DRAFT GUIDELINES FOR THE PRACTICAL IMPLEMENTATION OF THE PRECAUTIONARY APPROACH TO FISHERIES MANAGEMENT

(including reference to species introductions)[1]

by S.M. Garcia
Fishery Resources Division
FAO Fisheries Department
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OUTLINE

conservation and management of straddling fish stocks and highly migratory fish stocks. (A/CONF.164/22/Rev.1)

ANNEX 5: Report of the working group on reference points for fisheries management (A/CONF.164/Wp.2 of 24.3.1994)

ANNEX 6: Report of the Working Group on Reference Points for Fisheries Management

SUMMARY (To be revised)

1 The present status of many fishery resources around the world indicates that management practices need to be improved. An acceleration of the process of evolution of fisheries management and a broadening of its scope are required to take fully into account both the explicit requirements of the 1982 United Nations Convention on the Law of the Sea, of the UNCED Agenda 21, the Convention on Biological Diversity, and of the FAO Code of Conduct for Responsible Fisheries.

2 The uncertainty and risk resulting from the limitations in fisheries management systems and scientific information, as well as natural variability (including climate change) is progressively being recognized and taken into account. A global trend is developing in favour of the concept of precaution, which should now also be considered for implementation in fisheries management.

3 The concept of precaution requires management authorities to take pre-emptive action where there is a risk of severe and irreversible damage to human beings and, by extension, to the resources and the environment, even in the absence of certainty about the impact or the causal relationships. When there is doubt about the effect of a technology or fishing practice on the marine environment and resources, preventive action would have to be taken, erring on the safe side, with due consideration to the social and economic consequences.

4 The need for precaution in management is reflected in the precautionary principle and the precautionary approach for which no clear definition exists and which are usually define by the type of action they imply. The precautionary principle has suffered from this lack of definition, slack usage, extreme interpretations leading to moratoriums, and lack of consideration of the economic and social costs of its application. It has therefore developed a strong negative undertone.

5 The precautionary approach, has not been better defined, but has been more closely associated with the concept of sustainable development, recognizing that the diversity of ecological and socio-economic situations each may require different strategies. This concept has therefore a more acceptable "image" in the various development and management sectors and is considered more readily applicable to fisheries management.

6 Precautionary management measures have often been advocated in the past but they have rarely been implemented because of their potential short-term costs. On the one hand, they are needed to improve fisheries management and ensure more sustainable fisheries development, reducing risks for the resources and for fishing communities. For this purpose it is recommended to use more precautionary management reference points than in the past. On the other hand, it is recognized that overly stringent measures could lead to economic and social chaos in fishing and related industries and communities.

7 The requirement laid down in the Convention on the Law of the Sea for the "best scientific evidence available" remains the first condition for effective and equitable management and the concept of precaution does not exempt fishing States and management authorities from their responsibilities to build up the necessary scientific information and cooperation. The best scientific evidence could be viewed as the most statistically sound evidence.

8 In a situation of high potential risk and lack or inadequacy of information, the concept of precaution requires that the onus of scientific proof (e.g., in the form of an environmental impact assessment) be on those who intend to draw benefits from the resource and contend that there is no risk (reversal of the burden of proof). The necessity of this approach is recognized together with the need for equity in its application.

9 The precautionary approach propounds to use caution in all aspects of fishery activities: in applied fishery research, in management and in development. It is translated into a "tool-box" of precautionary strategies and measures among which appropriate ones can be selected for different situations. It would be consistent with the internationally agreed principles of sustainable development and those of responsible fisheries and would, inter alia:

-Promote the collection and use of the best scientific evidence;
-Adopt a broad range of reference points;
-Agree on a set of rules and guidelines;
-Adopt action-triggering thresholds and pre-agree courses of action;
-Agree on acceptable (tolerable) levels of impact and risk;
-Improve impact assessment and evaluation of measures;
-Improve participation of non-fishery users;
-Improve decision-making procedures;
-Promote the use of more responsible technology;
-Introduce prior consent or prior consultation procedures;
-Strengthen monitoring, control and surveillance;
-Adopt experimental management and development strategies;
-Institutionalize transparency and accountability;
-Re-establish natural feedback controls.

INTRODUCTION.

10 There is an obvious link between sustainable development and precautionary management. In 1988, the 94th session of the FAO Council adopted the following definition:

> *"Sustainable development is the management and conservation of the natural resource base, and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such development conserves land, water, plant genetic resources, is environmentally non-degrading, technologically appropriate, economically viable and socially acceptable."*

11 The strategies required to ensure a high degree of sustainability in human use of natural renewable resources systems are not easy to conceive and implement for at least two reasons: (a) Our insufficient understanding of the laws governing these systems and the inherent uncertainty about the consequences our decisions; and (b) the inadequate nature of our institutions and controls (Holling ????)

12 This definition applies well to sustainable fisheries development and management. However, The review of the state of world fishery resources undertaken by FAO and the global analysis available in the FAO report on the State of Food and Agriculture (SOFA) show that, although management practice has favourably evolved during the last half century, it has tended to lag behind management theory and that progress towards sustainability, since the first FAO Technical Committee on Fisheries in 1945, has been insufficient.

13 It is generally agreed that the inadequacy in management results essentially from the common property nature of the resources and the lack of effective mechanisms to directly control fishing effort levels in the absence of an explicit agreement on the allocation of resources between users. It is also being realized that, in addition, the problem lies partly in the non-recognition of the high levels of uncertainty that characterize fisheries and the related lack of precaution in most management regimes.

14 It is now recognized that the biomass of many important fish stocks is close to or even below the level that could produce the maximum sustainable yield (MSY), leading to resource instability and economic losses. A number of fisheries have collapsed ecologically or economically and the situation in the high seas raises particular concern. In many areas, the present situation is one of resource erosion, economic losses and social dislocations that illustrate the fisheries management risk and reflect behaviour which in the last decades has been neither sufficiently responsible nor precautionary (Garcia, 1992; FAO, 1993; Garcia and Newton, 1994; 1995).

15 The increased recognition that conventional fishery management needed to be improved has been accompanied by a growing concern for environmental management, particularly as a result of the World Conference on Human Environment (Stockholm, 1972), the FAO Technical Conference on Fishery Development and Management (Vancouver, 1973), the FAO World Conference on Fisheries Management and Development (Rome, 1984), the United Nations Convention on the Law of the Sea (hereafter, the 1982 Convention), the work of the Brundtland Commission from 1984 to 1987 (World

Commission on Environment and Development, 1987), the United Nations Conference on Environment and Development (Rio de Janeiro, 1992), the International Conference on Responsible Fishing (Cancun, Mexico, 1992) and the UN Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks (New York, USA, 1993-1995).

16 Moreover, the emerging awareness of the complexity of marine ecosystems and related scientific uncertainty, particularly in the high seas, and of the risk of error in management requires an acceleration of the evolution of fishery management, a broadening of its scope and a change in attitudes. Two important and related requirements of the new management context are the need for more caution and for better inter-generational equity. The latter issue concerns the ethics of renewable resource use and the moral obligation placed on the current generation to exploit the resources and enact conservation measures in such a manner as to preserve options for future generations.

17 In natural ecosystems, the abundance preys and predators and their variations are controlled and maintained within limits compatible with the ecosystems sustainability by a set of complex interactions and feed-back mechanisms. In ecological terms, fisheries are organized predators. As such, their survival depends on the survival of their living resources and they are far more sensitive to natural feedback information on the state of the resources they exploit than industrial systems using oceans as a waste dumping area.

18 However, contrary to natural predators, fishermen are not entirely controlled by feedback signals of resource stress. Their operations are not totally dependent on the abundance of the various elements of the resource ecosystem and, indeed, are partly protected from such feedback controls by various mechanisms such as price increases (as resources become scarcer), technological improvements in efficiency, shifts to other species or areas, and governmental subsidies. They can therefore continue and even expand their operations despite the environmental and resource degradation they may produce.

19 Section 1 of the document provides some definitions of key concepts used in the document. Section 2 provides with an updated review of trends and perspectives in the development of the principle of precautionary action. Section 3 reviews some of the main issues related to the necessary impact of fisheries and the sources of uncertainty and types of error that can result from it. Sections 4, 5 and 6, describe the implications of the precautionary approach and provide practical guidance for its application in the respective areas of research, technology development and transfer, and conservation and management.

Purpose of the guidelines.

20 In developing the International Code of Conduct for Responsible Fisheries, FAO member countries have adopted the concept of precautionary approach to fisheries, regardless of their jurisdictional nature. These guidelines intend to:

(a) raise awareness of the users of the Code by providing them with sufficient background information on the main issues and trends, and

(b) provide practical guidance to the users of the Code of Conduct for the

application of a precautionary approach to fisheries.

1. OBJECTIVES OF THE PRECAUTIONARY APPROACH

21 The **concept of precautionary action** aims generally at improving conservation of the environment and the resources by reducing the risk of inadvertently damaging them. More specifically, it aims at helping decision-makers and regulators to take a safegarding decision, when the scientific work in inconclusive but a course of action has to be choosen

22 In addition, it intends to promote a more equitable balance between the short-term considerations _ which led to the present environmental degradation and overfishing _ and considerations of a longer-term nature such as the need to conserve resources for future generations, promoting inter-generational equity by reducing the cost of our decisions to future generations, and counteracting the effects of current high economic discount rates (which provide a strong incentive to overfish, maximizing the discounted net benefits from a stock and de facto preferring present consumption over future consumption[23]).

23 The concept of precautionary action will also benefit directly present generations of fishers and consumers if fishery authorities and industry actively promote its implementation by other economic sectors whose activities damage ocean productivity, fishing communities' livelihood and consumers' health[4].

24 There must be a clear link between the objectives generally assigned to a fishery (as reflected for instance in the target reference points) and the particular objectives of the precautionary approach within that fishery (as reflected for instance in the limit and threshold reference points).

2. DEFINITIONS

25 **Acceptable impact**: A negative, or potentially negative, alteration of the exploited natural system, resulting from human activities (i.e. fisheries and other impacting industries), the level and nature of which is considered as representing a low risk for the resource, system productivity, or biodiversity, on the basis of the available knowledge and level of uncertainty.

26 **Approach**: "*The act of approaching. A way and means of reaching something. The method used in dealing with or accomplishing something*".

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[2]This factor often leads to proposals to introduce a social discount rate. However, there are severe practical difficulties in determining such rates and implementing them. A more satisfactory solution would appear to be through proper pricing of resources, including not only the marginal cost of harvesting, but also the foregone value of catches no longer available to future generations.

[3]By comparison, and despite the fact that it theoretically aims at sustainability, conventional fishery management addresses primarily, and rather inefficiently, the issue of intra-generational equity and allocation of resources between present users.

[4]Opportunity to promote this approach is given by the growing requirement to integrate coastal fisheries management into the Integrated Coastal Areas Management (ICAM) within which inter-sectoral competition for resources should be organized and controlled.

27 **Precaution**: The Shorter Oxford English Dictionary defines precaution as *"caution exercised beforehand to provide against mischief or secure good results. Prudent foresight. A measure taken to ward off an evil."* In environmental management, the meaning generally given to precaution is that of acting in advance to avoid or minimize negative impact, taking into account the potential consequences of being wrong.

28 **Precautionary**: *"Of, relating to, or constituting a precaution".*

29 **Principle**: *"A basic truth, an assumption. A rule or standard, especially of good behaviour. A fixed or predetermined policy or mode of action".*

30 **Management Reference points**: According to the *ad hoc* Working Group on Reference Points established by the UN Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks in New York, in March 1994 (cf. Annex ...), *"a reference point is an estimated value derived from an agreed scientific procedure and an agreed model to which corresponds a state of the resource and of the fishery and which can be used as a guide for fisheries management."*

Limit Reference Points (LRPs): A Limit Reference Point (LRP) indicates a state of a fishery and /or a resource which is not considered desirable. Fishery development should be stopped before reaching it. If a LRP is inadvertently reached, management action should severely curtailed or stop fishery development, as appropriate, and corrective action should be taken. Stock rehabilitation programmes should consider an LRP as a very minimum rebuilding target to be reached before the rebuilding measures are relaxed or the fishery is re-opened.

Target Reference Points (TRPs): A Target Reference Point (TRP) corresponds to a state of a fishery and/or a resource which is considered desirable. Management action, whether during a fishery development or stock rebuilding process, should aim it and at maintaining the fishery system at its level, on average.

Threshold Reference Points (ThRPs): A Threshold Reference Point (ThRP) indicates that the state of a fishery and/or a resource is approaching a TRP or a LRP, and at which a certain type of action (usually agreed beforehand) needs to be taken. Fairly similar to LRPs in their utility, the ThRPs' specific purpose is to provide an early warning, reducing further the risk that the TRP or LRP is inadvertently passed due to uncertainty in the available information or to the inertia of the management and industry systems. Adding precaution to the management set-up, they might be necessary only for resources or situations involving particularly high risk.

31 **Risk**: The American Heritage Dictionary of the English Language (3rd Edition, 1992) defines risk as *"the possibility (probability) of suffering harm or loss; danger. A factor, thing, element, or course involving uncertain danger, a hazard".*

32 **Uncertainty**: *"The condition of being uncertain. Doubt. Something uncertain. In statistics, the estimated amount or percentage by which an observed or calculated value may differ from the true value".*

3. TRENDS AND PERSPECTIVES

33 In fisheries, the concept of precautionary action seem to have become an important factor in negotiations between States to establish management measures in circumstances where there is an obligation to negotiate in good faith to reach agreement (e.g., with respect to highly migratory, straddling or shared fish stocks, under the 1982 Convention). It can be assumed that, given the wide support for this concept in environmental law, a State which refers objectively to it will hope that it cannot be accused of bad faith (Burke, 1991).

34 In fisheries, the concept of precaution has been expressed as "the **precautionary principle**" (hereafter, the principle) or "the **precautionary approach**". Although the two terms relate equally well to the concept of caution in management, and sometimes not differenciated by scholars (e.g. Bodansky (1991) uses the two terms alternatively), they are differently perceived by international lawyers, negociators and industry.

35 The term "precautionary principle" has developed a negative undertone because of slack usage. Radically interpreted, it has sometimes led to an outright ban of a technology (e.g. in the case of whaling (Bodansky, 1991) and the Large Scale pelagic Driftnet Fishing) and is sometimes considered incompatible with the concept of sustainable use. It remains contentious both within the scientific community and from the point of view of policy-makers and these controversies are illustrated in the fact that there is, as yet, no generally accepted formulation of the principle (Dethlefsen *et al.*, 1993)

36 The term "precautionary approach" is apparently more generally accepted because it implies more flexibility, admitting the possibility of adapting technology and measures to socio-economic conditions, consistent with the requirement for sustainability. It is particularly appropriate for fisheries because consequences of errors in their development or mismanagement are unlikely to threaten the future of humanity and, in most cases, are reversible.

37 These two related concepts are sometimes difficult to distinguish and are further elaborated on below.

3.1 The precautionary principle

38 This principle's most characteristic attributes are that: (a) It requires authorities to take preventive action when there is a risk of severe and irreversible damage to human beings; (b) Action is required even in the absence of certainty about the damage and without having to wait for full scientific proof of the cause-effect relationship; and (c) When there is disagreement on the need to take action, the burden of providing the proof is reversed and placed on those who contend that the activity has or will have no impact.

39 It seems generally agreed that the precautionary principle has originated in Germany as the "Vorsorgenprinzip" (Dethlefsen *et al.* 1993). The principle has been referred to and applied at the national level in relation to human activities with potentially severe effects on human health (engineering, the pharmaceutical and chemical industries, nuclear power plants, etc.).

40 In international environmental law, the principle has emerged as a recognition of:

(a) the uncertainty involved in measuring the impact of toxic substance on the ecosystem and the human health, and (b) deciding on the "assimilative capacity" of such ecosystems (i.e. their ability to absorb a certain quantity of the substance in question without unacceptable impacts).

41 In the 1970s, following the 1972 Stockholm Conference, concern for human safety was progressively extended to the human environment and to other species. This led to increasingly frequent reference to the principle in international agreements and conventions, often with limited analysis of its practical implications.

