

CHAPTER 1

FISHERIES MANAGEMENT

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1. WHY DO WE NEED THIS GUIDEBOOK?

Fish and fisheries are an integral part of most societies and make important contributions to economic and social health and well-being in many countries and areas. It has been estimated that approximately 12.5 million people are employed in fishery-related activities, and in recent years global production from capture fisheries has tended to vary between approximately 85 and 90 million tonnes. The products from these fisheries are used in a wide variety of ways, ranging from subsistence use to international trade as highly sought-after and highly-valued items. The value of fish traded internationally is approximately US\$40 billion per year.

Despite this enormous importance and value, or more correctly, because of these attributes, the world's fish resources are suffering the combined effects of heavy exploitation and, in some cases, environmental degradation. The FAO (2000) estimated that, in 1999, 47% of the 441

stocks for which some information on status was available were fully exploited, 18% overexploited, 9% depleted and 1% recovering. This pattern is broadly consistent with similar statistics available from other regions. For example, the National Marine Fisheries Service of the United States of America estimated in 1998 that 30% of the stocks in the waters of that country for which information was available were overfished. In the waters of the European Community, it was estimated that in 1990, 57% of the stocks were 'heavily exploited'. Fish stocks throughout the rest of the globe are likely to be in a similar condition to those in these regions.

There are many reasons for this unacceptable state of affairs, but the primary reasons all come down to a failure in fisheries governance in most countries. The responsibility for declining stocks and falling economic returns and employment opportunities in fisheries must be shared amongst fishers, fisheries management authorities, fishery scientists and those involved in environmental degradation. Not all of the underlying problems lie within the realm of fisheries management, but the fisheries manager is the person who is most often in the best position to observe and record what is happening in the fisheries under his or her jurisdiction, to establish the underlying cause or causes of any problems, to rectify those within their jurisdiction, and to bring the others to the attention of both the interested parties in fisheries and those with a responsibility covering the external causes. However, all too often the fisheries manager remains either unaware of the state of the resources, or fails to act sufficiently as the fisheries slip further and further into decay and crisis, or both. This is rarely, if ever, a deliberate choice and more often comes down to a lack of available information, an incomplete understanding of the nature of the task of fisheries management, and inadequate resources, structures and support to address the problems and utilise the resources in a planned and efficient manner.

The FAO Code of Conduct for Responsible Fisheries was produced in response to global concern over the clear signs of over-exploitation of fish stocks throughout the world and to recommend new approaches to fisheries management which included conservation, environmental, social and economic considerations. It was developed by and through FAO and was accepted as a voluntary instrument by the 28th Session of the FAO Conference in October 1995. In addition to five introductory Articles and one on General Principles, the Code contains six thematic articles on Fisheries Management, Fishing Operations, Aquaculture Development, Integration of Fisheries into Coastal Area Management, Post-Harvest Practices and Trade, and Fisheries Research. Overall it incorporates the key considerations in responsible fisheries and provides guidance on how these should be addressed in order to ensure sustainable and responsible fisheries. Subsequently, FAO has produced a number of Technical Guidelines on different aspects of the Code, including the FAO Technical Guidelines for Responsible Fisheries No. 4: Fisheries Management, which specifically addresses Article 7: Fisheries Management of the Code. The following Technical Guidelines had been produced at the time of printing this Guidebook (late 2001):

No. 1 Fishing Operations

No. 1, Suppl.1 Fishing Operations. Vessel Monitoring System

No. 2 Precautionary Approach to Capture Fisheries and Species Introductions

No. 3 Integration of Fisheries into Coastal Area Management

No. 4 Fisheries Management

No. 4, Suppl.1 Fisheries Management. Conservation and Management of Sharks

No. 5 Aquaculture Development

No. 5, Suppl.1 Aquaculture Development. Good Aquaculture Feed Manufacturing Practice

No. 6 Inland Fisheries

No. 7 Responsible Fish Utilization

No. 8 Indicators for Sustainable Development of Marine Capture Fisheries

This Guidebook has been produced to supplement the Code of Conduct and the Technical Guidelines No. 4 (FAO, 1997), in order to provide managers with additional and more detailed information in determining the scope of their task and how to execute their fisheries management functions. It cannot address in detail all of the issues which fall under Article 7 of the Code, the Article dealing directly with fisheries management, but focuses mainly on those aspects directly related to strategic and operational management of the fisheries themselves and the resources on which they depend. These are the areas in which the fisheries manager generally holds a direct mandate and responsibility.

2. WHAT IS FISHERIES MANAGEMENT?

There is no clear and generally accepted definition of fisheries management. We do not wish to get embroiled in a debate about exactly what fisheries management is and isn't, but use here the working definition used in the Technical Guidelines to provide a summary of the task of fisheries management:

