new one.

Instead of introducing a fundamental change, the Precautionary Principle follows and stresses the trend towards more environmental

concern already expressed, for instance, in the FAO Technical Conference on Fisheries in Vancouver (Canada) in 1973[34] and in the FAO World Conference on Fisheries Development and Management, Rome, 1984. It puts the focus more clearly on uncertainty and related hidden costs of present decisions for future generations. It is promoted as a means to ensure inter-generational equity but, if incorrectly applied, is an attempt to re-allocate resources to non-consumptive users, often without much reference or concern towards intra-generational equity or scientific objectivity.

The Principle underlines a growing consensus on the approaches to be taken. Its implicit extension to fisheries emphasizes the growing awareness that fisheries management cannot be seen in isolation and must fit an integrated context which satisfies the requirement for long-term resources sustainability and environmental conservation. The trend is particularly striking in the coastal areas where the concept of Integrated Coastal Areas Management and Development (ICAM) is developing extremely rapidly. The psychological importance of coining a new term should not be underestimated and, as Nollkaempfer[7] points out, if this term is perceived by policy-makers as carrying with it the feeling of urgency and of the need to take drastic preventive measures, it may be effective where traditional jargon failed.

No matter how irritating environmental constraints may be, a responsible approach is required for at least two good reasons. First, it is required for the long-term survival of the economic activity. Second, taking the USA as an example, commercial fishermen represent 1% of the voters while recreational fishermen represent 20% of the voters.[33] The 'public' pressure, triggered by environmental (or pseudo-environmental) considerations could therefore lead to actual shifts in resources allocation to user-groups considered, rightly or wrongly, as environmentally safer. It is important to stress here, with Miles[15] and Sumi[95] that the principles and criteria adopted to solve the high seas problems will, most probably, end up also in national law inside EEZS.

Following the recommendation of its member countries, FAO will develop guidelines for Responsible Fishing. The International Conference on Responsible Fishing (Cancún, Mexico, May 1992), organized by Mexico in close consultation with FAO, recognized the need for such a comprehensive and balanced concept of sustainable utilization of fisheries resources in harmony with the environment. The concept intends to promote fishery practices compatible with the requirements of ecosystems, ocean resources and consumers (food quality) and the guidelines needed for its implementation will have to give due consideration to the need for precautionary approaches.

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