42 It has been introduced at international level at the First International Conference on the Protection of the North Sea (1984) in relation to persistent toxic substances susceptible to bioaccumulation in the marine ecosystem. The 1987 Declaration of this Conference contains an example of the concept of precaution in relation to coastal States' jurisdiction, habitats, species and fisheries, including pollution from ships. It provides that:

> *"States accept the principle of safeguarding the marine ecosystem by reducing dangerous substances, 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 substances and technologies, even where there is no scientific evidence to prove a causal link between practices and effects."*

43 The scope of application of the precautionary principle was successively broadened from persistent toxic substances to all synthetic persistent substances, natural substances released in large quantities (e.g. nutrients responsible for eutrophication) and finally to all emissions responsible for global warming (Dethlefsen *et al.*, 1993).

44 The principle has been invoked in issues related to the ozone layer (1985 Vienna Convention for the Protection of the Ozone Layer, and 1987 Montreal Protocol on Substances that Deplete the Ozone Layer) where States agreed to reduce emissions of certain substance at a time when the causal links had not yet been firmly established (Boelaert-Suominen and Cullinan, 1994).

45 It has also ben referred to in relation to the greenhouse effect and the conservation of nature. It has touched indirectly on fisheries through provisions in the international conventions on dumping at sea (the Paris and Oslo Conventions, Marpol) relating to pollution by fishing vessels.

46 The 1991 International Conference on an Agenda of Science for Environment and Development into the 21st Century (ASCEND 21) referred to the principle, stressing *"the central importance of the precautionary principle according to which any disturbance of an inadequately understood system as complex as the Earth system should be avoided"*. Broadus (1992) asked whether that meant "any disturbance" and at "any cost" indicating that the principle was not a principle but a range of more-or-less rethorical prescriptions for choice in front of uncertainty.

47 It has also been considered as particularly appropriate in the context of Integrated

Coastal Areas Management (Boelaert-Suominen and Cullinan, 1994) because of the vulnerability of coastal resources, the likelihood of swift and irreparable harm, and the incomplete understanding available on the complex webb of interconnected biological processes in the coastal area.

48 Recently, the precautionary principle has also implicitely been included in the Convention on Biological Diversity (UNEP, 1992) which noted, in its preamble

> *"That, where there is a threat of significant reduction or loss of biological diversity, lack of full scientific certainty should not be used as a reason for postponing measures to avoid or minimizing such a threat."*

The large-scale pelagic driftnet issue

49 The UN General Assembly resolution 44/225 of 22 December 1989, on large-scale pelagic driftnet fishing and its impact on the living marine resources of the world's oceans and seas, could be considered a case of radical application of the concept of precaution, despite the lack of explicit reference to the principle.

50 The resolution expressed concern about the size of the fleets, the length of the nets, their mode of operation, their potential impact on anadromous and highly migratory species, their by-catch and the concern of coastal countries on the state of resources close to their exclusive economic zones.

51 It recommended that a worldwide moratorium should be imposed on all driftnet fishing by 30 June 1992 and it established a set of immediate and regionally tailored interim measures. It also provided that such measures would not be imposed in a region or, if implemented, could be lifted, should effective conservation and management measures be taken upon *statistically sound analysis* to be made jointly by concerned parties. The proposal is rational but the flaws in the process followed for the implementation of the resolution have been underlined (Miles, 1992, 1993; Burke, Freeberg and Miles, 1993).

52 The consequences of this resolution, after heated international debate and political pressure, has lead to the discontinuation of the issuance of fishing licences and research for alternative fishing techniques, in Japan and Taiwan (Province of China); the docking and conversion of driftnet fishing vessels in the Republic of Korea; and a regulation by the European Union (see below). Large scale driftnet fishing stopped in the South Pacific in 1993-93 but some fishing continued in the Mediterranean and Gulf of Biscay, where scientific experiments were conducted to assess the fishery's impact on the associated small cetaceans. Many other Mediterranean countries, however, have taken regulations prohibiting driftnet fishing in their waters.

53 On 27/1/1992, the European Community adopted a Council Regulation (N° 345/92) limiting to 2.5 kilometres the length of the driftnets authorized, but granting a derogation to 5.00 kilometres, until 31 December 1993, to vessels having fished for at least three years preceding the entry into force of the regulation. This derogation was to expire by the indicated date unless scientific evidence showed the absence of "*any ecological risk*".

UNCLOS and the precautionary principle

54 There is no explicit reference to the principle in the 1982 Convention. Part XII, on "Protection and preservation of the marine environment", does not contain detailed instruments for implementation of the conservation of the marine ecosystem, but it does state in a global instrument, in article 192, the following general obligation: "*States have the obligation to protect and preserve the marine environment*" (Burke, 1991). In addition, ecosystem conservation also requires measures for the fisheries sector, striking a balance between the provisions for environmental conservation and fisheries management to ensure sustainable exploitation.

3.2 The precautionary approach

55 In the early 1990s, the precautionary approach has been progressively more accepted and its field of application has been broadened to include the management of natural renewable resources, including fisheries. The aims of the precautionary approach are similar to those of the precautionary principle from which the approach is sometimes difficult to distinguish.

56 The main difference between the principle and the approach might be that the latter considers explicitly the social and economic implications of its application in order to ensure that: (a) it does not lead to imbalance in favour of non-fishery uses and future generations with undue strain on present generations and the fishery sector; and (b) that unavoidable sort-terms costs to the fishery sector are mitigated and equitably shared.

57 The main difference between fisheries and chemical polluting industries (for the control of which the precautionary principle was created) is that:

(a) the assimilative capacity in relation to fisheries impact (i.e. the quantities of fish that can be removed without damaging the system's productivity) exists without doubt and can be determined with some accuracy;

(b) the impacts are, in most cases, reversible, and as a result, the potential consequences of an error would rarely be dramatic, even though they can be significant in socio-economic terms.

58 The various interlinked processes that lead to the widespread adoption of the precautionary approach in fisheries, are briefly described below.

The Unced process

59 UNCED stressed the need for a precautionary approach to ocean development in its Rio Declaration and in Agenda 21, particularly in its chapters on the management of coastal areas, resources under national jurisdiction and high seas resources.

60 The principle 15 of the Declaration states that:

"In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall be not used as a reason

for postponing cost-effective measures to prevent environmental degradation."

61 The wording, largely similar to that of the principle, is subtly different in that: (1) it recognizes that there may be differences in local capabilities to apply the approach, and (2) it calls for cost-effectiveness in applying the approach, e.g. taking economic and social costs into account.

The FAO process

62 FAO, through its European Inland Fisheries Advisory Commission (EIFAC) (check), collaborated with the International Council for the Exploration of the Sea (ICES) in the development of ICES/EIFAC Codes of Practice and Manual of Procedures for Consideration of Introduction and Transfers of Marine and Freswater organisms (Turner, 1988)[5]. This Code stresses that, in a context of rapidly changing population pressures, the impact of the introduction of species to enhance the potential of sustainable fisheries should be examined in the light of the likely impacts of alternative development strategies, involving environmental degradation and likely to result in changes in species composition of both the terrestrial and aquatic ecosystems.

63 In a review of the FAO programme in marine fisheries management, Garcia (1992a) identified some of the challenges to be face by fisheries in the period 1993-2000. These included: the uncertainty in the scientific information, the need for a more precautionary approach to management, the problem of the burden of proof, and the need to define "acceptable" levels of impact.

64 At the 1992 FAO Technical Consultation on High Seas Fishing, Garcia (1992b) stressed the uncertainty in the "best scientific evidence available" for management and drew the attention on the issues of precaution and burden of proof, the non-precautionary nature of the traditional MSY reference point, and the need for more and different reference points to be used as a basis for more precautionary management strategies.

65 The Consultation provided guidance to the Fisheries Department of FAO on how to proceed (FAO, 1992) and, *inter alia,* agreed that:

* fisheries should be managed in a cautious manner;
* precaution did not necessarily require a moratorium on fishing;
* there was a need to identify methods to handle uncertainties
* the objective was to safeguard both people's livelihood and biodiversity;
* existing precautionary measures should be included in the Code of Conduct;
* precautionary measures should be based on science and not be discriminatory;
* measures should be revised or revoked when new information became available.

66 The International Conference on Responsible Fishing (Mexico, 6-8 May 1992), organized in close cooperation with FAO, defined the concept of Responsible Fishing as encompassing *" the sustainable utilization of fishery resources in harmony with the*

[5]A full scale practical application of this Code has been undertaken by FAO in Papua New Guinea (Coates, 1994), starting from the premises that introductions of new species in an aquatic ecosystem should be subject to prior evaluation, irrespective of whether species are "exotic" or not.

environment; the use of capture and aquaculture practices which are not harmful to ecosystems, resources or their quality; the incorporation of added value to such products through transformation processes meeting the required sanitary standards; the conduct of commercial practices so as to provide consumers access to good quality products". The Cancun Declaration contains a fairly complete prescription for modern fishery management covering environmental impacts; multispecies by-catch and discards issues; effort control requirements; etc, but did not include any explicit reference to the precautionary approach.

67 One year later, however, the Inter-American Conference on Responsible Fishing (Mexico City, 1993) referred to the need to take precaution into account in the Code of Conduct on Responsible Fishing, to be prepared by FAO.

68 In 1993, the review of the state of highly migratory species and straddling stocks, prepared by FAO at the request of the UN Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks indicated that it was necessary "*to analyse the potential role and agree on possible ways of implementing cautious management approaches compatible with sustainable fisheries*" (FAO, 1994, page 65).

69 A first attempt to analyse in detail the various implications of the concept of precautionary action in fisheries research, management and development, was made by Garcia (1994). A draft of this paper was used as a basis for the preparation of a document requested to FAO, in July 1993, by the United Nations Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks (2nd Session). The document was presented to the United nations Conference at its meeting of March 1994 (United Nations, 1994; Garcia, 1994b).

70 Even though the document was prepared for a meeting on straddling and highly migratory resources, it is generally pertinent because:

- The concept of precaution needs to be taken into account in all fisheries, regardless of the type of jurisdiction and

- The set of management measures applied to the various parts of a transboundary resource must be coherent.

71 In other words, the document proposed that, if the nature of a resource or fishery was such that it required precaution, the latter should be provided throughout the distribution range of the stock. Unfortunately, this logical and basic biological requirement became, at the UN Conference, one of the major points of disagreement because some coastal countries considered that the need for overall "coherence" or compatibility between the management regimes inside and outside the EEZ could represent or be interpreted as an encroachment on their sovereign rights[6].

72 The issues of scientific uncertainty and precaution were also addressed in a document prepared by FAO for the United Nations Conference on Straddling Fish Stocks

[6]A situation could be foreseen in which a sovereign coastal State could see its right to introduce a technology (e.g. a new fishing gear, or practice, or genetically modified organisms) questioned by non coastal countries exploiting the same straddling or highly migratory stock.

and Highly Migratory Fish Stocks, on management reference point (United Nations, 1994a; FAO, 1994). This report recognized that "*most of the difficulties experienced in using any target reference point results from the considerable uncertainties as to the current position of the fishery in relation to it*".

73 The paper suggested to use limit reference points (LRPs) as a way to increase the precautionary nature of the management set-up. Such LRPs, to be used alone or in combination, could correspond, for example, to situations where:

- Spawning biomass or proportion of mature individuals fall below, say, 20% of the values for the virgin stock;

- Fishing mortality falls below, say, 30% of the virgin stock biomass-per-recruit or reaches 80% of the rate of natural mortality;

- Total mortality reaches the level corresponding to Maximum Biological Production for the stock;

- Mean individual size fall below the mean size at maturity;

- Annual recruitment levels remain below a certain level (or average level) for a certain number of years;

- The resources rent have been totally dissipated (i.e. the total cost of fishing, including reasonable revenues to manpower and capital, are equal to total revenues).

- Etc.

74 FAO has started the preparation of a **Code of Conduct for Responsible Fisheries** following the International Conference on Responsible Fishing, held in Cancun (Mexico, 1992). The Code includes a section on precautionary approach as part of the Article 6 on Fisheries Management[7]. The implementation of the Code of Conduct will be facilitated by a series of specific guidelines, one of which will address the precautionary approach to fisheries management (including aspects related to the introduction of new species).

75 The precautionary approach promoted by FAO is being progressively reflected in the fishery sector reality. The applications to inland fisheries and aquaculture have been already mentioned above. In addition, the last session of the Working Party on Resources Evaluation of the Committee for Eastern Central Atlantic Fisheries (CECAF) it has been recommended that, *as a precautionary approach,* the fishing effort exerted on horse mackerels in Morocco, Mauritania, Senegal and Gambia, should be kept at the level of the late 1980s.

76 A practical application of the precautionary approach to management of tropical shrimp fisheries has been proposed by FAO (Garcia, 1994) illustrating the possibility to

[7]The text of this section (Annex 1) is only provisional and will be revised on the basis of the outcome of the United Nations Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks.

make maximum use of the available scientific information, with its uncertainty, to elaborate precautionary management advice.

The United Nations process

77 At its first substantive session, held at New York in July 1992, the United Nations Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks (hereafter called The Conference) also addressed the issue. It could not reach consensus on the precautionary principle, which many countries equated with a moratorium on fishing and considered too radical for such environmentally soft industries as fisheries. A consensus developed instead on the need to introduce or strengthen the precautionary approach to fishery management.

78 During its second session, in July 1993, the Conference considered again the issue. The Chairman negotiating Text (A/CONF.164/13*) contained only one reference to the precautionary approach, in Article 4: " *Use of the precautionary approach shall include all appropriate techniques, including, where necessary, the application of moratoria".*

79 A paper submitted at this meeting by Argentina, Canada, Chile, Iceland and New Zealand (UN, 1993) proposed selected precautionary measures on the High Seas, distinguishing between existing and newly discovered fisheries.

80 **For existing fisheries,** the text suggested *inter alia* that: (a) TACs and effort limitations shall be established to maintain exploitation rates below the level of MSY and, where appropriate, to allow the stock to rebuild; (b) Precautionary management thresholds shall be established at which pre-determined management courses of action should be taken; (c) Where stocks decline over time, TACs and effort shall be reduced to arrest the decline and subsidies for fishing operations shall be stopped; (d) By-catch limitations should be established and stocks of associated or dependent species should be maintained or restored;

81 For newly discovered stocks, the text suggested also that: (a) Early large-scale development of fisheries on newly discovered stocks shall be prohibited and limitations shall be applied immediately on effort and on Government assistance; and (b) Precautionary Total Allowable Catches (TACs) and quotas shall be established below the MSY level.

82 In addition to these largely technical measures aiming at increasing precaution, the document contained proposals aiming at giving to the coastal States **special prerogatives** to establish interim management measures: (a) in case of discovery of a new straddling or highly migratory resource and (b) when the coastal State has established that an emergency exists. The heated debate on this latter aspects of the proposal has overshadowed the other aspects of the proposal.

83 Nonetheless, during its 1993 session, the UN Conference requested the Food and Agriculture organization (FAO) to prepare two information papers: one on the precautionary approach in fisheries management and one on management reference points.

84 During its third session, in March 1994, the Conference considered again the issue of precaution, based on the document prepared by FAO and the proposals included in

paragraph 5 of the Chairman's Negotiating Text (Annex 2) which referred specifically to the precautionary approach to management. Two working groups were held: on the precautionary approach and on management reference points.

85 The outcome of the heated debate on precaution during the following sessions of the Conference was reflected in a number of modifications of the draft Chairman Negotiating Text which represented a substantial elaboration on the approach and, in its present state, one of the most detailed practical guidance on precaution ever included in an international agreement, including those on environmental protection (cf. Annex 3 and 4).

86 The Working Group on Management Reference Points established during the March 1994 session of the UN Conference reached consensus on all but one of a set of **Technical Guidelines on Biological Reference Points.** The only serious conflictual point, already referred to above, related to the need for coherence in management measures across the area of distribution of the species (Annex 4).