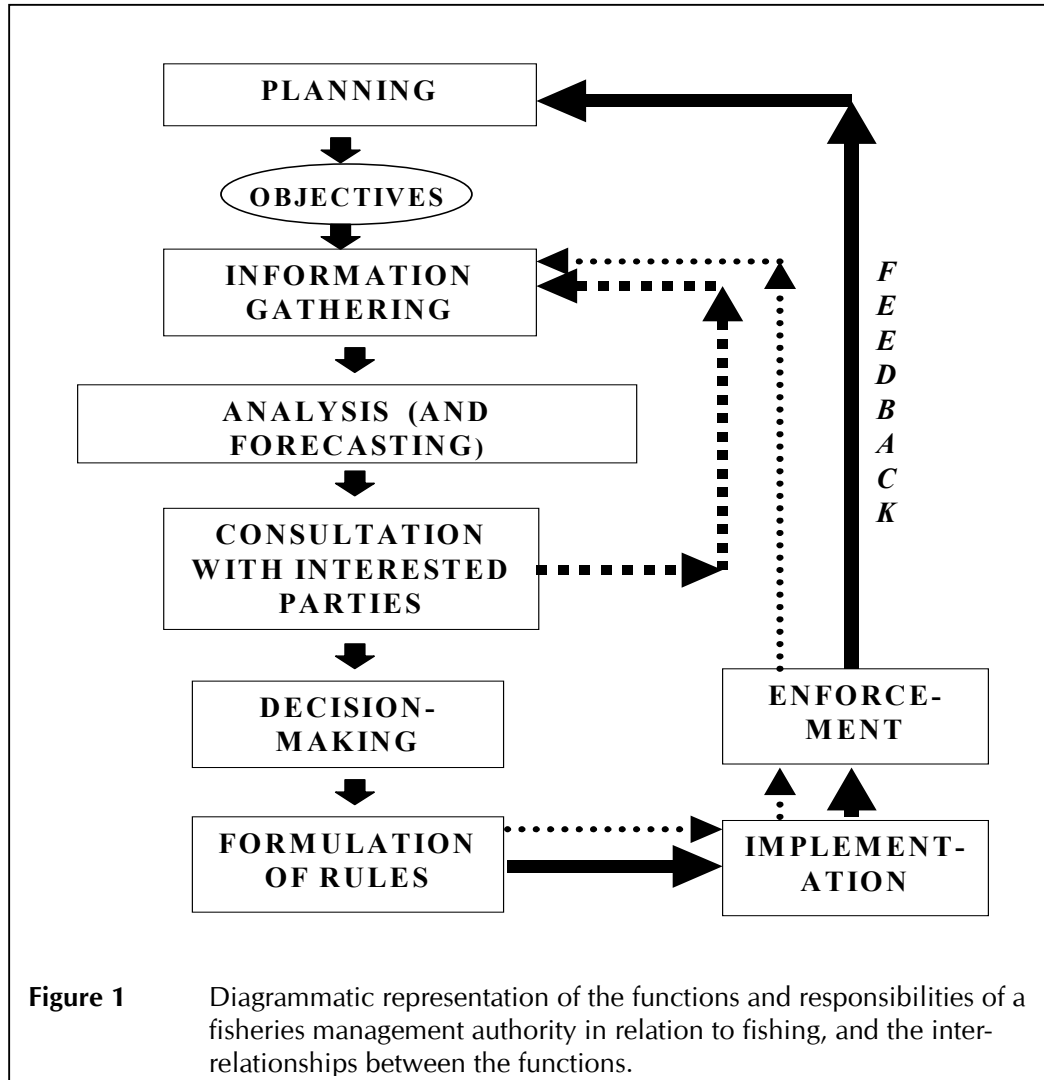
"The integrated process of information gathering, analysis, planning, consultation, decision-making, allocation of resources and formulation and implementation, with enforcement as necessary, of regulations or rules which govern fisheries activities in order to ensure the continued productivity of the resources and the accomplishment of other fisheries objectives.

From this description, it can be seen that fisheries management involves a complex and wide-ranging set of tasks, which collectively have the achievement of sustained optimal benefits from the resources as the underlying goal. These tasks are also summarised in Figure 1.

There has been a lot of interest in recent years in moving from fisheries management focused essentially on single-species or single fisheries, to management with an ecosystem orientation. This expanded approach has been termed ecosystem-based fisheries management (EBFM) and was recently discussed at "The Reykjavik Conference on Responsible Fisheries in the Marine Ecosystem" (1-4 October 2001), which was organised jointly by FAO and the Governments of Iceland and Norway. The Conference agreed on the Reykjavik Declaration¹ which included an affirmation "that incorporation of ecosystem considerations implies more effective conservation of the ecosystem and sustainable use" and also a reaffirmation of the principles of the FAO Code of Conduct for Responsible Fisheries.

In writing this Guidebook, the authors have implicitly accepted EBFM as a principle inherent in fisheries management and, while the term is not explicitly referred to in the Guidebook, its principles and requirements in fisheries management are incorporated and discussed throughout the volume.

¹ <http://www.refisheries2001.org/>



3. THE WORKING PRINCIPLES OF FISHERIES MANAGEMENT

The above description presents a complex and possibly confusing picture of all the tasks which need to be considered by the fisheries manager. Some of this complexity can be reduced by attempting to highlight the underlying key issues. There are both benefits and risks in attempting to simplify a subject and over-simplification can lead to neglect of important details. However, simplification can facilitate understanding important principles and highlighting the broad areas which need attention. Arising from the considerations discussed above, a number of key principles can be identified which may serve to focus attention on the starting points for effective fisheries management (Table 1).

Table 1 Suggested fundamental principles of fisheries management (modified from Cochrane, 2000).

Principle	Management Function	Pertinent Chapters
1. Fish stocks and communities are finite and biological production constrains the potential yield from a fishery.	The potential yield needs to be estimated and the biological constraints identified.	1,5
2. i) Biological production of a stock is a function of the size of the stock and ii) it is also a function of the ecological environment. It is influenced by natural or human-induced changes in the environment.	i) Target reference points need to be established through data collection and fisheries assessment; and ii) environmental impacts should be identified and monitored, and the management strategy adjusted in response as necessary.	1, 5
3. Human consumptive demands on fish resources are fundamentally in conflict with the constraint of maintaining a suitably low risk to the resource. Further, modern technology provides humans with the means, and demand for its benefits provides the motivation, to extract fish biomass at rates much higher than it can be produced.	Realistic goals and objectives must be set. Achieving the objectives will inevitably require controls on fishing effort and capacity.	2 – 5,9 5,6,8
4. In a multispecies fishery, which description encompasses almost all fisheries, it is impossible to maximise or optimise the yield from all fisheries simultaneously.	Realistic goals and objectives must be established across ecosystems, so as to manage for species and fisheries interactions.	2 - 5
5. Uncertainty pervades fisheries management and hinders informed decision-making. The greater the uncertainty, the more conservative should be the approach (i.e. as uncertainty increases, realised yield as a proportion of estimated maximum average yield should be decreased).	Risk assessment and management must be done in development and implementation of management plans, measures and strategies.	5,9
6. The short-term dependency of society on a fishery will determine the relative priority of the social and/or economic goals in relation to sustainable utilisation.	Fisheries cannot be managed in isolation and must be integrated into coastal zone and fisheries policy and planning and national policies.	5-7,9

Table 1 (cont.) Suggested fundamental principles of fisheries management (modified from Cochrane, 2000).

Principle	Management Function	Pertinent Chapters
7. A sense of ownership and a long-term stake in the resource for those (individuals, communities or groups) with access are most conducive to maintaining responsible fisheries.	A system of effective and appropriate access rights must be established and enforced.	6-8
8. Genuine participation in the management process by fully-informed users is consistent with the democratic principle, facilitates identification of acceptable management systems and encourages compliance with laws and regulations	Communication, consultation and co-management should underlie all stages of management	7-9

In keeping with the integrated nature of fisheries ecosystems, these principles cannot be considered in isolation in considering how best to manage fisheries: their implications and consequences overlap, complement and confound each other which is what makes fisheries management so demanding and challenging. Nevertheless, the consequences of the principles for fisheries give rise to the fundamental nature and tasks of fisheries management, and hence to the general structure of this Guidebook (Table 1).

4. WHO IS THE FISHERY MANAGER?

The Technical Guidelines (FAO, 1997) suggest that fisheries management institutions have two major components: the fisheries management authority and the interested parties. The fishers and fishing companies would usually be the major participants amongst the interested parties. The fisheries management authority is that entity which has been given the mandate by the State (or States in the case of an international authority) to perform specific management functions. In many countries that authority would be a Department of Fisheries or, within a broader Department, a Division of Fisheries. However, a fisheries management authority does not have to fall directly within central government, and could be, for example, provincial, local, parastatal or private. Any one of these arrangements can function effectively, given an adequate legal framework in which to operate and the resources necessary to fulfil their function.

Who, then, within this authority is the fisheries manager and to whom is this Guidebook addressed? In fact, despite the fact that we have deliberately used the term in the title, we suggest that in modern fisheries management, there is rarely a single individual who fulfils the functions of "fisheries manager". The head of the authority, for example, a Director of Fisheries, may have overall responsibility for implementing fisheries management and, as well as being accountable and responsible for the advice passed on from his or her Department to the political decision-maker, may act in an overall coordinating role. However, this individual is unlikely to, and generally should not, have sole responsibility for receiving information, formulating advice and making and implementing decisions. Fisheries management is a complex and multi-faceted discipline and requires input from a range of perspectives. It is therefore inappropriate to expect any individual to fulfil this function on their own. In addition, as discussed above and reflected in Paragraph 7.1.2 of the Code of Conduct, fisheries management should involve the legitimate interested parties in the management process.

Perhaps the closest we can come to a "fisheries manager" is the management authority as a whole, including technical experts, monitoring, control and surveillance (MCS) units, administrative units, the executive body of the formal authority, the consultative mechanisms, the advisory body where one exists, and the responsible political head who is often a Minister. Each member of these functional bodies is, to some extent, a fishery manager and this Guidebook is aimed at all of them. It is not designed to go into great technical and operational detail on each function or task as this would require a set of Guidebooks. Instead, it is intended to give a holistic picture of how the different functions should interact in a fisheries management authority in order to develop appropriate objectives, management strategies and plans, and how to encourage all those participating in a fishery to collaborate in and adhere to the agreed strategy.

5. WHAT CONSTITUTES A MANAGEMENT AUTHORITY?

The responsibility for fisheries management rests with the designated fisheries arrangement or organization which, in this Guidebook, we have referred to without distinction as the fisheries management authority. Following the practice used in the Technical Guidelines on Fisheries Management (FAO, 1997) the term is used broadly here to describe that legal entity which has been designated by the State as having the mandate to perform specified fisheries management functions. In practice, it may be a national or provincial ministry, a department within a ministry, or an agency and could be governmental, parastatal or private. In the case of shared resources it should be international.

The area of competence, geographical area, fish resources and fisheries for which a given management authority is responsible must be precisely specified in each case in the appropriate legislation. The task of an authority is diverse and complex and as a result, fisheries management authorities are normally divided into institutional support structures: the fisheries management institutions. The institutions need to encompass the basic tasks and functions of fisheries management as described in Section 2 and Figure 1 of this Chapter. The actual institutional structure and mechanisms may differ from authority to authority and it would be inappropriate for us in this Guidebook to attempt to prescribe any specific set of characteristics as representing the 'best' institutional structure and processes. What is best in each case will depend in large part on the specific circumstances and context. What is universal, however, is that it is essential for the different institutions concerned with management of any fishery or fisheries to be able to interact effectively, requiring good channels of communication and feedback. The institutions must also be seen by the different interested parties as being legitimate.

The need for collaboration between the authority and the interested parties is as important as collaboration between the institutions within the authority and is discussed at length in Chapter 7. That chapter also examines the pre-requisites for effective partnerships between the management authority and the interested parties and the different types of partnership which can be considered.

It is common and frequently desirable for the national government to devolve all or some fisheries management functions to local government or to smaller groups such as fishing communities. In such cases, it is essential to specify precisely the responsibilities and functions, including the geographical area, falling under this local authority or smaller group. The institutions within the local authority must follow the same principles as those for a national authority as discussed here.

The Code of Conduct requires that fisheries management should be concerned with the whole stock over its entire area of distribution (Code of Conduct, Paragraph 7.3.1) and therefore that States should cooperate in the management of transboundary, straddling, highly migratory and high seas fish stocks exploited by two or more states (Paragraph 7.1.3). General rules for cooperation towards conservation of such fish stocks are foreseen in the United Nations

Convention on the Law of the Sea of 10 December 1982, and in the 1995 UN Fish Stocks Agreement (see Table 2). The responsibilities, functions and structure of international or regional fisheries authorities will usually not differ substantively from those of national authorities.

6. GOALS AND OBJECTIVES: WHO NEEDS THEM IN A FISHERY?

The over-riding goal of fisheries management is the long-term sustainable use of the fisheries resources (Code of Conduct, Paragraph 7.2.1). Achieving this requires a proactive approach and should involve actively seeking ways to optimise the benefits derived from the resources available. This rarely happens, though, and fisheries management is still most commonly practised as a reactive activity, where decisions are made and actions taken largely in response to problems or crises. The resulting crisis decisions are then normally attempts merely to solve the immediate problems without properly considering the broader perspective and the longer-term objectives. Such an approach may succeed in maintaining dissatisfaction sufficiently low to avoid major conflict, but it is extremely unlikely to result in the best use of the marine resources being exploited by the fishery.

The first step in proactive fisheries management is to decide what is meant by optimising the benefits for each fishery - what can the State or the collection of legitimate interested parties agree on as being optimal benefits? This may be described in general terms in the national fisheries policy which must be the starting point for determining the specific objectives for each fishery. The broad goals stated in the fisheries policy may need to be tailored for a specific fishery, but the goals for each fishery should be consistent with the policy.

In general terms, the goals in fisheries management can be divided into four subsets: biological; ecological; economic and social, where social includes political and cultural goals. The biological and ecological goals may be more correctly thought of as constraints in achieving desired economic and social benefits but for simplicity and consistency with the terminology most commonly used in fisheries management, we will include them as goals in this Guidebook. Examples of goals under each of these categories include:

- to maintain the target species at or above the levels necessary to ensure their continued productivity (biological);
- to minimise the impacts of fishing on the physical environment and on non-target (bycatch), associated and dependent species (ecological);
- to maximise the net incomes of the participating fishers (economic); and
- to maximise employment opportunities for those dependent on the fishery for their livelihoods (social).