The NGOs process

87 Non-Governmental Organizations (NGOs), both international and national, environmental or professional have participated actively in the UN process lobbying for recognition of the need for a precautionary approach to fisheries which would involve, *inter alia*:

- taking decisions even with inadequate evidence;
- reversing the burden of proof;
- requesting Environmental Impact Assessments;
- avoiding non-reversible impacts
- adopting management reference points;
- establishing action-triggering thresholds points;
- allowing people's participation;
- promoting transparency;
- establishing sanctuaries;
- taking into account combined stresses on resources;
- reducing by-catch and increasing selectivity;
- conserving also associated and dependant species;
- testing management regimes robustness;
- allowing new fisheries only at very low pilot level;
- Establishing dispute settlement mechanisms;
- Promoting inter-generational equity;

88 NGOs have generally welcomed the FAO efforts towards the operationalization of a precautionary approach to fisheries which recognized the need to: (a) apply it to all fisheries; (b) apply it throughout the stock range; and (c) agree on criteria actions to be taken before a crisis occurs. Many of the FAO views have found their way into the NGO proposals. Some environmental NGOs, however, considered that the FAO approach was too much oriented towards the protection of the fishery sector, making excessive reference to the socio-economic burden associated with it. Some criticized the proposed **criteria of reversibility** in which they apparently saw a loophole. Some professional NGOs, on the contrary, considered that the FAO proposals were unbalanced, setting an impossible

burden for industry.

Other contributions to the issue

89 Another example of the precautionary approach can be found in the form in which the Advisory Committee on Fisheries Management (ACFM) of the International Council for the Exploration of the Sea (ICES) delivers its advice to its member States. The ACFM states that

> *"For stocks where, at present, it is not possible to carry out any analytical assessment with an acceptable reliability, ACFM shall indicate precautionary total allowable catches (TACs) to reduce the danger of excessive efforts being exerted on these stocks"* (Serchuk and Grainger, 1992).

90 The implicit assumption in the ACFM advice is that, in the absence of scientific assessments, uncontrolled fisheries are likely to build up overcapacity and overfish the resources. The preventive action is to establish TACs at conservative levels to limit fishing until better assessments become available. The implication is that such conservative measures would be lifted only if better information, in the form of an acceptable analytical assessment were provided.

91 The IUCN view on precaution is that:

> "*a precautionary approach should underlie all fisheries management, rather than being restricted to special cases*"
>
> "*major interventions in the natural environment should not be conducted in the absence of information to assess the potential consequences*" (Cooke, 1994).

92 Cooke stressed that it was necessary to not only set and declare the management objectives but also to ensure (through scientific simulations or otherwise) that the management procedures in place result in a high probability to meet these objectives under a wide range of scenarios with respect to stock dynamics and ecological interactions. In order to qualify as "precautionary" a management approach would therefore have "*to be sufficiently fully specified to enable its simulation, and to pass at least a minimum checklist of tests*". Cooke, further proposed that authorized levels of catches be inversely related to the amount of data available and that considerations related to protection of fishery habitats, non-target species and biodiversity be included in a precautionary approach.

93 When describing the elements needed to test a management procedure, however, Cooke lists all the sources of uncertainty regarding the stock, required to predict how the stock might behave (e.g. sampling variability and biasses; uncertainty and long-term fluctuations in stock productivity, dynamics and structure, recruitment, mortality and growth; interactions with other species).

94 Conspicuously lacking from the recommended approach are, however, all the important and often driving sources of uncertainty regarding the fishery sector itself, the fleet and capital dynamics, the alternative employment, the fishermen's behaviour, etc. Without such elements, simulation of management systems in most fisheries would be fairly unreliable.

95 The International Centre for Living Aquatic Resources Management (ICLARM) has recently developed its position regarding the introduction of species and the need for a precautionary approach (Pullin, 1994) which promotes adherence to the ICES-EIFAC guidelines and acknowledges the potential impact of genetically modified organisms.

96 The Commission for the Conservation of the Antarctic Marine Living Resources (CCAMLR) has introduced precautionary catch limits for krill fisheries (in 1991 and 1992) and for *Electrona carlsbergii* (in 1993). It instituted, in 1992, the requirement for advance notification and data requirements prior to the development of a new fishery. Finally, in 1993, in the absence of sufficient data for the establishment of a management regime, it authorized the starting of an experimental fishery for the crab *Paralomis spp.*

Conclusions

97 From the beginning of the UNCED process and the first FAO proposals for the development of a precautionary approach to fisheries in 1992, the concept has progressed significantly. It has become familiar to the fishery sector which, in most cases, does not generally oppose it even though, concerned about potential extreme interpretation and their resultant socio-economic costs, it intends to follow very carefully the development of guidelines for its practical implementation,

98 The view has been generally accepted that a generalization of reasonable levels of precaution at all levels of the fisheries systems (research, operations, management) and at all times is preferable to extreme corrective measures imposed to correct crisis resulting from non-responsible fisheries practices.

99 NGOs have actively contributed to the development of the approach, both directly and through the national delegations of the UN Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks.

100 The approach is now imbedded in the outcome of the UN Conference and its ommission in the 1982 Convention can therefore be considered as corrected. Its detailed reference in the FAO Code of Conduct for responsible fisheries and the development of specific FAO guidelines for its practical application will help greatly in promoting its effective implementation by States and the fishing industry, assisted in this process by NGOs.

4. UNCERTAINTY, ERROR AND RISK

101 The necessary impact[8] of fisheries needs to be accurately assessed and forecast in order to propose management options reducing to a minimum the possible risk of severe and costly or irreversible crisis.

102 The scientific understanding of the fisheries ecosystems and capacity to predict their future status in accurate quantitative terms is limited by the the properties of fishery resources, their "fluid" nature and interconnectedness; the limited knowledge on genetic stock structure and impacts of fishing on resources genetics; the complexity of the

[8]See a detailed discussion on fisheries impacts in the section on Management Implications.

interactions between species and gears and fisheries; the poor quality of the available fishery data; the limitation of scientific models and research funds; and the fluctuations of economic parameters.

103 This leads to a degree of uncertainty in the scientific, technical, economic and political information upon which managers and industry leaders base decisions which may not always be wholly appropriate.

104 There are numerous illustrations of this but the most recent and famous relates to the management of the Northern Cod stock in the Northwest Atlantic where, following a collapse of the resources, it was necessary to establish a very expensive emergency welfare programme to support a stunted coastal fishery sector. A polemic has started as to whether research, management, industries, national decision makers or foreign fleets, where responsible for the mistakes (Finlayson, 1994) and it should be obvious that: (a) responsibilities are shared and (b) the debate comes too late.

105 Scientists have repeatedly addressed the issue of uncertainty and the related risk, trying to find ways of identifying and quantifying better the levels of uncertainty in their statements as well as more robust (forgiving) management approaches (Walters and Hilborn, 1978; Shepherd, 1991; Smith, Hunt and Rivard, 1993).

106 It is generally accepted that errors might be made that may affect: (a) The basic fishery data used for analysis such as on catches, effort, sizes landed, etc. (**measurement error**); (b) The estimation of populations and parameters derived from such data (**estimation error**); (c) The understanding of relationships between the different elements of the fishery system and their interaction (**process errors**); (d) The way these relationships are mathematically represented (**model error**); (e) Decisions that management takes on the basis of such information (**decision error**); and (f) The way in which management measures are implemented (**implementation error**).

107 The errors affect both the biological, economic and social component of the fishery system. They may affect, for example, the decision maker's expectation regarding fishermen's reaction to a proposed measure, as a consequence of errors in the explicit or unformulated behavioural model, used in forecasting such likely reaction.

108 Management errors can lead to two types of situations:

(a) **Necessary management measures were not taken** and, as a result, the resource is damaged. There are short-term costs for the resource and, possibly, for the fishing community if not compensated by government subsidy. The biological impact is usually reversible if a corrective measure is applied, except perhaps in the case of major damage to the habitat. This type of error may also carry the risk of major economic consequences (e.g. in Peru or, more recently, on the Eastern Coast of Canada).

(b) **Unnecessary management measures were taken**, and, as a result, fishing activities were curbed. The cost of the error is borne by the fishery. The biological effects of the measure, if any, would usually be positive and reversible soon after the measure is suppressed. The socio-economic impact may or may not be reversible (e.g., where there the error resulted in the loss of the market).

109 Improving information and understanding to the point of reducing substantially the risk of error implies data and financial resources requirements which would often be unrealistic, particularly for high seas or highly unstable resources. It must therefore be recognized that management decisions addressing actual or perceived risks will often be necessarily taken with less than complete and accurate information.

110 A fishery management strategy aiming at no risk at all for the resource and the fishing communities would imply either research costs beyond the value of the fishery or no development at all (in the case of an extreme interpretation of the concept of precaution). Few Governments would find either of these two extreme options viable. Cautious management will therefore deal explicitly with risk and aim at a compromise and it should be clear that the higher the uncertainty and/or risk the greater will be the need for caution, particularly in the selection of management reference points (FAO, 1994).

111 An important and difficult task for cautious management authorities will be to develop a societal consensus about the nature and levels of the biological and societal impacts (and risks) that might be considered acceptable (tolerable) and to highlight and address the fundamental trade-offs implications of the decisions, for different elements of the society and for both the short and long-terms.

112 Add a paragraph on comparative risk-assessment in reference to Pullin (1994) and Shroder-Frechette (1995): in TREE, 10(1) 1995. Ask Bartley for copy.

113 Particular caution may be necessary when resources and people are in a highly vulnerable situation as, for example, in small island countries where the erosion of natural resources may lead to the degradation of the coral reef ecosystem and, beyond a certain threshold, to breakdown of development opportunities, life support and social order.

5. IMPLICATIONS FOR FISHERIES RESEARCH

114 All expressions of the concept of precaution require that the *"lack of full scientific certainty shall be not used as a reason for postponing cost-effective measures to prevent environmental degradation"* (principle 15 of the Rio Declaration). The requirement for precaution may therefore have been be interpreted as requiring no input from fishery research.

115 Gray (1990), for instance, has stated that the *"acceptance of the precautionary principle has nothing to do with science"* and that it leads to arguments "*that do not have the required objectivity and statistical validity*". In practice, however, and as proposed below, the effective implementation of precaution requires substantial support from fishery science, which needs to be adapted to the new requirements.

5.1 The "best scientific evidence available"

116 Prior scientific consensus on cause-effect relationships, appropriate models, and potential consequences of fishing has been the basis for cooperation in international fisheries management in the past. Scientific cooperation should continue to be one of the most neutral contribution to the resolution of conflict between nations and competing user groups.

117 The Christiania Conference, in 1901, held just before the creation of the International Council for the Exploration of the Sea (ICES), endorsed the principle of scientific inquiry as a basis for rational exploitation of the sea. The same principle was also agreed at the International Conference on the Conservation of the Living Resources of the Sea, hosted by FAO (Rome, 1955).

118 More recently, the 1982 Convention provided that the best scientific evidence shall be taken into account by the coastal State when designing and adopting management and conservation measures in exclusive economic zones (article 61). For the high seas, this Convention provides that measures are designed on such scientific evidence (article 119). More recently, General Assembly resolution 44/225 recognized, in its preamble, that "any regulatory measures ... should take account of the best scientific evidence available".

119 The 1982 Convention does not define the quality of the evidence required in any quantitative manner. The requirement that the evidence should be the best available implies that even poor evidence can be used in designing conservation measures provided it is recognized as the best available. The 1982 Convention does not provide any guidance on how to decide which is "the best" scientific information (see note 16). Nor does it indicate how to operate in the absence of scientific consensus which it implicitly assumes or when no scientific information is available at all.

120 Although the 1982 Convention does not foresee that an existing fishery could be closed if not enough scientific information is available, it does not impose a great burden to be discharged before the necessary conservation measures can be taken (Burke, 1991). One would assume therefore that, in such a case, the spirit of the Convention is that the missing scientific information should be urgently collected but this does not preclude measures being taken in the meantime. The concept of precaution would ensure that action is not deferred sine die.

121 Cooke (1994) proposes that there be relationship between the amount of data available and the level of catches allowed, indicating that a **minimum information requirement** be requested, such as a recent estimate of the low end of the likely available biomass. This might sometimes be difficult to obtain without any fishing at all, although, for many resources, some rough estimate could be obtained through trawl or acoustic surveys.

122 Concern has been expressed that the adoption of the precautionary approach could imply that scientific facts to back up management decisions were no longer considered necessary. There is an obvious risk that, by referring to the concept of precaution, scientific objectivity could be less rigorously applied and that international dialogue could be negatively affected. It is hardly debatable, however, that when scientific data are available together with a monitoring and management system, the basic requirement of the 1982 Convention should prevail, and decisions should be taken on that basis.

123 It should also be clear that in order to satisfy the requirement of the 1982 Convention for the best scientific evidence available, the information must be scientific

(i.e., obtained and presented in an objective, verifiable and systematic manner)[5] and it does need to be made "available" to all concerned. This, in the context of straddling and highly migratory resources, requires the existence of effective international scientific cooperation and the elimination of non-reporting and misreporting

124 In the absence of scientific consensus, emergency action should therefore only be justified when there is the risk of severe and irreversible effects and the concept of precaution may be seen as filling the gaps in the 1982 Convention, preventing the absence of scientific data or consensus from opening a loophole leading to "laissez-faire" management and development strategies with damaging or irreversible consequences.

125 In an international fishery management body, a State willing to invoke the need for a precautionary approach in order to promote exceptionally stringent management measures would have to convince the other parties that exceptional conditions are met for its application: that there is indeed a high risk of severe and irreversible damage. Science should demonstrate the existence and extent of risk through risk analysis.

126 If the available information was considered insufficient to demonstrate objectively the risk, the application of the concept of precaution could become counter-productive. In such a case the management authority would face "perceived risks", in the absence of objectively demonstrated ones. This is often the case with global societal risks, and consensus will have to be achieved through a purely political process involving as much consultation and transparency as possible.

127 Cooke (1994) specifically proposed that " permitted catches be lower when data are sparse then when data are plenty" and stressed that this "attaches a positive effective value to fisheries data and opens the way to data collection programmes financed by the users.

5.2 The role of statistical methods

128 The 1982 Convention does not give any indications on how to determine which scientific evidence is the "best". General Assembly resolution 44/225 required "sound statistical analysis" and this new terminology could be considered an attempt to clarify further the concept of "best evidence", equating it with "statistically sound evidence".

129 The advantage of incorporating statistics into the concept is that it offers a way of using well-established mathematical techniques and tests to assess the probability that a certain action has had or may have a certain type of effect. It also forces scientists and decision-makers to recognize and measure explicitly the levels of uncertainty and the risks attached to these decisions.

130 A research programme to monitor a fishery will use statistics to test, for instance, a null hypothesis (Ho) that the ongoing fishing, or planned increase in fishing effort or change in fishing strategy, will not drive (or has an acceptably low probability of driving)

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[5]This implies that the "traditional knowledge", the foundation and accuracy of which is largely unknown be collected and assessed in oredr to eventually become part of the "scientific" basis for management.

the reproductive capacity of the species below some pre-determined safe threshold level.

131 Scientists still must agree on which type of statistical methods to use (parametric, non-parametric, geostatistics) and which test is most appropriate for a particular problem. Fisheries do not usually conform strictly to the requirements for unbiased application of conventional statistical methods and the reliability of many statistical tests might still be a matter for debate. As a consequence, obtaining consensus on the "best statistical analysis" to use might not always be easy.

132 In addition, Peterman and M'Gonigle (1992) have stressed the potential contribution of Statistical Power Analysis to the issue. They remind us that *"statistical power is the probability that a given experiment or monitoring programme will detect a certain size of effect if it actually exists".* Related to the example given above, it means that the statistical power measures the probability that the fishery monitoring programme will effectively detect the reduction of the reproductive capacity below the safe threshold level. Peterman and M'Gonigle suggest that the lower is the statistical power of an experiment, the more precautionary the management response should be.

133 The best statistical methods applied to unreliable data can only lead to unreliable results. It is therefore obvious that rigorous statistical methods should also be applied in data collection systems. This is particularly critical for fisheries data.

5.3 The Burden of Proof

134 Independently of the party on which the burden falls, a major problem in the concept of "proof", whether of an impact or of the absence of an impact, is that the concept implies usually a level of certainty that is generally not reachable in fisheries research.

135 In practice, the burden of "proof", or at least of providing the best evidence available, has fallen traditionally on research and management. It has been necessary to demonstrate, with the available data, that harm could be (or was) done to the stock or that fisheries performance could be improved before management measures could be imposed. In many instances, this approach was not effective because fishery research usually lagged behind development. Both the principle and the precautionary approach imply that action might have to be taken without full evidence of the extent of the risk and of the causal relationships.

136 When international consensus on what action to take cannot be obtained because of insufficient information, it has been suggested that the burden of proof be reversed, placing on those who derive benefits from the ecosystem the responsibility to prove that what they intend to do will not lead to "severe and irreversible" effects on the resources. In such a case, the burden of demonstrating that industrial business is conducted in a responsible manner would be on industry.