Identifying such goals is important in clarifying how the fish resources are to be used to benefit society, and they should be agreed upon and recorded, both at the policy level and for each fishery. Without such goals, there is no guidance on how the fishery should be operated, which results in a high probability of *ad hoc* decisions and sub-optimal use of the resources (resulting in lost benefits), and increases the probability of serious conflicts as different interest groups jostle for greater shares of the benefits. This is often seen in practice and one of the important causes of failures in fisheries management has been identified as the frequent absence of clear and precise objectives.

While setting goals is an essential first step, the goals stated above have two obvious limitations. Firstly, they have clear conflicts in intention as it is impossible, for example, to minimise impacts of the fishery on the ecosystem and simultaneously to maximise net incomes. Similarly, it is very probable that management strategies that aim to maximise net incomes will not also maximise employment opportunities. Some compromise between these goals has to be achieved before an effective management strategy can be devised. The second limitation of the

goals is that they are too vague to be of much benefit to the manager. For example, the impacts of fishing can only be "minimised" by having no fishing at all, which is unlikely to have been the intention of those who stated the goal. Maximising employment opportunities could mean allowing as many fishers as possible to participate, regardless of whether or not they could make a living from the fishery, or it could mean maximising the number which could still earn some acceptable income, or many other such targets. Too much is left to the discretion of the manager with these examples of goals.

It is therefore necessary to refine the goals further and to develop operational objectives for each fishery (Figure 2). Operational objectives are very precise and are formulated in such a way that they should be simultaneously achievable in that fishery. In other words, the trade-offs between the biological, ecological, economic and social goals must have been agreed upon and the conflicts and contradictions resolved. The development of operational objectives is discussed in Chapter 5 but, to illustrate the difference between goals and operational objectives, two examples of objectives taken from Chapter 5 are:

- to maintain the stock at all times above 50% of its mean unexploited level (biological);
- to maintain all non-target, associated and dependent species above 50% of their mean biomass levels in the absence of fishing activities (ecological).

With operational objectives such as these, it is possible for any observer, including the manager, to establish whether or not they are being achieved and hence whether or not the management strategy is appropriate and being successfully implemented. These operational objectives can also easily be used as the foundation for reference points, which are essentially the operational objectives expressed in a way which can be estimated or simulated in a fisheries assessment (Figure 2). Once operational objectives have been agreed upon, a management strategy can be developed, made up of a suite of different management measures, to achieve those objectives.

All of this may sound complex, but in reality is no more than most people do in order to develop a budget for their personal finances. Most of us have realistic but imprecisely expressed hopes and needs for our lifestyle as well as a knowledge of the nature of the resource (in this case our net income). These hopes and needs are the goals of our budget but they will all compete for the same resource, our net income, so there will probably be conflicts which need to be resolved. Therefore we have to modify our goals and express them more precisely: we develop operational objectives in which we specify what we can realistically achieve in terms of food, housing, education etc. Thereafter, we need to decide on our budget strategy: how can we meet those objectives: what type and quantities of food and clothing should we be buying; what type of housing can we consider; can we consider an annual holiday, etc.

Clearly, our operational objectives must be consistent with the yield we can expect from the resource (our income). Normally the process of developing realistic objectives will require trade-offs and most of us find, for example, that we cannot allocate as much for entertainment or holidays as we would like and at the same time make our rental or mortgage payments. Therefore priorities are established and compromises made until eventually we arrive at realistic objectives that balance our desires with our income, and that provide a good guide on how to manage our finances from month to month and in the longer-term. At the end of this, we should have a feasible financial management strategy that, barring totally unexpected events, will have a predictable outcome. If we have done our calculations correctly and responsibly, the strategy should mean we enjoy a reasonable lifestyle without being sued for bankruptcy. This is little different from the basic task, and overall hope, of the fisheries manager!

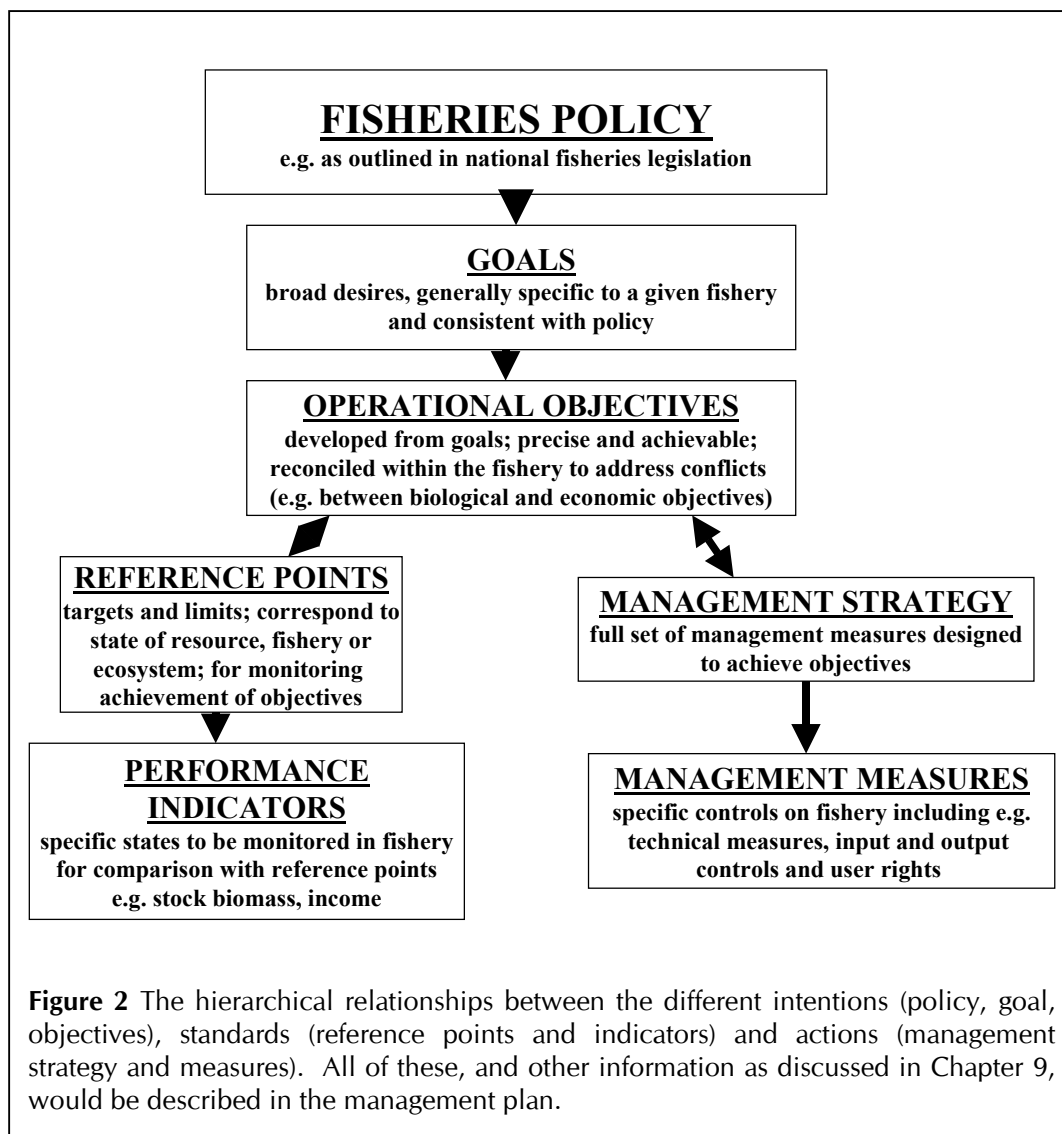
7. MANAGEMENT PLANS, MEASURES AND STRATEGIES

There is a lot of terminology floating around in fisheries management that, unless clearly understood, can cause further confusion in an already confusing environment. In addition to the words 'goals' and 'operational objectives', the terms management plans, management measures and management strategies will crop up on many occasions in this Guidebook and we need to clarify what we mean by each of them and how they differ.

The Technical Guidelines on Fisheries Management (FAO, 1997) describe a management plan as "a formal or informal arrangement between a fisheries management authority and interested parties which identifies the partners in the fishery and their respective roles, details the agreed objectives for the fishery and specifies the management rules and regulations which apply to it and provides other details about the fishery which are relevant to the task of the management authority." A well formulated management plan should be prepared for every fishery and the Code of Conduct (Paragraph 7.3.3) states that: "Long-term management objectives should be translated into management actions, formulated as a fishery management plan or other management framework." Given the importance of management plans in fisheries, the final chapter in the Guidebook, Chapter 9, is devoted to their development.

As discussed in the previous section, fisheries policy is translated into goals and the goals into objectives that indicate precisely what is expected to be achieved from the fishery. The objectives are achieved through the implementation of a management strategy which will also be a central element of a management plan. The management strategy is the sum of all the management measures selected to achieve the biological, ecological, economic and social objectives of the fishery. It is possible that in a single species fishery a management strategy could consist of a single management measure, such as a specified total allowable catch (TAC), but in practice the great majority of management strategies consist of a number of management measures, encompassing technical, input and output controls and a system of user rights. An effective management strategy, however, should not contain so many management measures that compliance and enforcement become so difficult as to be practically impossible.

A management measure is the smallest unit of the fishery manager's tool kit and consists of any type of control implemented to contribute to achieving the objectives. Management measures are classified as technical measures (Chapters 2 and 3), input (effort) and output (catch) controls (Chapter 4), and any access rights designed around input and output controls (Chapter 6). Technical measures can be sub-divided into regulations on gear-type or gear design (Chapter 2) and closed areas and closed seasons (Chapter 3). A minimum legal mesh size, a seasonal closure of the fishery, a total allowable catch (TAC), a limit on the total number of vessels in a fishery, and a licensing scheme to achieve the limit are all examples of management measures. A substantial part of the Guidebook is intended to assist managers in considering and selecting different management measures for a given fishery.



8. PRIMARY CONSIDERATIONS IN FISHERIES MANAGEMENT

If marine living resources were infinite and indestructible, we could leave people to use and abuse them at will. However, this is not the case and we therefore need to manage fisheries to ensure that the resources are utilised in a sustainable and responsible way, and that the potential benefits are not inefficiently dissipated and possibly totally lost. Fisheries production and yield are constrained by a number of factors which can be classified as biological, ecological and environmental, technological, social and cultural, and economic considerations. There are frequently also considerations imposed by other users of the fishing grounds and neighbouring areas. These considerations are discussed in considerable detail in the Technical Guidelines on Fisheries Management (FAO, 1997). Some of the key points are discussed immediately below, but the reader is referred to that publication for more detail. Several of the themes are also dealt with in subsequent chapters of this Guidebook.

8.1 Biological Considerations

As living populations or communities, aquatic living resources are capable of on-going renewal through the processes of growth in size and mass of individuals and additions to the population or community through reproduction (leading to what in fisheries is often called 'recruitment'). In a population at equilibrium, the additive processes of growth and reproduction on average equal the loss process of total mortality. In an unexploited population, total mortality consists only of natural mortality, made up of processes such as predation, disease, and death through drastic changes in the environment. In a fished population, total mortality consists of natural mortality plus fishing mortality, and a primary task of fisheries management is to ensure that fishing mortality does not exceed the amount which the population can withstand, in addition to natural mortality, without undue harm or damage to the sustainability and productivity of the population. This requires not only that the total population is maintained above a certain abundance or biomass, but also that the age structure of the population is maintained in a state in which it is able to maintain the level of reproduction, and hence recruitment, necessary to replenish the losses through mortality. Further, fishing over a long period on selected portions of a stock, for example large individuals or individuals spawning at a specific time or locality within a wider spawning season or range, can reduce the frequency of the particular genetic characteristics giving rise to that feature or behaviour. This has the effect of reducing the overall genetic diversity of the stock. With reduced genetic diversity, the production potential of the population can be adversely affected and it may also become less resilient to environmental variability and change. Fisheries management needs to be aware of this danger and avoid maintaining such selective pressures over a prolonged period.

Achieving an appropriate level and pattern of fishing mortality is hindered substantially by difficulties in estimating population abundance and population dynamics rates and the variability in these rates. The fisheries manager must, however, have sufficient knowledge to make good decisions. The Code of Conduct specifies (Paragraph 7.2.1): "...States... should, *inter alia*, adopt appropriate measures, based on the best scientific evidence available, which are designed to maintain or restore stocks at levels capable of producing maximum sustainable yield, as qualified by relevant environmental and economic factors..." and further (Paragraph 7.5.2, referring to the Precautionary Approach) "In implementing the precautionary approach States should take into account, *inter alia*, uncertainties relating to the size and productivity of the stocks, reference points, stock condition in relation to reference points, ...". These issues are discussed in Chapter 5.