137 As an example, General Assembly resolution 44/225 recommended a total ban on large-scale driftnet fishing in the absence of scientific consensus on the likely long-term impact, implying that the prohibition of a disputed fishing technique is in order until its acceptability has been demonstrated. It stated that *"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 jointly made by concerned parties ..."

138 This resolution reversed the conventional course of action, recommending immediate and drastic action (i.e., a total ban of the offending gear) on the basis of international concern assuming that driftnets had an undesirable impact on resources, until shown otherwise. It was agreed that such action could, in principle, be reversed should the joint scientific analysis lead to consensus on the effectiveness of management measures.

139 The UNGA resolution 44/225 gave no guidance or criteria on how to judge the quality or adequacy of the available evidence or the effectiveness of the management measures. The action was confirmed by General Assembly resolution 46/215 of 20 December 1991, which called for action against this type of fishing on the basis that *"the international community [has] reviewed the best available scientific data and [has] failed to conclude that this practice has no adverse impact ... and that ... evidence has not demonstrated that the impact can be fully prevented".*

140 Another example of reversal of the burden of proof can be found in Council Regulation 345/92 of the European Economic Community (EEC), which regulated the use and the length of driftnets (limited to 2.5 km) in EEC waters. Article 9(a) granted a derogation until 31 December 1993 to some vessels for the use of longer gear, stating that "*The derogation shall expire on the above-mentioned date, unless the Council, acting by a qualified majority on a proposal from the Commission, decides to extend it in the light of scientific evidence showing the absence of any ecological risk linked thereto.*"

141 The reversal of the burden of proof implies that, unless proved otherwise, some fishing techniques may be considered harmful, giving systematically to the resources the benefit of doubt. It may be taken as implying that fishing techniques, which would not be formally authorized in a management area or for a particular species, would be forbidden. The requirement is related to the notion that an environmental impact assessment should be presented before a new technology or practice is introduced in an ecosystem. It is also related to the concept of prior consent or prior authorization discussed below.

142 Under this concept, the industry and fishing communities would bear the cost of research and may have to forego some income-generating activities if they are unable to convince the authorities of the acceptability of the technique. It would be fair to give the people whose activity and livelihood are threatened by the measure the opportunity to develop the proof required within a given time span.

143 A major problem is that it is usually impossible to forecast, with any degree of accuracy, the impact that a new fishery will have before it starts and some data are collected. It might therefore be imagined that no new fishery could be developed because evidence of the absence of adverse impact cannot be given by those involved in the venture. The extreme application of the reversal of proof in fishery management and development could therefore lead to considerable economic damage and discredit the concept of precaution itself.

144 A reasonable precautionary approach, in such a case, should lead to agreement for

a pilot fishery large enough to collect data and build up the scientific evidence required, but small enough to ensure that no irreversible effect is likely. In practice, there will usually be a trade-off: a small amount of risk for the resources being exploited will have to be accepted in exchange for the possibility to provide food and a livelihood for humans[6].

145 Meanwhile, and in accordance with the precautionary approach, interim precautionary measures may be taken giving due consideration to the actual nature and level of risk for the resource, and to the social and economic costs to the community. Therefore, banning fishing techniques would be justified only when the risk of irreversible damage to the resource and the community is high.

5.4 Practical Guidelines

146 The effective implementation of a precautionary approach to fisheries requires substantial support from fishery science, which needs to be adapted to the new requirements. A major contribution of fishery science to the development of a precautionary approach to fisheries would be to:

147 - Take into account the best scientific evidence available when designing and adopting management and conservation measures, in accordance with the provisions of the 1982 Convention.

148 - Require a minimum level of information to be made available for any fishery to start or continue.

149 - Make all necessary efforts to collect the required scientific information. For new fisheries, data collection should start with the fishery, including data on genetic and stock structures. For existing fisheries, data collection should start as soon as possible and any increase in effort should be preceded by a research or assessment programme.

150 - Ensure that the *"lack of full scientific certainty shall be not used as a reason for postponing cost-effective measures to prevent environmental degradation"* (principle 15 of the Rio Declaration).

151 - Ensure and require that information provided as a basis for management be "scientific" (i.e., obtained and presented in an objective, verifiable and systematic manner) and "available" to all concerned.

152 - Develop the effective international collaboration required to collect and jointly analyse the scientific information, particularly in the case of trans-boundary, highly migratory or high seas resources.

153 - Take measures aiming at eliminating or reducing non-reporting and misreporting,

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[6]The question is more complicated in the case of introductions of species and GMOs where there is no guaranty that the introduced elements could be safely eradicated once introduced, even on a pilot phase, and there is opposition, in this case to the concept of pilot experiments REF

inter alia, by ensuring that the fishery sector cooperates in data collection and is fully informed of the results and uncertainty in the assessment.

154 - Relate the allowance in terms of TACs, catch quotas, number of licences, etc. to the amount and quality of the available data, ensuring that permitted catches be lower when data are sparse then when data are plenty.

155 - Generalize the use of standard statistical procedure to juge the quality of the scientific evidence available and ensure that such information and the analysis thereon is statistically sound.

156 - Assess the **statistical power** of the tests and methodologies used for comparing the relative "soundness" of the available informations. The lower the statistical power of the assessment, the more precautionary the management measures.

157 - To promote multidisciplinary research, including: (a) social and environmental sciences; and (b) research on management institutions and decision-making processes, because the availability of biological evidence alone has not prevented overfishing;

158 - To expand the range of fishery models (e.g. bio-economic, multi-species, ecosystem and behavioural models), taking into account: (a) environmental effects; (b) species and technological interactions; and (c) fishing communities' social behaviour;

159 - To systematically analyse various possible management options using the whole range of available models, showing: (a) the likely direction and magnitude of the biological, social and economic consequences; (b) the related levels of uncertainty and the potential costs of the proposed action (risk assessment), and of no action (*status quo* scenarios).

160 - To systematically analyse and

highlight the most pessimistic scenarios[7], in situations of doubt and high risk of irreversible damage to the resource.

161 - To develop scientific guidelines and rules for multi-species and ecosystem management as a basis for agreement on acceptable degrees of disturbance.

162 - To agree on quantitative reference points and thresholds as well as on methods to establish them[8]. (To be addressed by the TCPA in Lysekil).

163 - To improve statistical methodologies for assessing the biological and economic parameters, testing their sensitivity to uncertainties in the data used and systematically estimating bias and precision in the derived parameters. The sensitivity of models to uncertainties in their parameters and functional structure should also be tested;

164 - To systematically quantify the risk associated with scientific advice at the various reference levels selected;

165 - To improve understanding of environmental impact, raising the awareness of fishermen to the possible impact on fisheries potential resulting from fisheries as well as from environmental degradation caused by other industries. Environmental Impact Assessments should be used more frequently.

166 - To improve resarch on better ways to use gear and also on the development of better gear with better selectivity and less long-term environmental impact.

167 - To **reverse the burden of proof** in case of high risk of damage to the resource and lack of consensus on action to be taken, placing on those who derive benefits from the ecosystem the responsibility to collect the data, analyse it, and prove that what they do or intend to do will not lead to "severe and irreversible" effects.

168 - When the burden of proof is reversed, to give to the party whose activity and livelihood are threatened by the measures a fair opportunity to develop the proof required within a given time span (e.g. through controlled and/or collaborative pilot projects).

6. IMPLICATIONS FOR TECHNOLOGY DEVELOPMENT AND TRANSFER

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[7]For instance, models which assume strong dependance of recruitment on adult stock size and predict rapid collapse when effort develops beyond a critical level (such as the Gulland-Schaefer production model or the Ricker stock-recruitment model) should be used rather than models assuming no relation between stock and recruitment and high resilience of stocks to high fishing rates (such as the Fox production model or the Beverton and Holt yield-per-recruit and stock-recruitment models).

[8]For instance, if it is agreed that it is safe to exploit a resource at two thirds of its MSY, it will be necessary to agree on the reference data set and on the conventional model on which to base the calculations because the true value of 2/3 MSY and of its corresponding level of effort will never be exactly known and may vary according to the model used

6.1 The concept of Responsible Technology

169 In international environmental law, the principle is often associated with the requirement to use the "*best available technology*", an obvious parallel to "*best scientific evidence available*". This wording has sometimes been interpreted as requiring the technology which has the smallest environmental impact, regardless of the short-term socio-economic costs. This interpretation has, however, been contested on the basis that such technology might not always be affordable by all countries and, in particular, by developing ones (GESAMP, 1986).

170 General Assembly resolution 44/228 of 22 December 1989 on UNCED referred instead to "*environmentally sound technology*", stressing the need for socio-economic constraints to be taken into account. The wording does not pretend to limit the choice to a single "best" or soundest technology, implying that many "sound" technologies may be used together, depending on the socio-economic context of their introduction.

171 The Cancun Declaration (Mexico, 1992) provides that "*States should promote the development and use of selective fishing gear and practices that minimize waste of catch of target species and minimize by-catch of non-target species*", focusing on only one aspect of responsible fishing technology.

172 If social and economic factors are taken into account, in line with the concepts of sustainable development and responsible fishing, the technological requirements should be defined with a view to maintaining (or reducing) the accidental effects of capture and post-capture fishery activities within pre-defined acceptable (tolerable) levels, allowing general application by all countries.

173 Concerns have been expressed that some fishery technologies were not sustainable. The potential danger represented by an unconsidered expansion of the Large Scale Pelagic Driftnet Fishing has been theoretically "solved" by a moratorium on all driftnets of more than 2.5 kms of length. Miles (1992) indicated, however, that the application of the same flawed process and criteria to EEZ fisheries, particularly in USA, would lead to closing down of many domestic fisheries[9].

174 The press have also echoed concerns regarding impacts on cetaceans off Ireland and Denmark (Schoon, 1994) by bottom gillnets of up to 7 miles long, used in coastal waters, for the last 15 years to catch bottom fish (turbot, plaice, cod).

6.2 Prior Informed Consent (PIC) and Prior Consultation

175 For dangerous polluting industries, reference has often been made to Prior Informed Consent (PIC) and Prior Consultation Procedures (PCPs). The practical significance of the procedures involved is that, before introducing a dangerous technology or any new technology in a controlled or sensitive area, the proponent must produce a substantial

[9] As a matter of fact, arguments similsr to those used to request the closure of the large scale pelagic driftnet fisheries were invoked to force the closure of the small-scale bottom gillnet fishery in California, showing both the potential and the danger of media-driven campaigns against fishing techniques.

amount of information about the technology to be introduced and its potential impact and, eventually, obtain the consent of the State, the managing authorities, or the other users. If the introduction is agreed, a number of specific measures are usually foreseen such as limiting the scale of the initial project, special monitoring and reporting requirements, etc.

176 An example can be found in the ICES/EIFAC Code of Practice to Reduce the Risk of Adverse Effects Arising From Introduction and Transfers of Marine Species including the Release of Genetically Modified Organisms (Turner, 1988) which has been adopted by the International Council for the Exploration of the Sea (ICES) and the European Inland Fishery and Advisory Commission (EIFAC) of FAO.

177 The ICES/EIFAC Code foresees that "*Member countries contemplating any new introduction should be requested to present to the Council, at an early stage, information on the species, stage in the life cycle, area of origin, proposed plan of introduction and objectives, with such information on its habitat, epifauna, associated organisms, potential competitors with species in the new environment, genetic implications, etc., as is available. The Council should then consider the possible outcome of the introduction, and offer advice on the acceptability of the choice.*"

178 The European Directive 90-220 on dissemination of genetically modified organisms intends to frame the development of biotechnologies in Europe and address the "genetic risk" potentially represented by these technologies, which are of great potential interest also for fisheries (EEC, 1990). Hermitte and Noiville (1993) stress the precautionary character of the Directive, which applies the precautionary principle, not to a single product (chemical substance), or to a specific problem (ozone hole) but to a whole mew mode of production, even before any incident has been registered.

179 The Directive recognizes that a new production mode carries with it significant social (societal) changes and potential risks and, contrary to what has happened in industrial development since the 18th century, attempts to foresee and limit the negative impacts of this new technology. It reverses the traditional industrial culture and freedom to undertake, produce and sell as long as a danger has not been proven.

180 In exclusive economic zone fisheries, where effective effort controls have been established, there is often a requirement to obtain prior consent from the management authority before a new vessel is ordered or even before the banks are approached for a loan for this purpose. This might be considered for some particularly efficient and potentially dangerous technologies and/or for particularly vulnerable resources or fragile ecosystems when severe, irreversible effects are possible.

181 Prior Informed Consent of the competent regional management organization or arrangement could be required before introducing the new methodology. The procedure may be better accepted if the new technology is patented, limiting the risk that the benefits to the "discoverer" will be jeopardized in the process.

182 In such an international or regional mechanism, a State willing to introduce a new technique would be requested to present a report, comparable to an **environmental impact assessment** (see below). Such an assessment would address potential effects on the target species and on associated species which might be targets for other fisheries in the area or food items for such target species. However, apart from its scientific complexity,

it is clear that such impact assessment cannot be conducted in the absence of at least a pilot fishery (see below).

183 It has been mentioned that an overly stringent application of the precautionary principle might be contrary to the willingness and need to ensure techonological progress. Hermitte and Noiville (1993), however, indicate that the prior authorization process, the resulting direct involvmemt of industry in promotion of data collection and research, and the transparency resulting from the public information and participation would, on the contrary, contribute to dissipate the fears towards technology and, indeed, limit irrational reactions to innovative technologies.

184 One major benefit from a prior authorization process, beyond the limitations of risk, would be in the mandatory delivery, by industry, its scientists and experts, and at industry's expense, of information on ecosystem functionning and technological impacts, and of the resulting "memory" that Hermitte and Noiville call **"scientific jurisprudence"**.

185 These authors state that the acceptance of the procedures by scientists and industry would be a sign of good faith given to a more and more suspicious, skeptical and unforgiving society and that these procedures may in fact be the only way to avoid irrational bans on research and development avenues and development of "wild" experiments.

186 The administrative burden imposed by prior authorization procedures could be overwhelming and, at least in fisheries, there would be obvious advantages if the procedure would remain exceptional. The scope of application (and unnecessary burden) of the measure could be reduced using the concepts of **"familiarity"** and **"previously acquired experience"** (Hermitte and Noiville, 1993) or refering to **"evidentiary presumptions"** (Bodansky, 1991) to take into account available knowledge (obtained elsewhere in similar or sufficiently comparable conditions), to reduce the amount of uncertainty and presumption of risk. In order not to permanently re-evaluate technologies which are well known (including their mild or acceptable impacts on particular ecosystems), a typology of fishery technologies, gears and practices could be developed leading to a classification of gear/species/ecosystems on the basis of their impacts (see below).

187 This classification could be used, regionally or nationally as a guide, to the establishment of gear and technology lists (see below). The special monitoring and reporting procedures could then be limited to those really new technologies or those recognized as unacceptable in the long term and for which phasing out has been decided. Interim reports could be requested during the phasing out period.

188 In the case of high seas areas not covered by any specific international agreement, there would be no competent authority to which the request for prior consent could be made. In addition, there would also be no monitoring or enforcement system in place, making it impossible to detect the introduction of harmful techniques and to measure impact. This is a case where the legal responsibilities of the flag States would need to be clearly determined, especially if the flag State registers all vessels authorized to fish in the high seas as provided for in the 1993 Agreement on the Promotion of Compliance with Conservation and Management Measures by Fishing Vessels in the High Seas.

6.3 Environmental Immpact Assessment (EIA)

189 Impact assessment is a major instrument of environmental law, which conditions the beginning of an activity or the deployment of a technology toan assessment of the consequences on the environment. Generally, an EIA provides not only an assessment of the impacts but also proposals aiming at mitigating the impact if necessary. As it would not be practical to condition all fishing activities to EIA it might be necessary to define the conditions under which an EIA might be necessary. This could be done: (a) through preliminary studies, on a case-by-case basis; (b) through an overall identification and cataloging of the technology/resources combinations requiring such approach.

190 If adopted, the EIA procedure should be part of the legal procedure leading to the granting of a fishing right or license for a particular fishing activity by an authority with the legal competence required to authorize or deny such a right. This authority should define the requirements and specifications of the EIA.