Fishery managers must also respect the stock structure of the resources. Fish populations are frequently made up of a number of different stocks, each of which is genetically largely isolated from the others through behavioural or distributional differences. The different stocks also reflect genetic diversity and if a particular stock is fished to extinction or to very low levels, this genetic diversity may be lost. The stock will not readily be replenished from other stocks, because of the genetic isolation, and therefore the production it was generating will also be lost, leading to a permanent or at least long-term loss of benefits. Fisheries management should therefore attempt to address each stock separately and to ensure sustainable use of each stock and not just of the population as a whole. In this regard, the Code of Conduct states (Paragraph 7.3.1): "To be effective, fisheries management should be concerned with the whole stock unit over its entire area of distribution and take into account previously agreed management measures established and applied in the same region, all removals and the biological unity and other biological characteristics of the stock."

8.2 Ecological and Environmental Considerations

The abundance and dynamics of a population place an important constraint on fisheries but aquatic populations do not live in isolation. They exist as components of a frequently complex ecosystem, consisting of biological components which may feed on, be fed on by, or compete

with a given stock or population. Even those populations which are not directly linked through the food web may indirectly affect each other through their direct interactions with predators, prey or competitors of the other. The physical component of the ecosystem, the water itself, the substrate, inflows of freshwater or nutrients and other non-biological processes may also be very important. Different substrates may be essential for the production of food organisms, for shelter, or as spawning or nursery grounds.

The environment of fish is very rarely static and conditions, particularly of the aquatic environment, can vary substantially over time, from hourly variability, such as the tides, to seasonal variability in, for example, water temperature and currents, to decadal variability as in the occurrence of El Niño events and regime shifts. These changes frequently affect the population dynamics of fish populations, resulting in variability in growth rates, recruitment, natural mortality rates or any combination of these. Such variability can also affect the availability of fish resources to fishing gear, not only affecting the success of the fishing industry, but also the way in which the fishery scientist must interpret catch and catch rate information from the fishery.

Changes in any of the biological, chemical, geological or physical components of the ecosystem can have impacts on the resource population and community. Some of these changes may be beyond human control, such as upwelling processes enriching some coastal ecosystems or large scale temperature anomalies, but they still need to be considered in the management of the resource. Others, such as the destruction of coastal habitats for development, or the direct impact of fishing on the substrate or on other species impacting the resources, are due to human action. In these cases, fisheries management should both take into account their impacts on the resource and, in consultation with other relevant agencies and parties, take steps to minimize their impacts on the fishery ecosystem.

The manager also needs to consider the impact of the fishery on the ecosystem as a whole (Code of Conduct, Paragraph 7.2.2 g and 7.6.9). There are four types of impact of fisheries on the ecosystem: direct impact on the target species; direct impacts on the bycatch species (including discards and by-mortality – Chapter 2); indirect impacts on other organisms transmitted through the food chain (i.e. by changing the abundance of predators, prey or competitors of a population); and direct impact of fishing on the physical or chemical environment. The manager needs to be aware of these potential impacts and to use management measures that minimise negative impacts.

The potential to address the ecosystem considerations will vary depending on whether they are caused by or independent of human action, but in both cases the constraints imposed on the resources and the fishery by biological and non-biological ecosystem factors need to be recognised. At the most fundamental level, these factors in combination with the biology of the species determine the maximum abundance, or carrying capacity, and productivity of the resources. Changes in the ecosystem can affect both and, where they are occurring, need to be considered by the fisheries manager.

Again, these aspects are dealt with by the Code of Conduct. Amongst several references, Paragraph 7.2.3 specifies "States should assess the impacts of environmental factors on target stocks and species belonging to the same ecosystem or associated with or dependent upon the target stocks, and assess the relationship among the populations in the ecosystem." and Paragraph 7.6.9 affirms "States should take appropriate measures to minimize waste, discards, catch by lost or abandoned gear, catch of non-target species, both fish and non-fish species, and negative impacts on associated or dependent species, in particular endangered species.

8.3 Technological Considerations

The fishery manager has very little, if any, ability to influence directly the dynamics of the fish populations or communities which support a fishery. In some case, particularly inland waters,

there may be opportunities and a desire to undertake stock and habitat enhancement and in some coastal fisheries, habitat destruction may have had an impact on fish production. In the latter case, restoration or stabilization may well be an issue the fisheries manager needs to consider (Code of Conduct, Paragraph 7.2.2 f) and Article 10). However, in most fisheries, the only mechanism the fishery manager has to ensure sustainable utilization of the resources is by regulating the quantity of fish caught, when and where they are caught and the size at which they are caught. This can be done through directly regulating the catch taken, by regulating the amount of effort allowed in the fishery, by specifying closed seasons and closed areas and by regulating the type of gear and fishing methods used. However, there are constraints on how precise the manager can be in setting such regulations. Catch controls are often difficult to monitor and therefore to implement. It is difficult to estimate fishing effort precisely, and normally improving technology and developing skills result in on-going increases in the efficiency of fishing operations, leading to continuing increases in effective effort, unless steps are actively taken to counter these improvements or their consequences. Fishing gear is rarely strongly selective and bycatch of non-target species or unwanted sizes of target species is frequently a problem. The uncertainties in fisheries management are not just at the level of predicting the status and dynamics of the resources, and uncertainties in the real consequences of implementing fishery measures is also a significant problem to the manager. The properties of these measures and when and how to use them is dealt with in considerable detail in subsequent chapters, especially Chapters 2 to 4.

A fundamental problem in many fisheries is the existence of too much effort. The presence of excess effort will frequently result in on-going pressure on the fisheries manager to exceed the sustainable fishing mortality on a resource. The social and political pressure to provide employment and opportunities for all those with a stake in the fishery is often hard to resist and readily leads to over-exploitation. The Code of Conduct requires that States take measures to prevent or eliminate excess fishing capacity (Code of Conduct, Paragraph 7.1.8) and such is the global level of concern that the FAO members have agreed on an International Plan of Action (IPOA) for the Management of Fishing Capacity².

8.4 Social and Cultural Considerations

Human populations and societies are as dynamic as other biological populations, and social changes take place continuously and on different scales, affected by changes in weather, employment, political circumstances, supply of and demand for fisheries products and other factors. Such changes can affect the appropriateness and effectiveness of management strategies, and therefore need to be considered and accommodated by them. However, again as with biological and technological factors, it can be difficult to identify and quantify the key social and cultural factors influencing fisheries management, generating additional uncertainties for the manager.

A major social constraint in fisheries management is that human societies and behaviour are not easily transformed and fishing families and communities may not be willing to move into other occupations, or away from their normal homes when there is surplus capacity in a fishery, even when their quality of life may be suffering as a result of depleted fish resources. The problem is much worse when there are no other opportunities outside of fisheries in which they could earn a basic living. Under such circumstances, the political decision to reduce capacity in the fishery is an extremely unattractive option, as the short-term costs of excluding dependent people from the fishery will be much more visible and hence unpopular than a "hands-off" approach which allows the resource and fishery to dwindle in magnitude and quality under sustained excess fishing mortality. Nevertheless, the ecological, economic and social consequences of the latter choice are far more serious in the longer term. This reluctance or inability to take decisions with

² The details of the IPOA can be found at <http://www.fao.org/fi/ipa/capace.asp>

serious, immediate social consequences for some has been one of the constraints most responsible for over-fishing around the world.