191 An EIA procedure requires the establishment of a system to control the conditions of the assessment, its relevance and objectivity. This implies that:

- The proponent must be able to appeal if the procedure imposed is not in line with the established specifications or if the decision of the authority does not appear in line with the conclusions of the EIA.

- The authority, which must decide on the acceptability or otherwise of a new technology or practice must be able to oversee the whole EIA process to guanrantee to all users the quality and reliability of the assessment.

- The procedure should be transparent to all users which should receive information on the request and on the EIA process. It might be necessary to organize a debate on the issue to get all the views. It would be necessary, however, to ensure that the authority keeps the necessary prerogative to ultimately decide.

- The other users (and in particular the users of a different technology on the same resource) should have the possibility to appeal on a decision if it appears to be in contradiction with the conclusions of the EIA.

- As a last resort, recourse to tribunals (in EEZs) or to dispute settlement mechanisms (in international fisheries) should always be possible if one of the parties in the EIA process belives that its interests are being unduly affected.

192 There should be some relation between the cost of the EIA and the cost of the potential negative consequences of the proposed development and its potential benefits. There should also be some relation between the cost of the foreseen investment and the cost of the EIA. In some instances, participation by the authority or State in the EIA might be worthwile and equitable, particularly when the technology being considered has general potential application.

6.4 Pilot projects[10]

193 Despite their relatively smaller size, pilot projects can be considered as "full scale" experimentations, limited in duration and geographical extension. They could be a useful way to implement a precautionary approach to fishery development provided that specific rules are adopted for their conduct, data collection, and analysis. They have the advantage of being less theoretical than EIAs, and therefore more convincing, while limiting the risks to the resource, and allowing a more realistic approach to socio-economic impacts than otherwise possible. Allowing for a phased approach to full scale application of a technology, they represent a practical tool for implementation of a **"stepwise decision making"** and **"progressive deconfinement"** of a new technology, advisable to situations of high uncertainty (Hourcade, 1994).

194 Pilot projects have been extensively used in the past (including in FAO fishery development programme) to demonstrate the technical and economic feasibility of a development or of management measures, and the concept is one with which industry is generally familiar.

195 A basic assumption behind the concept of pilot projects is that the full scale implementation of the technology is a simple extrapolation of the pilot scale. This may not always be the case and a significant involvement of basic and applied sciences is necessary to improving the protocols and the specifications of traditional pilot projects and allow them to become also useful reliable elements of a precautionary fishery development policy.

196 Another implicit assumption is that all traces of the experiment can be eliminated if the pilot scale project indicates that the tested approach or technology results in unacceptable consequences. This may not aleays be true and explains the opposition of some scientists to the concept, particularly in cases where the consequences detected in the pilot project are not reversible (as may be the case with introduction of GMOs).

197 The implication is that only part of the cost of a pilot project could be considered as additional charge required for precaution. Most of it could, in many cases, be considered as normal pre-investment expenses.

198 The management authority should have enough latitude to impose to a proponent of a new technology or new fishery the type of experimentation considered most appropriate. A contractual agreement between the authority and the proponent would improve the probability that the rights of the "discoverer" of a technology or a stock are respected.

199 The pilot project goes beyond the EIA in the sense that real development will occur, even though at small scale. In some cases, the authority itself could be (and often has been, in the past) the promotor of the initiative.

200 In some cases, both an EIA and a pilot project might be required and executed sequentially when the EIA is not totally negative but some aspects may not be addressed

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[10] See Boutet M. (1995)

without an experimentation.

6.5 Technology classifications

201 The development of typologies and classifications is usually the basis of a process of normalization or standardization of technology in view of its regulation. The basis of a classification in fisheries could be horizontal or vertical. A **vertical classification** would involve classifying gears according to their priorities with the aim to regulate their use. An **horizontal classification** would classifiy ecosystems and species assemblages or parts of them as a bais for the regulation of their use. In practice, both classifications would be required in order to develop flexible regulations taking into account the diversity of gears and ecological situations (and even socio-economic situations).

202 The use of lists to classify chemical substances, techniques, species[11], weapons, etc. is fairly frequent. In environmental law, technologies are often catalogued on separate lists, the "colour" of which reflects the perceived degree of environmental friendliness. "Black" or "red" lists refer to technologies with unacceptable impacts. "Grey" and "orange" lists refer to technologies usable under some conditions and which would require some impact assessment before being introduced. "Green" lists contain those technologies believed to be harmless or producing only acceptable levels of impact and which could be introduced without a particular precautionary procedure.

203 The problem is not easy. One problem is decide whether one would catalog the gears, the aids to navigation and detection (which increase fishing power) or the fishing practices, or both. Another problem is to decide on the objective criteria for the classification. If responsible fisheries is the objective, gears should be classified according to related criteria (refering for instance to selectivity and by-catch rate; impact on bottom, navigation, and environment in general; relative energy consumption; biodegradability; difficulty to control and monitor, etc.).

204 For fishing gear, the classification of a technology will depend, *inter alia*, on the type of habitat. Heavy trawls may be considered "green" on deep muddy grounds but "red" in shallow estuaries and coastal zones or coral reefs. Artificial reefs might be on a grey or orange list because their impact on coastal habitat is long lasting and, if made of derelict material, they may contaminate the environment.

205 This approach has been indirectly applied to fisheries by reference to the Convention on the Conservation of European Wildlife and Natural Habitats (Bern, 1979). That Convention gives, in its annex IV, a list of non-selective gear to be banned, which includes all nets. Although it had been designed for migratory birds, the list has been referred to, in Italy, in connection with the banning of large-scale pelagic driftnet fishery. The importance of nets in fisheries and their contribution to the livelihood of small-scale fishermen and indigenous people illustrates the need for careful consideration before referring to lists contained in non-fishery agreements and before elaborating specific lists of fisheries.

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[11] CITES, has recorded species in lists, according to their status, and specific measures correspond to each list.

206 Considering that, in fisheries, the concept of responsible fishing is well defined and that a Code of Conduct for Responsible Fishing has been prepared and will be adopted, it may be of value to refer to the requirement for **"Responsible Fishery Technology"** (including capture and post-capture technology) as defined in the Code. Responsible technology will have to be used in all areas of fisheries, including capture, land-based or sea-based processing and distribution.

207 As a consequence, and although some general guidelines can be given, based on known characteristics of types of resources and technology, the most responsible mix of technologies to be used in a particular fishery will have to be agreed on a case-by-case basis with explicit reference to the agreed management reference points and acceptable levels of impact agreed for that fishery. The implication is that technology lists could not be for general application and would have to be established locally, at regional and national level.

208 One must recognize, however, that lists of prohibited gears and practices exists in most national legislations and that these are frequently ignored. Examples are: fishing with dynamite or poison, fishing with scuba-diving equipment, use of obstructive shaffers on trawls cod-ends, use of driftnets, of small-meshed beach-seines, etc. The efficiency of technology classifications and list of authorized gears is therefore strongly dependant on the capacity of monitoring and enforcement.

209 Care would have to be taken to ensure that the use of gear lists does not lead to freezing the evolution of technology and that mechanisms exist (including the use of pilot projects) to allow this evolution while keeping the overall fishing mortality under control.

210 Moreover, a "better" technology might be theoretically available on the market but in effect not accessible to some countries because of its cost or its sophistication. It is clear that in many instances the general use of the "best technology" will require an improvement in international cooperation in technology transfer, as underscored in Agenda 21[12].

6.6 Precautionary approach to fishermen's safety

Insurance schemes, etc. See Fitzpatrick.

6.7 Practical guidelines

211 Responsible fishery technology should be used in all areas of fisheries, including capture, land-based or sea-based processing and distribution. Responsible technology is compatible with long-term resource conservation, minimizes by-catch of endangered species and discards to the extent possible, and results only in acceptable impact.

212 The mix of responsible technologies to be used in a particular fishery will be agreed on a case-by-case basis with explicit reference to the management reference points and

[12]The successful efforts made by the Inter-American Tropical Tuna Commission in the Eastern Central Pacific area to train crews of the region in effectively avoiding by-catches of dolphins through the use of appropriate technology is a good example of what can be achieved in this respect.

acceptable levels of impact agreed for that fishery.

213 A technology recommanded as the best responsible one should, ideally, be easily available on the market, and affordable, including to developing countries, and its transfer should be promoted through international cooperation.

214 Assessment of the responsible nature of a technology should be based on an objective analysis of the actual or likely impacts and of the risks involved, for the resources, for the associated species and, in the long term, for the fishing community.

215 Criteria for the selection or determination of responsible technology should include local biological and environmental conditions and socio-economic constraints.

216 Selection or determination of responsible technology should be based on an objective assessment of the actual or likely impacts and of the risks involved, for the resources, for the associated species and, in the long term, for the fishing community.

217 There may not be only one "best" technology to exploit a resource but a set of technologies (or gears or practices) compatible both with local conditions for sustainability and socio-economic conditions of the operators.

218 Technological requirements should be defined with a view to maintaining (or reducing) the accidental effects of capture and post-capture fishery activities within pre-defined acceptable (tolerable) levels, allowing general application by all countries or parties involved.

219 States and management organizations and mechanisms may wish to list the fishery technology used or potentially usable, in lists, the "colour" of which would reflect the perceived degree of environmental friendliness[13].

220 The classification of a technology will depend on the type of resources, the ecosystem characteristics and the habitat[14].

221 Before introducing a new technology in a controlled or sensitive area, on a low-resilience or particularly vulnerable species, the proponent must produce a substantial amount of information about the technology to be introduced and its potential impact and, eventually, obtain the prior consent of the other users.

222 If the introduction of a new technology is agreed, a number of specific measures

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[13]"Black" or "red" lists refer to technologies with unacceptable impacts. "Grey" and "orange" lists refer to technologies usable under some conditions and which would require some impact assessment before being introduced. "Green" lists contain those technologies believed to be harmless or producing only acceptable levels of impact and which could be introduced without a particular precautionary procedure.

[14]Heavy trawls may be considered "green" on deep muddy grounds but "red" in shallow estuaries and coastal zones or coral reefs. Artificial reefs might be on a grey or orange list because their impact on coastal habitat is long lasting and, if made of derelict material, they may contaminate the environment

are usually foreseen such as limiting the scale of the initial project, special monitoring and reporting requirements, etc.

223 When adopting Prior Informed Consent or prior consultation procedures, States or regional management organization or arrangement should ensure that the potential rights (interests) of the inventor of the resource or of the technology can be protected.

224 Request for the introduction of new techniques should be supported by a documentation amounting to an Environmental Impact Assessment identifying potential effects on the target species and on associated species which might be targets for other fisheries in the area or food items for such target species.

225 The administrative burden imposed by PIC and PCPs could be overwhelming and, as a consequence, the procedures should remain exceptional.

226 Special monitoring and reporting procedures could also be used for activities recognized as unacceptable in the long term and for which phasing out has been decided. Interim reports could be requested during the phasing out period.

7. IMPLICATIONS FOR CONSERVATION AND MANAGEMENT

227 Precautionary measures for fisheries management have long been advocated as a means to avoid crises and higher costs to society (Walters and Hilborn, 1978). These have not often been applied in practice because much attention has been paid to short-term costs while longer-term benefits have not been properly valued. Crisis management is unlikely to offer sustainable solutions to the problems encountered by fisheries.

228 Shotton (1994) argues that risk is unavoidable when deciding on harvest levels aiming at a range of conservation, social and economic (and we could add political) objectives. In such situation, decisions should be consistent with the theory of rational choice. He argues that, because the uncertainties on the data and models, it is impossible, in most cases, to define and reach any optimum. As a consequence, Reference Points are defined, which identify desirable or critical states of the known component of the system, and can be used to influence the changes in the fishery system.

229 The stand taken by FAO is that a progressive but systematic and decisive shift towards more risk-averse exploitation and management regimes is preferable, for all users, to the present combination of a general "laisser-faire" policy with a few mediatic bans with significant negative socio-economic impacts.

230 What is new in the modern requirement for precaution is not so much the sort of management measures that are suggested but the fact that they would be automatically enforced with no exceptions and that they should be implemented as soon as a serious and potentially irreversible effect is detected (Hey, 1992).

231 Extreme interpretation of the concept of precaution, leading to unnecessarily stringent and costly measures, could rapidly become counter-productive by deterring fishery authorities from using the concept as widely as possible.

232 The problem is therefore one of promoting effective caution in fisheries to the point where the risk of an irreversible impact on the environment and resources will be reduced below the level which would call for drastic measures with potentially irreversible damage to the fishery sector and the coastal communities. This could be achieved by exerting caution systematically, at all levels of the management process, to reduce substantially the risk of errors.

233 It is often supposed that preventive (or proactive) approaches to management are more precautionary than reactive ones because they anticipate unwanted events through knowledge of the system. According to Boelaert-Suominen and Cullinan (1994), the principle of preventive action is based on "*the recognition (or assumption) that it is cheaper, safer, and more desirable (in the long-term) to prevent environmental harm than to rectify it later, if indeed this is feasible at all*" (Comments betwen brackets added by the writer).

234 A strong and unwarranted assumption behind the principle of preventive action is that there is enough knowledge to allow such events to be reliably anticipated and avoided. Unfortunately, fishery systems are not fully predictable and errors are always likely. As a consequence, a precautionary management strategy would need both a sufficient preventive capacity to avoid predictable problems, and enough reactive (corrective) capacity, flexibility and adaptability to ensure a safe "trial-and-error" process, as knowledge about how the system works is collected (stepwise decision making).

235 For the same reason, it may not be prudent to rely on deterministic pseudo-quantitative reference points of dubious precision for a target-oriented management (e.g., based on TACs and quotas). Precautionary management strategies would recognize the uncertainties in the data and promote adaptability and flexibility through appropriate institutions and decision-making processes. These would rely not only on expert advice but also on people's participation.

236 In case of doubt, decisions should err on the safe side with due regard to the risk for the resource and the social and economic consequences.

237 A precautionary approach to fisheries management implies agreement on action to be taken to avoid a crisis as well as action required if such a crisis occurs unexpectedly. Agreement on such action, at an international level, implies the existence of agreed standards, rules, reference points, critical thresholds and other criteria. It also implies international consensus on acceptable levels of impact.

7.1 Management principles and decision rules

Need for objective criteria

238 Better quantification and qualification are required for such widely used subjective terms as "*detrimental*", "*harmful*" and "*unacceptable*" impacts, which are generally used in expressions of the need for precaution. One of the major tasks for research and management is to develop agreement on standards, rules, reference points and critical thresholds on which to base decisions and meet the management requirements of the 1982 Convention and Agenda 21, for the various types of ecosystems and resources.

239 Over-restrictive rules (e.g. rules implying socio-economic consequences without proportion to the risks involved) or recommended without a clear understanding of their practical implications are not likely to lead to the sort of consensus required for the general application of a precautionary approach.

240 Because of the universality of conservation principles, precautionary management rules need to be established for all resources whether in EEZs or in the high seas. Because of the transboundary nature of many high seas resources, straddling stocks and highly migratory species, precaution should be applied accross the entire area of distribution of the stock. This implies that coherent precautionary management regimes should be put in place, taking into account the geographical location of critical life phases (e.g. nursery, feeding or spwaning areas) and ensuring compatibility between the measures required inside the EEZs and outside them.

241 In international fisheries, economic criteria are not easy to consider and agreement on biological criteria will usually be easier. There is a high probability that criteria adopted for ensuring conservation and sustainability in the high seas would be soon proposed (e.g. by NGOs) for application in EEZs too. I would therefore be advisable, when selecting criteria for the high seas, to consider also their potential social and economic consequences if generalized to the whole distributional area and to the exclusive economic zones.

242 The following list gives some examples of principles or decision rules that have been proposed in the literature with a view to illustrating both the need for them and the difficulty of defining them in realistic terms:

1. Fisheries should not result in the decrease of any population of marine species below a level close to that which ensures the greatest net annual increment of biomass;

2. Fisheries should not catch amounts 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;

3. 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;

4. Fish management authorities should 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.

5. Fisheries management should take into account the combined stresses imposed by fishing , habitat loss and destruction, point and non-point sources of pollution, climate change, ozone level changes and other environmental and human impacts.

243 The first principle implies that populations should not fall below the level of abundance corresponding to MSY, where their annual rate of biological production (turnover) is the highest. This is in line with the 1982 Convention requirements. It has been repeatedly shown, however, that it is often inadvisable to try to extract the MSY

from a resource. Moreover, for multi-species fisheries, this principle 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, reducing drastically the utility of the resource[6].

244 The second principle, which rightly aims at preserving the qualitative parameters and fundamental integrity of the ecosystem mechanism, implies that fishing will not "significantly" disturb the food chain (an unreasonable assumption), without guidance on how to judge whether an observed or potential disturbance is significant.

245 Moreover, fishing all species at MSY, if at all possible, would lead, in practice, to applying different fishing mortalities to different species and this would lead to a change in relative abundance of species, affecting the food chain. As a consequence, the second principle may be difficult to use, in practice, for many fisheries and may not even be always consistent with the first.

246 The third and fourth formulations require that all sources of mortality are taken into account when assessing fisheries impact. These would include natural mortality as well as direct and indirect fishing mortalities (through by-catch, drop-out, damage, ghost-fishing, etc.). In practice, this principle implies also that mortalities imposed by non-fishery users (e.g. through environmental degradation) should also be taken into account. A very demanding task indeed, in most cases beyond the present capacity of research systems, even in the developed world.

247 Assuming that the task implied by the third principle is feasible, a problem remains with the vagueness of the term "sustainable" in then formulations. In theory, fisheries are "sustainable" at various levels of stock abundance and rates of harvesting, but these are not equivalent in terms of risk of recruitment collapse[7]. To be of practical use in fishery management, the concept of sustainability needs to be combined with the notion of risk for the resource, and consequently to the fishing communities.

248 The fifth principle, which in itself is perfectly laudable, has been reproduced only

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[6]In a typical Mediterranean multi-species trawl fishery, where long-lived bottom species (e.g., seabream and red mullet) are targeted together with short-lived pelagics (e.g., sardine), this would imply fishing sardine well below the possible level of harvest in order to comply with the guidelines for seabream and mullet. The problem has been recognized in the report of the FAO Expert Consultation on Large-Scale Pelagic Driftnet Fishing (Rome, 1990).

[7]Surplus production models, on which the concept of MSY is based, assume that natural renewable resources are "sustainable" (i.e., able to regenerate themselves year after year) at various levels of abundance depending on the level of harvest. A stock can in theory reproduce itself, and be considered sustainable, at high (virgin state), medium (MSY level) and even low levels of abundance, except for some species such as marine mammals and sharks. However, as stocks are fished down, their variability and the risk of collapse increases and it should be clear that all levels of theoretical "sustainability" are not equivalent in terms of risk for the resource.

to illustrate the difficulty in practical implementation of some prescriptions[8]. It is clear that the scientific data necessary to understand and forecast the impacts of all the sources of stress listed in the principle, some of which are still in the very early stage of study, are not available. As a consequence, they cannot be "taken into account". The point, however, that all stresses need to be addressed, including those imposed by non-fishing or related to natural fluctuations, is well taken and has been underlined in the FAO proposals.

7.2 Precautionary use of biological reference points

Management Reference Points (MRPs)

> *"A (management) reference point is an estimated value derived from an agreed scientific procedure and an agreed model to which corresponds a state of the resource and of the fishery and which can be used as a guide for fisheries management."*[9]

249 The above definition stresses the fact that reference points are conventional constructions based on the knowledge and often on a model available at the time of their adoption[10]. As a consequence, they are meaningful only with a reference to the underlying theory and model, method and data used for their estimation as well as species to which it applies. The consequence is that reference points should be re-assessed periodically as new data is collected as new understanding or methods become available. There would be a great danger to "chisel them in marble" as was done for MSY. In addition, as stated by Cooke (1994), in order to be useful for management, reference points should retain their validity in the face of short and long-term fluctuations in fish stocks due to recruitment variability and other factors.

MSY as a Management Reference Point

250 The 1982 Convention states that stocks should not be driven below the level of abundance that could produce the Maximum Sustainable Yield (MSY). For decades, MSY has been used, explicitly or implicitly, as a reference point by research, development and management and considered as a bottom-line threshold for stock "sustainability"[11].

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[8]The example is drawn from the proposals of the National Audubon Society, WWF and Alaskan Marine Conservation Council, to the UN Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks, in March 1994.

[9]Ad hoc Working Group on Reference Points established by the UN Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks in New York, in March 1994 (cf. Annex 3):

[10]For a more detailed treatment than what follows on management reference points the reader could refer to FAO (1993).

[11]Understood by all States as a highest level of withdrawal from the resource (and fishing intensity) allowed by the 1982 Convention. Understood by some States as the recommended target level of development.

251 MSY has been qualified by scientists as a very dangerous target reference point since the early 1960s (Christy and Scott, 1965; Larkin, 1977; Gulland, 1969, 1977, 1978; Sissenwine, 1978, etc.). At the 1992 FAO Technical Consultation on High Seas Fishing, attention was drawn on the non-precautionary nature of the traditional MSY reference point, and to the need for more and different reference points as a basis for more precautionary management strategies (Garcia, 1992).

252 New reference points, not foreseen in the 1982 Convention are, therefore, required if management aims at a low risk of collapse. Because of the uncertainty inherent in their determination, these reference points should preferably relate to probabilities[12].

Figure from Caddy

253 Pre-established measures or courses of action, "automatically" triggered when thresholds are reached would be particularly advisable:

- When the probability of occurrence of an unwanted negative outcome that threshold is particularly high (e.g in areas of high environmental variability such as upwellings or semi-arid climates;,

- For species which are at the extreme end of their geographical range of distribution or with particularly low resilience (e.g., small cetaceans, sharks, etc.);

- When the potential cost of going beyond the threshold could be particularly high.

254 In the paper prepared for the UN Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks, Caddy (1994) described two types of management reference points: Target Reference Points (TRPs) and Limit Reference Points (LRPs). A tentative definition of these points is given below.

Target Reference Points (TRPs)

255 A Target Reference Point (TRP) corresponds to a state of a fishery and/or a resource which is considered desirable . In most cases, it will be expressed in a level of desirable output from a fishery, and related to catch.

256 When a target reference point is reached, management action, whether during a fishery development or stock rebuilding process, should aim it and at maintaining the fishery system at its level, on average (e.g. through establishment of total allowable catches and quotas or through effort controls).

Limit Reference Points (LRPs)

257 A Limit Reference Point (LRP) indicates a state of a fishery and /or a resource which

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[12]For example, a **"Minimum Biological Acceptable Limit"** (MBAL), related to recruitment or reproductive biomass would be defined as a level beyond which the recruitment has 50% chances to fall below a critical level (R_{max} for instance or R_{mean}) or the residual spawning biomass (escapement) has 50% chances to fall below 20% of the virgin stock spawning biomass.

is not considered desirable. Fishery development should be stopped before reaching it. Limits are usually expressed in biological terms (e.g. minimum spawning biomass required) but could be expressed in economic terms also (minimum profitability).

258 When a LRP is reached, management action should severely curtail or stop fishery development, as appropriate, and corrective action should be taken. Stock rehabilitation programmes should consider an LRP as a very minimum rebuilding target to be reached before the rebuilding measures are relaxed or the fishery is re-opened.

259 An example is given by the rebuilding strategy adopted for the Southeast Australian stock of orange roughy *(Hoplostethus atlanticus)* following heavy overfishing between the late 1980s and the early 1990s. The Australian Fisheries Management Authority (AFMA) has endorsed, starting in 1995, a strategy to base Total Allowable Catches (TACs) on a target of 50% probability that the stock is at or above 30% of the spawning biomass present at the beginning of the fishery (Phillips and Rayns, 1995). This latter figure will be used, first, as a rebuilding target (TRP) and, as soon as it is reached (in 2004 according to forecasts), as an LRP.

Precautionary use of RPs

260 Contrary to what has been sometimes said or apparently understood, LRPs are not, by essence, more precautionary than TRPs and the relative degree of precaution they effectively provide depends on the way and spirit in which they are used. For example, in a context of high uncertainty as to their real position, f_{MSY} or MSY would not be precautionary TRPs as they could lead to the stock being overfished 50% of the time. It would indeed be more precautionary to use them as LRPs, as this would reduce the probability to overfish the stock. However, choosing different TRPs could be just as precautionary and possibly even more so. For instance, in the same uncertain context, using $F_{2/3MSY}$ as TRP could be more precautionary than using MSY as an LRP if this leads to a lower probability to overfish the stock inadvertently.

261 TRPs and LRPs will, usually, be used in combination and, most often refer to different system control or status variables. For instance, a TRP might be established in terms of a proportion of MSY (e.g. two thirds of MSY) and used together with an LRP established in terms of spawning biomass (e.g. 20% of the virgin one). The implication is that the manager will drive the fishery towards producing two-thirds of MSY while watching the evolution of the spawning biomass as effort increases (just as a captain will aim the vessel towards a destination while watching at the depth under the vessels's keel). The manager will immediately change the fishery TRP or the way the TRP is being approached, if the LRP is being too dangerously close (e.g., just as the captain will change the destination or the route to it if reefs signals appear in the echo-sounder).

Threshold Reference Points

262 A Threshold Reference Point indicates that the state of a fishery and/or a resource is approaching a TRP or a LRP, and that a certain type of action is to be taken (preferably agreed beforehand), to avoid (or reduce the probability) that the TRP or LRP is accidentally passed.

263 Fisheries (like highly computerized tankers) have a high level of inertia, due to

various financial, technical and administrative reasons. As a consequence, stopping them, reversing historical trends or more simply significantly changing them are not trivial tasks and may require time. Similarly, the life parameters of long-lived target species (e.g. low natural mortality and fecundity, late maturation and slow growth) are such that reversing resource trends and promoting their recovery once depleted tend to be very lengthy processes.

264 There is therefore a risk that, having effectively reached a TRP or an LRP, in a dynamis development process, it takes too long to effectively stop the unwanted evolution and to reverse trends, particularly when the target species are long-lived animals, leading to a risk of more extensive damage than foreseen when establishing these reference points.

265 In order to reduce the probability of inadvertently "crossing" a target or limit reference point, to facilitate decision on when action becomes necessary and should start, and, therefore, in order to increase the precautionary nature of a management set-up, one could set the TRPs and LRPs further ahead of the danger zone, adopting more precautionary levels for both of them (at the expense of foregoing some potential benefits).

266 If the cost of doing so appears too high or the risk of overshooting is considered low, one could add to the TRPs and LRP already established, some Threshold Reference Points (ThRPs). Fairly similar to LRPs in their utility, the ThRPs' specific purpose would be to provide an early warning, reducing further the risk that the TRP or LRP is inadvertently passed due to uncertainty in the available information or to the inertia of the management and industry systems. Just as in highly computerized tankers, "automatic" alarms are set to be automatically triggered if the distance to other vessels on route of collision, or the depth under the keel, falls below a pre-determined value.

267 Adding precaution to the management set-up, ThRPs might be necessary only for resources or situations involving particularly high risk.

7.3 Socio-economic reference points

268 A major difficulty in selecting socio-economic reference points for management resides in the task of calculating the resulting total benefits from the adoption of a particular precautionary management reference point (e.g. implying, for instance, a prudent reduction of effort and catches). It should be evident that the cost of the measure should be matched by its future benefits but that calculation is not trivial.

269 A major problem, highlighted by Shotton (1994), is that of the multiplicity of stakeholders and the diversity of time preferences between them. The implication of the so-called "future discounting" is that the future value of some management benefits is generally lower that the present value of the benefits from not applying the management measure. The degree to which present and future (discounted) value differ depends on the stakeholders and their objectives and on the likelihood that they will effectively receive the

theoretical benefit[13].

270 Another serious problem resides in the fact that fisheries (even EEZ ones) are multi-objective enterprises and it is difficult to summarize a set of socio-economic objectives into one single reference point.

271 To circumvent at least partially this difficulty, decision rules could also be established on economic grounds, related, for instance, to fishing capacity: e.g., if capacity increases faster than catches for a given number of years, then some capacity freezing action is taken. If capacity is higher than that required to take the allowable catch by more than a given percentage, then it should be reduced, etc.

272 The selection of socio-economic decision rules and economic reference points is difficult enough in national fisheries. In management of high seas, straddling, and highly migratory stocks, the difficulty is even higher owing to the divergence of economic situations of the various actors. In such a situation, the selected rules and references would have to be general enough to be acceptable to all parties and specific enough to be of practical use.

7.4 Ecosystem reference points

273 Ecosystem management is being recognized with increasing frequency as the necessary basis for fisheries management and the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) is often cited as the champion of the ecosystem management concept. The CCAMLR convention mentions *"the maintenance of ecological relationships between harvested, dependent and related species"* as well as the *"prevention of change or minimization of the risk of change in the marine ecosystem which are not potentially reversible"*. This requirement is precautionary in nature in the sense that it requires that the integrity and essential functions of the ecosystem must be preserved as a prerequisite to fisheries sustainability.

274 In practice, however, we do not yet know how to manage entire ecosystems and the recognition of this fact has sometimes led, in the international debate on the precautionary approach, to delete the requirement for to ecosystem management and to replace it by the more specific and, possibly, reachable goal of conserving not only the target species but also the associated and dependant species.

275 If the balance between ecosystem components must be maintained, minimizing by-catch or using extremely selective gear, as common sense suggests, might not be the best solution. It has been proposed, for instance, that, in multi-species management, a reasonable strategy would be to exploit all species in proportion to their abundance in order to maintain the overall ecosystem structure. This is, however, not easy to achieve without wastage of less demanded species; and additional work is certainly required on this matter before objective guidance can be given.

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[13]Considering the major impact of discount rates, the uncertainty about their future evolution, and the likely difference between "local" and "global" rates, a key problem of establishing socio-economic reference points is that of agreeing on these rates.

276 New guidelines and reference points are needed for a precautionary approach to ecosystem management, related to global stress indicators, resilience factors, habitat conditions, etc. Measures or scales of ecological stress need to be established and agreed upon if usable reference points are to be provided and effects classified as acceptable/unacceptable from an ecosystem point of view.

277 Clarification is also required, for example, on the measure of **ecosystem sustainability** and on the definition of **"impact reversibility"** of an impact on it. Ecosystems have a degree of natural variability and can shift from one equilibrium state to another because of natural environmental variability or human stress. Sustainability should therefore not be confused with constancy. As far as reversibility is concerned, fisheries management may be able to suppress unwanted fisheries impacts and rebuild productivity but there is no assurance that the ecosystem could be returned exactly to its **pristine state.**

278 Some of the aims and principles of ecosystem management can be found in the management charter of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) and in the 1990 Strategy for Sustainability elaborated by the World Conservation Union (IUCN). These include: minimizing conversion of critical ecosystems to "lower" conditions, compensating habitat conversion with restoration (allowing no net loss)[14], maintaining ecological relationships, maintaining populations at greatest net annual increment, restoring depleted populations, minimizing risk of irreversible change in the marine ecosystem, etc.

279 A useful principle could be to aim at maintaining all the fundamental components of the ecosystem (nurseries, spawning areas, feeding areas, migration routes, etc.) in order to ensure permanency of the ecosystem structure even though the abundance (or even the permanence) of some of its species components cannot be absolutely warranted.

280 Genetic conservation guidelines, when introduced, will make matters even more complicated as management will have to meet conservation requirements at the ecosystem, biodiversity, species and genetic levels. Nevertheless, the definition and analysis of management reference points and the behaviour of stocks and risks attached to those points should be one of the main applied research issues of the next decade if a precautionary approach to management is to be implemented.

281 The above considerations related to standards, rules and reference points demonstrate that a precautionary approach to management requires a thorough scientific effort to develop the scientific tools. Without these the concept of precaution will remain at the level of international rhetoric.

7.5 Acceptable Impacts

282 An **acceptable impact** could be defined as a negative, or potentially negative, alteration of the exploited natural system, resulting from human activities (i.e. fisheries and other impacting industries), the level and nature of which is considered as representing a

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[14] This concept of "compensation", which proposes that human activities should lead to "no net loss of habitat", implies that, if some part of a habitat must be damaged somewhere, compensation is provided somewhere else

low risk for the resource, system productivity, or biodiversity, on the basis of the available knowledge and level of uncertainty.

283 Such a definition implies that: (a) The risk has been assessed using the best available evidence and considered by parties concerned which agreed to it, in the light of the objectives stated for the resource; (b) The impact will never be fully accepted (in the sense of definitely approved) but it will be kept continually under review and decision about its acceptability eventually modified as knowledge progresses.