A key requirement for ensuring that social and cultural considerations are properly considered is to involve the interested parties in fisheries management, keeping them well-informed on the management aspects of the fishery and providing them with the opportunity to express their needs and concerns. This is discussed in Chapter 7 of the Guidebook. The Code of Conduct (Paragraph 7.2.2) suggests that "the interests of fishers, including those engaged in subsistence, small-scale and artisanal fisheries are taken into account;" and (Paragraph 7.1.2) "Within areas under national jurisdiction, States should seek to identify relevant domestic parties having a legitimate interest in the use and management of fisheries resources and establish arrangements for consulting them to gain their collaboration in achieving responsible fisheries".

The relative balance between social and economic considerations in a fishery will depend on the priority given by the appropriate authority to social objectives and economic objectives. Social and economic objectives can conflict: for example it is unlikely that maximising economic efficiency and maximising employment could be simultaneously pursued within a given fishery, and attempting to do so will result in conflict. A common example of such conflicts is that between a commercial fleet pursuing essentially economic objectives and an artisanal fleet fulfilling primarily social objectives, with both having an impact on the same stock, and possibly also interfering with each other's fishing operations. It is important for the management authority to have identified such potential conflicts and to have resolved them, identifying and specifying compromise objectives that achieve general support.

8.5 Economic Considerations

In a fishery for which sustainable economic efficiency had been specified as the sole benefit to be extracted and in which optimum circumstances prevailed, market forces could be anticipated to lead to the desired objective of economic efficiency. However, in reality such optimum conditions are rarely if ever found and uncertainties and externalities distort the natural selection of market forces. Uncertainties include unpredictable variability in resources and other sources of imperfect information, and externalities can include the impacts of other fisheries on the target resources (e.g. taking them as bycatch), subsidies, trade regulations, fiscal regulations and variability in markets and demand. All of these introduce complexity and additional uncertainty into a fishery and, without proper management, will lead to sub-optimum economic performance. It is important for the management authority to consider the broad economic context of a fishery, including relevant macroeconomic factors. As with social considerations, this requires close consultation with the legitimate users who will be the ones most affected by and sensitive to these issues.

At one extreme, although still very common in fisheries especially in many developing countries, are the problems of open access fisheries, in which anyone is allowed entry into a fishery. Under these circumstances, people will continue to enter the fishery until the benefits from fishing are so low as to be unattractive to prospective new entrants (Section 2, Chapter 6). How low this is will depend largely on the availability of other options and in many countries, especially developing countries, such alternatives may be extremely scarce. Even where there are reasonable alternatives, the inevitable result of open access fisheries is dissipation of rent leading to very poor economic efficiency and, unless strong and effective management measures are in place and enforced, to over-exploitation of resources. Such circumstances prevail in many fisheries around the world.

Recognizing this most elementary lesson in fisheries management, the Code of Conduct calls for the adoption of "measures to ensure that no vessel (by which should also be understood no shore-based fisher) be allowed to fish unless so authorised.." (Paragraph 7.6.2), that "States should ensure that the level of fishing is commensurate with the state of fisheries resources."

(Paragraph 7.6.1), and going further than that, that "Where excess fishing capacity exists, mechanisms should be established to reduce capacity to levels commensurate with the sustainable use of fisheries resources so as to ensure that fisheries operate under economic conditions that promote responsible fisheries." (Paragraph 7.6.3), where underlining and bracketed comments on Code text are additions by the Chapter author. Taken together, these three paragraphs specify that responsible fisheries require limited and authorised access by fishers, where actual and potential effort is appropriate to the productivity of the resource or resources being exploited.

8.6 Considerations Imposed by Other Parties

Some offshore fisheries operate in effective isolation from any other users and the regional fisheries organisations charged with their management may be able to manage the fisheries without needing to consider conflicts with or interference from non-fishery users. However, the bulk of global fishery landings come from coastal waters and for many if not most of the fisheries producing these landings, other users are an important consideration and frequently a constraint. Other users of the fishing grounds can include, for example, tourism, conservation, oil and gas extraction, offshore mining and shipping, while use of the intertidal and coastal area can include tourism again, aquaculture and mariculture, coastal zone development for housing, business or industry, and agriculture. All of these can impose significant constraints on fishing activities and may be impacted by fishing activities. The manager therefore needs to be aware of such activities and of real or potential impacts in both directions. When developing management strategies and formulating management measures, potential conflicts with other users need to be identified and addressed, and the potential impacts of other users on the efficacy of the management strategy and measures need to be considered. The strategy must be adapted so as to account for and be robust to these impacts.

An unavoidable implication of overlapping interests is that the fishery manager, through the management authority, must ensure that suitable structures and mechanisms are put into place for effective communication and decision-making with representatives of the other users. In addition to reference in Paragraphs 6.8 and 6.9, this is dealt with mainly in Article 10 of the Code of Conduct: Integration of Fisheries into Coastal Area Management, which includes the requirement that (Paragraph 10.4.1): "States should establish mechanisms for cooperation and coordination among national authorities involved in planning, development, conservation and management of coastal areas."

9. IS ALL THIS LEGAL?

It should not need to be stated that it is essential for the fisheries manager to be thoroughly conversant with the laws and regulations which control the fisheries within his or her jurisdiction. These laws and regulations constitute the legal regime under which the fishery should be operated and managed, and include the national legislation and any relevant international legal instruments (Table 2). The term legislation is used here to include all types of national laws, local laws, regulations and customs.

9.1 National Legislation

The scope of the national legislation varies substantially between countries, depending on, for example, whether a particular country has a common law system, a civil law system or any other system. However, typically the primary legislation is broad, prescribing the principles and policy relating to fisheries and is usually approved by the Legislature of that country, which may be the national Congress or Parliament. It may also specify details on the implementation of aspects of the policy considered to be particularly important or sensitive and should include reference to establishing fishery management plans and the procedures for the planning process. This primary legislation would usually be described in a Fisheries Act or equivalent legislation.

As passage through the legislature is usually a slow process, such primary legislation should normally not need to be changed frequently. Therefore, for example, control measures such as the amount of effort allowed in a given fishery, or the annual TAC should not be included in the primary legislation.