284 There is no doubt that fisheries have an impact on the ecosystem, reducing species abundance and reproductive capacity, possibly affecting habitats and genetic diversity. Some species might be endangered, especially when fisheries, natural variability, and environmental degradation by other industries combine their effects. An impact on the resource base cannot be totally avoided if fisheries are to produce a significant contribution to human food and development.

285 However, the biological effects of fishery activities are usually reversible and experience has shown that trends in biomass and species composition can be largely reversed when fishing effort is curtailed or fisheries are closed, even though rehabilitation may take some time and the characteristics of the "rehabilitated" system may not be accurately predicted[15]. Degraded habitats may require particularly long recovery times and higher rehabilitation costs.

286 If development and benefits are to be obtained from fish resources, some level of impact has to be accepted. In fisheries, a zero-impact strategy would be impossible to implement in practice. It would therefore be necessary to: (a) identify and forecast fishery effects (and risks) accurately enough, (b) agree on acceptable levels of impact (and risk) and (c) develop management structures capable of maintaining fisheries within these levels.

287 The concept of acceptable impact may be related to that of **assimilative capacity**. This capacity, which has generated considerable debate amongst those concerned with environmental protection (Hey, 1992), has been defined as "*a property of the environment which measures its ability to accommodate a particular activity or rate of activity without unacceptable impacts*" (GESAMP, 1990). It assumes that nature might be able to absorb a certain quantity of contaminants (e.g., effluents from urban concentrations, radioactive waste, heavy metals and other causes of dramatic and potentially non-reversible impacts) without significant effect.

288 However, with fisheries, the problem is different. Fishery resources do possess an assimilative capacity in terms of the fishing mortality they can withstand while still conserving most of their resilience or capacity to return to their original state once the fishery-induced stress is removed[16]. In a way, the concept of Maximum Sustainable

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[15]The introduction os exotic species and genetically modified organisms may be the most notable and serious exception to this observation as it is generally impossible to remove species (and certainly genes) them from the ecosystem once successfully introduced.

[16]Except in the case of serious damage of the habitat, and introduced species and GMOs.

Yield, enshrined in the 1982 Convention, could be considered a reference point corresponding to the "maximum assimilative capacity" of a stock in terms of fishing stress, i.e. a level of stress beyond which fisheries should not be allowed to go, and perhaps not even to approach[17].

289 The principles listed above imply an agreement on an acceptable level of impact. The situation becomes more complex when considering the assimilative capacity of a multi-species resource or an ecosystem for which no means of measurement are yet available.

290 The degree of acceptability of impacts (or risks) will be determined, inter alia, in terms of risk-benefit trade-offs with proper weighting given to long-term societal needs and value of natural assets. This requires research capacity to separate the effects of "natural" year-to-year fluctuations and the impacts of fishing from anthropogenic degradation, including global climate change. It requires the development of an effective enforcement capacity to ensure that such levels will be respected. Finally, it requires the establishment of **"safety net arrangements"** (e.g., in terms of insurance, compensation, etc.) to protect the users and the resource from hazardous occurrences.

291 There is no scientific criteria to determine objectively what is acceptable to society[18]. One of the important prerequisites for the effects of fishing to be acceptable to society could be that they should be **reversible**[19] if the fishing pressure is reduced or suppressed. It is likely, however, that what may be acceptable to some countries or user-groups may not be acceptable to others, and the relevance and importance of traditions and culture in this respect should not be underestimated.

292 Decisions on what impact could or not be allowed are comparatively easy when risks are known and extremely high. Proposals to prohibit, even without any scientific background, the use of explosives to fish (say, in the high seas) would probably not meet with much international opposition because harmful fisheries techniques (e.g., dynamite and poison) are normally banned by national fisheries legislation. However, deciding whether a 5 per cent by-catch of sharks in a long-line tuna fishery is acceptable would require more careful consideration and debate.

293 Science should provide the methods needed to forecast and measure the impacts, as well as objective criteria on the basis of which agreements can be reached. The difficulty in this regard will not be less than in other scientific mandates (e.g. that of determining MSY) and we should expect considerable scientific argument on the type of

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[17]Research has amply demonstrated during the last two decades that even at MSY, stock instability and risk of recruitment failure are sometimes already high. This, added to the fact that MSY and the fishing rate corresponding to it are usually difficult to determine accurately, should lead us to consider MSY as a non-precautionary target for stocks with low resilience or high natural variability.

[18]Even though alternatives and their consequences (including for society) can be scientifically analysed, and transitory agreements might be reached on their basis.

[19]It has already been mentioned that this requirement was particularly critical in the case of introductions of species and GMOs.

impact one might expect and on the level of certainty with which it can be determined.

294 The degree of acceptability of any impact will only be established after intense negotiations between the parties concerned. These are unlikely to proceed easily or rationally if undertaken in a context of crisis. It is therefore advisable to integrate negotiations on impact into the management process before stocks are damaged and before potential socio-economic problems reach an overwhelming level.

295 Cooke (1994) proposes, for instance, that when information to set a full-fledged management system is lacking, precautionary exploitation rates could be limited to 1% of the original biomass estimate. He argues, rightly, that this rate might still be too high for some very long-lived species. One should note, equally, that such a rate would be extremely and unjustifiably low for all short-lived tropical stocks where sustainable annual catches can be equal or higher to standing stock biomass and might sustainably by about 30-50% of the virgin stock biomass.

296 Returning to the old approximative rule that the fishing mortality at MSY is close to natural mortality (Gulland, 1971) and recognizing its shortcomings, one could suggest a less arbitrary and more flexible precautionary rate of exploitation. One could, for instance decide that precautionary exploitation rates should never approach natural mortality rates (if only because catching MSY is not desirable) and be limited to, say, 25% of these levels. In other words, it could be decided that:

$$F_{Prec} = 0.25 \times M$$

leading to catches below 1% of the biomass per year for very long-lived animals, but well above 25% for others, with equivalent degrees of precaution.

7.6 Practical Guidelines

297 In most fishery systems, a progressive but systematic and decisive shift towards more risk-averse exploitation and management regimes is advisable. This implies that precautionary measures for fisheries management should be widely used as a means to avoid crises and reduce long-term costs to society.

298 Because uncertainty is pervasive in the ocean ecosystem and fisheries, precaution should become an integral part of fishery management systems, to be aplied routinely in decision making. Unnecessarily stringent and costly measures, should be avoided as they would rapidly become counter-productive by deterring fishery authorities from using the concept as widely as possible and discrediting the approach among industry.

299 A precautionary management strategy would need both a sufficient **preventive capacity** to avoid predictable problems, and enough **reactive (corrective) capacity**, flexibility and adaptability to ensure a safe "trial-and-error" process, as knowledge about how the system works is collected (stepwise decision making).

300 Precautionary management strategies should recognize the uncertainties in the data and promote adaptability and flexibility of management regimes through appropriate institutions and decision-making processes. These would rely not only on expert advice but also on people's participation.

301 In case of doubt, decisions should "**err on the safe side**" with due regard to the risk for the resource and the social and economic consequences.

302 A fishery management policy based on a reasonable interpretation of the concept of precaution should: (a) explicitly adopt the principle of sustainable development as defined by the FAO Conference[20], (b) select a set of objectives broadly compatible with it and (c) adopt a precautionary approach based on the following measures:

Promotion and use of research

303 - Promote research in support of the precautionary approach to management, e.g. research aiming at understanding better the conservation requirements at the ecosystem, biodiversity, species and genetic levels as well as research towards better definition of management reference points.

304 - Use the best scientific evidence available and, if it is not sufficient, invest in emergency research while interim management measures are taken at the level required to limit risk of irreversible damage;

305 - Improve information systems commensurate with the level of risk, covering costs through fishing fees as required, addressing all resources, directly or indirectly affected, and promoting joint research programmes in international and regional arrangements;

306 - Experiment with management strategies and pilot development projects with the support of research generalizing the use of Environmental Impact Assessment (EIA).

Reference points, rules and criteria

307 - Adopt a set of objectives for the fishery and a related set reference points (broader that the traditional MSY) and management benchmarks, and use the latter to measure the efficiency of the management system (e.g., in relation to fleet capacity targets or spawning stock size);

308 - When alternative options are considered, adopt a risk-averse attitude based, inter alia, on the following elements: (a) Consider *a priori* that fisheries have a negative impact on the resources, and minimize the risk of this impact being too drastic or irrevesible; (b) Consider that recruitment is likely to be affected by fishing and act accordingly.

309 - Ensure that precautionary management plans specify, *inter alia*, the data to be collected and used for management and their precision, the methods of stock assessment, the decision rules and reference points needed for determining and

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[20] "Sustainable development is the management and conservation of the natural resource base, and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for present and future generations. Such development conserves land, water, plant genetic resources, is environmentally non-degrading, technologically appropriate, economically viable and socially acceptable."

initiating management measures as well as measures to be taken in case of danger for the resource.

310 - Adopt provisional reference points when data are poor or lacking, established by analogy with other similar and better known fisheries, and update/revise them as additional information becomes available.

311 - View Maximum Sustainable Yield (MSY) as a minimum international standard, that fishing mortality does not exceed the level needed to produce it and that stock biomass is maintained above it.

312 - Adopt precautionary management reference points should be defined, based on agreed scientific procedure and models, including Target Reference Points (TRPs) and Limit Reference Points (LRPs). Because of the uncertainty inherent in their determination, these reference points should preferably relate to probabilities.

313 - Adopt action-triggering thresholds and management strategies which include pre-agreed courses of action, automatically implemented if the stock or the environment approaches or enters a critical state as defined by pre-agreed rules, criteria and reference points[21];

314 - Adopt Threshold Reference Points (ThRP) where local conditions require it, to indicate that the state of a fishery and/or a resource is approaching a TRP or a LRP, and that a certain type of action (preferably agreed beforehand) is to be taken, to avoid (or reduce the probability) to accidentally go beyond the selected TRPs or LRPs.

315 - Ensure that management action maintains the stock around the selected TRP on average (e.g. through establishment of total allowable catches and quotas or through effort controls).

316 - Severely curtail or stop fishery development, as appropriate, when the probability of exceeding the adopted LRP is higher than a pre-agreed level, and take any corrective action deemed necessary, including stock rehabilitation programmes with the LRP as a very minimum rebuilding target to be reached before the rebuilding measures are relaxed or the fishery is re-opened.

317 - Bring into force, "automatically" the set of pre-established measures, or courses of action, when a ThRP is reached particularly in cases or situations involving particularly high risk.

318 - Ensure that selected reference points are robust to short and long-term fluctuations in fish stocks due to recruitment variability and other factors and that they are periodically re-assessed as new data is collected as new understanding or methods become available.

319 - Agree on a set of criteria and rules before a crisis develops. They would be the

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[21] One of these courses of action could be a moratorium, but if reference points are selected on a cautious basis and monitoring produces information on a quasi-real-time basis, a range of actions is available (seasonal or temporary closures, modification of fishing patterns, significant reduction of effort, etc.)

basis for agreement on the degree of harmfulness of a new fishing technique or practice;

320 - For newly discovered stocks, establish safe biological limits (in absolute or relative terms) and threshold reference points from the onset; prohibit large scale development; limit removals, through effort and catch limitations and resource allocation schemes, to a fraction of the stock well below annual natural mortality; set-up monitoring and assessment programmes on the target and associated species.

321 - Aim at maintaining the fundamental components of the ecosystem (nurseries, spawning areas, feeding areas, migration routes, etc.), minimizing their degradation and, where possible, re-establishing them in order to ensure permanency of the ecosystem structure and productivity mechanisms even though the abundance (or even the permanence) of some of its species components cannot be absolutely warranted.

Acceptable impacts

322 - Promote discussion and agreement on acceptable levels of impact (and risk) in a process that will identify trade-offs and promote transparency, particularly in relation to public opinion;

323 - Take into account the combined stresses of fishing and environment on resources. Effort reductions may be imposed or special measures affecting fisheries taken when the stock faces unusually unfavourable environmental conditions;

324 - Address as far as possible all combined stresses to the resource, including those imposed by non-fishing activities or related to natural fluctuations[22].

325 - Prohibit irreversible impacts as well as decrease of any population of marine species below the which ensures the greatest net annual increment of biomass (i.e. the MSY level). For overfished fisheries, an important objective should be to rebuild the stock at least to that level.

326 - Set catch and effort levels for target species in accordance with the requirement that they do not result in unsustainable levels of mortality for both target and non-target species.

Management framework

327 - Manage fisheries in the context of integrated management of coastal areas, raising sectoral awareness about exogenous impacts on fisheries productivity;

328 - Improve participation of, and dialogue with, non-fishery users, taking all interests into account when developing and managing fisheries as required in Agenda 21, improving management transparency and reporting procedures;

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[22]This means that restrictive action on fishing might be needed when the causal mechanism is natural (e.g. related to El Niño, droughts, or other medium-term natural fluctuations).

329 - Improve decision-making procedures replacing consensus decision-making by voting procedures wherever possible.

330 - Strengthen monitoring, control and surveillance, thereby improving detection and enforcement capacity (including legal tools), raising penalties to deterrent levels and exerting more vigilant and effective flag State and port State responsibilities;

331 - Avoid overburdening of management systems and industry by limiting the number of precautionary devices and measures implemented at all times, based on an analysis of the probability of occurrence of negative impacts of a certain magnitude, pre-agreed as part of the management scheme, and reflected in appropriate reference points.

332 - Establish "**safety net arrangements**" (e.g., in terms of insurance, compensation, etc.) to protect the users and the resource from hazardous occurrences.

333 - Establish precautionary management regimes for all resources and for the entire stock accros its area of distribution, whether in EEZs, in the high seas, or both in case of transboundary resources (high seas, straddling and highly migratory resources) as part of compatible management regimes.

8. IMPLICATIONS FOR SPECIES INTRODUCTIONS

(To be developed later)

8.1 Main issues

8.2 Implications for research

8.3 Implications for technology development and transfer

8.4 Implications for management

8.5 The ICES-EIFAC guidelines

CONCLUSIONS

(To be revised)

334 A widely applied precautionary approach offers an opportunity to reduce substantially the risk created by the fisheries on the resources and ecosystem, in line with the requirements of UNCED.

335 Hermitte and Noiville (1993) draw attention on the risk of erosion of the precautionary system because, for the moment, and despite international agreements (at UNCED, in the UN Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks) a large part of the scientific, economic and political community have not endorsed, in practice, the legitimacy of an approach which considers technology as dangerous *a priori* with the risk to slow down its development. These authors indicate (in the field of biotechnology) that there are strong pressures to dismantle the regulatory system which contains the instruments for its own dismantling.

336 The same situation exists in the fishery sector which rightly refuses to be assimilated to a polluting industry. Until now, the risks invoked (mainly by NGOs) referred

to risks to the resource and the environment. Following the clamorous economic and social disaster represented by mismanagement of stocks in the Northwest Atlantic, the issue of socio-economic risk to the fishing sector and communities may start taking more relevance as fishermen and governments realize that "future generations" are not only those of the next decades but also those of tomorrow.

337 To be efficiently implemented, the precautionary approach requires both: (a) an explicit set of objectives; (b) a well define set of users with defined user rights and obligations; (c) an adequate, independant and recognized research capacity and advisory mechanism; (d) an efficient decision-making structure[23]; (e) a scientifically established monitoring system; and (f) a deterrent enforcement system.

338 Independant expertise is required to support the development of national, regional and international norms of good conduct and advise on the precautionary nature of a proposal in a particular situation[24]. The active participation of industry is essential but experience has shown the dangers of normative systems controlled by industry (Hermitte and Noiville, 1993). In EEZs, the State must be the warrant of the adequacy of the advisory and decision-making system.

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[23]Particularly when the potential effects of a technology might affect other countries or users than those introducing it (e.g. impacts on transboundary resources, aquatic environments, etc.).

[24]A gear might be inocuous in a given ecosystem, in normal conditions, but not advisable in others (e.g in ecosystem damaged by other factors than fishing, series of droughts, ecosystem in a rebuilding phase, etc.).

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ANNEX 1

DRAFT FAO CODE OF CONDUCT FOR RESPONSIBLE FISHERIES

(Extract of Article 6: Fisheries Management)

6.5 Precautionary approach

6.5.1. In order to reduce the risk of damage to the marine environment and living aquatic resources, the precautionary approach should be widely applied.