The primary legislation would typically provide the legal basis for development of detailed procedures and regulations for its implementation by a designated law-making authority. The delegated powers should define and empower the designated institutional components responsible for fisheries management, including specification of who is responsible for administration and control of fisheries management. The second-tier laws, or so-called subsidiary legislation, produced by the delegated regulatory authority are often referred to as regulations, orders, proclamations etc. They would include specifying the control measures which require frequent, typically annual, revision such as licences, gear restrictions, closed areas and seasons and input and output controls (Chapters 2 to 4).

9.2 International legislation and instruments

The modern fisheries manager is required to be familiar not only with the national legislation governing fisheries, but also with the bewildering diversity of international legislation and voluntary instruments dealing directly with or impinging on fisheries. There has been a proliferation of such instruments in recent decades and a few of the more important examples and types are listed in Table 2.

Chief amongst the international instruments is the United Nations Convention on the Law of the Sea of 10 December 1982 (LOS Convention), which entered into force in 1994 (Table 2). This convention sets the legal context for all subsequent international arrangements and agreements relating to the use of the oceans and seas. Arising directly from the LOS Convention and designed to strengthen its provisions relating to high seas fisheries and transboundary stocks, are the UN Fish Stocks Agreement and the FAO Compliance Agreement.

There is also a host of other global agreements, both binding and voluntary. To date the Convention for International Trade in Endangered Species of Fauna and Flora (CITES) has had little impact on marine fisheries management, but concern about some marine species subjected to international trade is growing. Given this growing attention, there is a high likelihood that more species of fisheries interest will be listed through CITES in the future. For example, sturgeon species (*Acipenseriformes* spp.) are currently listed on Appendix II, under which international trade is carefully monitored and controlled, and the basking shark was placed on Appendix III of CITES by the United Kingdom in 2001. Some other global instruments of more immediate relevance are also shown in Table II, including the Convention on Biological Diversity.

Most countries involved in fisheries are or will become members of one or more regional bodies involved in utilization, management and conservation of marine living resources. These include bodies such as the various tuna commissions (e.g. the International Convention on the Conservation of Atlantic Tuna (ICCAT) and the Convention on Indian Ocean Tuna (IOTC)), the Convention on the Conservation of Antarctic Living Marine Resources (CCAMLR), various FAO regional fishery bodies such as the Fishery Committee for the Eastern Central Atlantic (CECAF) and the Asia-Pacific Fishery Commission (APFIC), and many others. The manager must be aware of those in which his or her country is involved, and the implications and obligations of membership.

10. RECOMMENDED READING

- Berkes, F, R. Mahon, P. McConney, R. Pollnac & R. Pomeroy. 2001. *Managing Small-scale Fisheries. Alternative Directions and Methods*. IDRC, Canada. 320 pp.
- Caddy, J.F. and Griffiths, R.C. 1995. Living marine resources and their sustainable development. Some environmental and institutional perspectives. *FAO Fisheries Technical Paper*, **353**. 167 pp.
- Charles, A. T. 2001. *Sustainable Fishery Systems*. Blackwell Science, London. 384 pp.
- Cochrane, K.L. 2000. Reconciling sustainability, economic efficiency and equity in fisheries: the one that got away? *Fish and Fisheries*, **1**: 3-21.
- FAO. 1995. Code of Conduct for Responsible Fisheries. FAO, Rome. 41pp.
- FAO. 1997. FAO Technical Guidelines for Responsible Fisheries No. **4**: Fisheries Management. FAO, Rome. 82pp.
- FAO. 2000. *The State of World Fisheries and Aquaculture*. 2000. FAO, Rome.
- United Nations. 1998. *International Fisheries Instruments with Index*. Division for Ocean Affairs and the Law of the Sea, Office of Legal Affairs. United Nations, New York. 110 pp.

Table 2. Some key legislation and agreements which make up the legal regime of fisheries management.

Law or Agreement	Comments
a) Legislation directly pertaining to fisheries	
- The primary national legislation relating to fisheries (e.g. a National Fisheries Act)	
- The secondary legislation pertaining to specific fisheries and control measures, including regulations and, where appropriate, traditional customs and practices.	
- United Nations Convention on the Law of the Sea of 10 December 1982	Entered into force on 16 November 1994. Provides a comprehensive regime of law and order in the world's oceans and seas establishing rules governing all uses of the oceans and their resources. It enshrines the notion that all problems of ocean space are closely interrelated and need to be addressed as a whole.
- 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 (1995 UN Fish Stocks Agreement)	The 30 th ratification or accession necessary for it to enter into force was received on 11 November 2001. The Agreement elaborates on LOS Convention principle that States should cooperate to ensure conservation and promote the objective of the optimum utilization of fisheries resources both within and beyond the exclusive economic zone.
- Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas (FAO Compliance Agreement)	As of November 2001 not yet in force: 22 of the 25 acceptances required had been received. Addresses the problems associated with reflagging of fishing vessels as a means of avoiding compliance with applicable conservation and management rules for fishing activities on the high seas.
Convention on Biological Diversity	A binding agreement: countries that are parties to the Convention are obliged to implement its provisions. Has three main goals: conservation of biodiversity; sustainable use of the components of biodiversity; and sharing the benefits arising from utilization of genetic resources in a fair and equitable way.
- Any obligations imposed by international organisations of which the State is a signatory e.g. CITES, International Whaling Commission (IWC), tuna commissions, etc.	

Law or Agreement	Comments
- Any relevant, binding bilateral or multilateral fisheries agreements	
b) Voluntary Agreements pertaining to fisheries	
- FAO Code of Conduct for Responsible Fisheries	Adopted by the Twenty-eighth Session of the FAO Conference on 31 October 1995. Sets out principles and international standards of behaviour for responsible practices with a view to ensuring the effective conservation, management and development of living aquatic resources, with due respect for the ecosystem and biodiversity.
- FAO International Plans of Action (IPOAs) for: <ul style="list-style-type: none"> • Reducing Incidental Catch of Seabirds in Longline Fisheries; • the Conservation and Management of Sharks; • the Management of Fishing Capacity; • to Prevent, Deter and Eliminate IUU Fishing. 	The four IPOAs are voluntary instruments elaborated within the framework of the Code of Conduct for Responsible Fisheries. They apply to all States and entities and to all fishers.
- Agenda 21 of the United Nations Conference on Environment and Development	Especially Chapter 17: Protection of the Oceans, All Kinds of Seas, Including Enclosed and Semi-Enclosed Seas, and Coastal Areas and the Protection, Rational Use and Development of Their Living Resources.