6.5.2. In applying precautionary approach, fisheries management authorities should take into account, *inter alia*, uncertainties with respect to the size, productivity and state of the stocks, management reference points, levels and distributions of fishing mortality and the impact of fishing activities on associated and dependent species including discard mortality, as well as climatic, environmental, social and economic conditions.

6.5.3. The precautionary approach should be based on the best scientific evidence available, include all appropriate techniques and be aimed at setting stock-specific minimum standards for conservation and management. Fishery management authorities should be more cautious when information is poor. They should determine precautionary management reference points and apply precautionary measures consistent with management objectives.

6.5.4. When precautionary or limit reference points are approached, measures should be taken to ensure that they will not be exceeded. These measures should where possible be pre-negotiated. If such reference points are exceeded, recovery plans should be implemented immediately to restore the stocks.

6.5.5. In the case of new or exploratory fisheries, conservative measures including precautionary catch or effort limits should be established as soon as possible in cooperation with those initiating the fishery and should remain in force until there are sufficient data to allow assessment of any increase in fishery intensity on the long-term sustainability of stocks and associated ecosystems.

ANNEX 2

EXTRACT OF THE NEGOTIATING TEXT OF THE UN CONFERENCE ON STRADDLING FISH STOCKS AND HIGHLY MIGRATORY FISH STOCKS (A/CONF.164/13, March 1994)

5. In order to protect the environment and the living marine resources, the precautionary approach shall be applied widely by States to fisheries management and exploitation, in accordance with the following provisions:

(a) States shall act so as to obtain and share the best scientific evidence available in support of conservation and management decision-making. States shall take into account uncertainties with respect to the size and productivity of the targeted stock levels and distribution of fishing mortality, and the impact of fishing activities on associated and dependent species, as well as other relevant factors, including climatic, oceanic and environment changes;

(b) The absence of adequate scientific information shall not be used as a reason for failing to take strict measures to protect the resources;

(c) Use of the precautionary approach shall include all appropriate techniques, including, where necessary, the application of moratoria;

(d) In cases where the status of stocks is of concern, strict conservation and management measures shall be applied and shall be subject to enhanced monitoring in order to review continuously the status of stock(s) and the efficacy of the measures to facilitate revision of such measures in the light of new scientific evidence;

(e) In the case of new or exploratory fisheries, conservative catch and/or effort limits shall be established as soon as possible and shall remain in force until there are sufficient data to allow assessment of the impact of the fishery on the long-term sustainability of the stocks and associated ecosystems.

ANNEX 3

EXTRACT OF THE NEGOTIATING TEXT OF THE UN CONFERENCE ON STRADDLING FISH STOCKS AND HIGHLY MIGRATORY FISH STOCKS (A/CONF.164/13/Rev.1 of 30/3/1994)

B. Precautionary approaches to fisheries management

In order to protect the environment and the living marine resources, consistent with the Convention, the precautionary approach shall be applied widely by States and by regional or sub-regional fisheries management organizations or arrangements to fisheries conservation, management and exploitation, in accordance with the following provisions:

(a) In order to improve conservation and management decision-making, States shall obtain and share the best scientific information available and develop new techniques for dealing with uncertainty. States shall take into account, inter alia, uncertainties, including with respect to the size and productivity of the stocks, management reference points, stock condition in relation to such reference points, levels and distributions of fishing mortality, and the impact of fishing activities on associated and dependent species, as well as climatic, oceanic, environmental changes and socio-economic conditions;

(b) In managing fish stocks, States should consider the associated ecosystems. They should develop data collection and research programmes to assess the impact of fishing harvesting on non-target species and their environment, adopt plans as necessary to ensure the conservation of non-target species and consider the protection of habitats of special concern;

(c) The absence of adequate scientific information shall not be used as a reason for postponing or failing to take measures to protect target and non-target species and their environment;

(d) The precautionary approach shall, based upon the best scientific evidence available, include all appropriate techniques and be aimed at setting stock-specific minimum standards for conservation and management. States shall be more cautious when information is poor. States should determine precautionary management reference points taking into account the guidelines contained in Annex 2 (see below), and the action to be taken if they are exceeded. When precautionary management reference points are approached, measures shall be taken to ensure that they will not be exceeded. If such reference points are exceeded, recovery plans shall be implemented immediately in order to restore the stock(s) in accordance with pre-agreed courses of action;

(e) In cases where the status of stocks is of concern, strict conservation and management measures shall be applied and shall be subject to enhanced monitoring in order to review continuously the status of stocks and the efficacy of the measures to facilitate revision of such measures in the light of new scientific evidence;

(f) In the case of new or exploratory fisheries, conservative measures including catch

and/or effort limits shall be established as soon as possible in cooperation with those initiating the fishery, and shall remain in force until there are sufficient data to allow assessment of the impact of the fishery on the long-term sustainability of the stocks and associated ecosystems.

Suggested guidelines for applying precautionary reference points in managing straddling fish stocks and highly migratory fish stocks. (Annex 2 of (A/CONF.164/13/Rev.1)

1. Management strategies should seek to maintain and restore populations of harvested stocks at levels with previously agreed precautionary reference points. These strategies should include measures which can be can be adjusted rapidly as reference points are approached;

2. Conservation and management objectives should be stock-specific and take account of the characteristics of fisheries exploiting the stock.

3. Distinct reference points are used to monitor progress against conservation and management objectives. Reference points should incorporate all relevant sources of uncertainty. When information for determining reference points for a fishery is poor or absent, provisional reference points should be set. In such situation, the fishery should be subject to enhanced monitoring so as to revise reference points in light of improved information as soon as possible.

4. Reference points related to conservation should be chosen to warn against over-exploitation. Management strategies using such reference points should ensure that the risk of exceeding them is low. In this context, Maximum Sustainable Yield should be viewed as a minimum international standard. Conservation-related reference points should ensure that fishing mortality does not exceed and that stock biomass is maintained above, the level needed to produce the Maximum Sustainable Yield. For already depleted stocks, the biomass which can produce Maximum Sustainable Yield can serve as an initial rebuilding target.

5. Management-related reference points provide an indicator as to when and how quickly maximum allowable levels of stock removals are being approached. Management action should ensure that such reference points, on average, are not exceeded.

ANNEX 4

DRAFT AGREEMENT FOR THE IMPLEMENTATION OF THE PROVISIONS OF THE UNITED NATIONS CONVENTION ON THE LAW OF THE SEA OF 10 DECEMBER 1982 RELATING TO THE CONSERVATION AND MANAGEMENT OF STRADDLING FISH STOCKS AND HIGHLY MIGRATORY FISH STOCKS

(A/CONF.164/22/Rev.1)

Article 6: The application of the precautionary approach

1. States shall apply the precautionary approach widely to conservation, management and exploitation of straddling fish stocks and highly migratory fish stocks in order to protect the living marine resources and preserve the marine environment.

2. States shall be more cautious when information is uncertain, unreliable or inadequate. The absence of adequate scientific information shall not be used as a reason for postponing or failing to take conservation and management measures.

3. In applying the precautionary approach, States shall:

(a) improve decision-making for fishery resource conservation and management by obtaining and sharing the best scientific information available and implementing improved techniques for dealing with risk and uncertainty;

(b) apply the guidelines set out in Annex 2 and determine, on the basis of the best scientific information available, stock-specific reference points and the action to be taken if they are exceeded;

(c) take into account, inter alia, uncertainties relating to the size and productivity of the stock(s), reference points, stock condition in relation to such reference points, levels and distributions of fishing mortality and the impact of fishing activities on non-target and associated or dependent species, as well as oceanic, environmental and socio-economic conditions; and

(d) develop data collection and research programmes to assess the impact of fishing on non-target and associated or dependent species and their environment, adopt plans as necessary to ensure the conservation of such species and protect habitats of special concern.

4. States shall take measures to ensure that, when reference points are approached, they will not be exceeded. In the event that such reference points are exceeded, States shall, without delay, take the additional conservation and management action determined under paragraph 3(b) to restore the stock(s).

5. If a natural phenomenon has a significant adverse impact on the status of straddling fish stock(s) or highly migratory fish stock(s), the relevant coastal States and States fishing those stock(s) on the high seas shall, directly or through the relevant subregional or regional fisheries management organization or arrangement, cooperate for the adoption, without delay, of emergency conservation and management measures to ensure that fishing activity does not exacerbate the adverse impact of the natural phenomenon on the stock(s). Such emergency measures shall be temporary in nature and shall be based on the best scientific evidence available.

6. Where the status of target stocks or non-target or associated or dependent species is of concern, States shall subject those stocks and species to enhanced monitoring in order to review regularly their status and the efficacy of conservation and management measures and shall revise those measures in the light of new information.

7. For new or exploratory fisheries, States shall establish conservative conservation and management measures as soon as possible, including, inter alia, catch and effort limits. Such measures shall remain in force until there are sufficient data to allow assessment of the impact of the fishery on the long-term sustainability of the stocks, whereupon conservation and management measures based on that assessment shall be implemented, which, if appropriate, allow for the gradual development of the fishery.

ANNEX 5

REPORT OF THE WORKING GROUP ON REFERENCE POINTS FOR FISHERIES MANAGEMENT[25]
(A/CONF.164/WP.2 of 24.3.1994)

Technical Guidelines on Biological Reference Points

1. INTRODUCTION

1. The United Nations Convention on the Law of the Sea (articles 6 and 119) obliges States to take measures, based on the best scientific evidence available, to maintain or restore harvested stocks at a level which can produce MSY as modified by relevant environmental and economic factors. In order to accomplish this goal, MSY should be adopted as a limit reference point rather than target reference point as described below. However, for already depleted stocks the biomass which can produce MSY may serve as an initial rebuilding target.

2. Many fish stocks around the world are currently depleted. Improvements in fishing technology have allowed fleet fishing power to increase rapidly and to move quickly from one fishery to another. Maximum sustainable yield (MSY) can often be exceeded in the early period of a fishery, resulting in resource depletion, associated ecological changes and serious economic problems. Although this is largely due to the lack of efficient controls, enforcement and compliance, the establishment of a set of biological reference points would contribute to better and more precautionary management.

3. Distinction should be made between limit reference points and target reference points. Limit reference points are boundaries which constrain utilization within safe biological limits and beyond which resource rebuilding programmes are required. Target reference points guide policy makers in resource utilization.

4. Reference points for a given stock are developed from biological models which need to take into account the best possible estimates of all sources of mortality, and should incorporate the special biological characteristics of each stock. Therefore, to develop reference points, stocks must be regarded as a biological unit throughout their range of distribution. Information on the state of the resource should cover the entire biological unit for comparison with reference points. this will require the identification of biological units for straddling fish stocks and highly migratory fish stocks.

5. As pollution from land and sea-based sources affect fishery resources productivity and resilience, as well as fishery product safety and quality, management should include not only reference points and measures to control fishing, but also action to promote the reduction and, where feasible, the elimination of pollution and degradation of critical habitats.

6. The documents prepared by FAO for the Conference on the precautionary approach and

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[25]This document is the report of the Working Group on Reference Points for Fisheries Management. The Group agreed that all concepts contained in this document reflect its consensus. However, there was insufficient time avaiable to polish the drafting of paragraph 4 in this report.

reference points for fisheries management, contains useful information and further guidance on these subjects and should be used in conjunction with the present document.

2. DEVELOPMENT OF MANAGEMENT OBJECTIVES

7. Prior to deciding upon a set of reference points, management objectives must be agreed upon. Reference points are not management objectives; they simply serve as a guide to aid managers in choosing from the range of options open to them.

8. The concept of optimal utilization in the United Nations Convention on the Law of the Sea includes the importance of economic and environmental factors as a basis for setting fisheries management objectives. However, optimal utilization does not have a simple technical definition and cannot be addressed with a single reference point. Therefore, a set of reference points is needed to take these factors into account, on the basis of the best scientific evidence available and with an explicit recognition of uncertainty.

9. Objectives must be set explicitly in order to be able to assess the success of the management procedures. The setting of objectives should, whenever possible, include the specification of the relative importance of different objectives in the overall policy. As objectives are often not explicitly stated, scientific advice must aim at providing an analysis of management options and their implications for the fishery.

10. There are a wide variety of complex objectives in the development of management policy for straddling fish stocks and highly migratory fish stocks. States may have many, sometimes competing, management objectives. However a fundamental objective for all concerned must be the long-term conservation and utilization of fishery resources, and where feasible, other species of concern. That objective can be achieved, inter alia, through a precautionary approach to management of fisheries resources in their ecosystems.

3. TARGET AND LIMIT REFERENCE POINTS

11. A reference point is an estimated value derived from an agreed scientific procedure and an agreed model to which corresponds a state of the resource and of the fishery and which can be used as a guide or fisheries management. Reference points should be stock-specific to account for the reproductive capacity and resilience of each stock and are usually expressed as fishing mortality rates or biomass levels.

12. Two types of reference points, limit reference points and target reference points, should be used. Limit reference points are designed for conservation and warn against the-risk of over exploitation. Target reference points are designed to indicate when an objective is being approached.

13. Agreement on the appropriate technically defined set of reference points is a prerequisite for a common approach to the management of straddling or highly migratory resources. By introducing limit reference points for triggering pre-agreed management responses, action may be facilitated when a problem occurs.

14. The fishery management strategy should be developed in a multispecies context and describe the action that is taken as resource status changes. Management strategies need to be developed for each fishery, including newly developing fisheries, and account for the biological characteristics of the resources by the use of appropriate reference points. These

management strategies should take into account species belonging to the same ecosystem or dependent on, or associated with, a target species.

15. Provisional limit and target reference points can usually be established, even when data are poor or lacking by analogy with other similar and better known fisheries. In all cases, reference points should be updated as additional information becomes available.

16. For broad application of the precautionary approach to stock conservation, it is important to agree on a minimum international guideline for management. With respect to the use of reference points, an appropriate minimum guideline is to apply MSY as a limit on fisheries. Fishing mortality should not be permitted to exceed the level that would produce MSY and stock biomass should be maintained above the level needed to produce MSY. The choice of target reference points should be made such that there is low risk of exceeding the MSY limit reference point after accounting for all major sources of uncertainty. This guidance should be viewed as a minimum and not preclude more conservative management strategies.

4. ACCOUNTING FOR UNCERTAINTY

17. To account for uncertainty, management strategies should be so designed that they will maintain or restore the stock at a level consistent with the selected reference points. Uncertainty always occurs In the advice with respect to the current position of the fishery in relation with the reference points. It is vital that uncertainty be quantified and used explicitly in the analysis.

18. The major sources of uncertainty are incomplete and/or
inaccurate fishery data, natural variability in the environment and imperfect specification of models of the resources. Simulation studies which incorporate the expected variability and bias in input parameters and uncertainty concerning the factors controlling stocks should be used to scientifically evaluate management strategies. Results must be interpreted in a probabilistic way to reflect these uncertainties.

19. For a limit reference point, management actions should be taken if analysis indicates that the probability of exceeding the limit is higher than a pre-agreed level. If a stock falls below a limit reference point or is at risk of falling below it, action on the fishery is required to facilitate the rebuilding of the biomass whether or not the decrease is caused by the fishery or is related to environmental fluctuations.

20. The estimates of the reference points should be continuously revised as fisheries evolve and new information is obtained, particularly in the case of stocks subject to strong environmental fluctuations. Both biological and environmental studies will be necessary to facilitate this updating.

21. To be amenable to scientific evaluation, management plans should specify, inter alia, the data to be collected and used for management and their precision, the methods of stock assessment, as well as the decision rules for determining and initiating management measures.

5. LINKAGE TO MANAGEMENT

22. In order to estimate reference points, states should cooperate to promote the collection of data necessary for the assessment, conservation and sustainable use of the

marine living resources, and develop and share analytical and predictive tools. Precaution should be exerted at all levels of management, in defining data requirements, developing stock assessment methods, elaborating management measures. The need for precaution requires the development of an effective capacity to rapidly take action for resource conservation and management. To facilitate this, the selection of reference points should be flexible to allow practical approaches to management.

23. To design effective management strategies, the management process needs to be clarified. It should include the specification of management objectives, development of limit and target reference points, agreement on management actions and assessment of management performance with respect to the accepted reference points. Management steps should ensure that target reference points are not exceeded on average and that the risk of exceeding limit reference points is low.

24. In some fisheries, the management approach used has had the undesirable effect of deteriorating the quality of the data collected. Management procedures should specifically be designed to reduce uncertainties in the data.