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**THE MONITORING, CONTROL AND SURVEILLANCE
OF DOMESTIC ARTISANAL FISHERIES**

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LIST OF ACRONYMS USED

CFRA	community-fishing-rights area
CMT	Customary Marine Tenure
DFID	Department for International Development (UK)
FMSP	Fisheries Management Science Programme
ITE	Individually Transferable Effort
ITQ	Individually Transferable Quota
MCS	monitoring, control and surveillance
NGO	non-governmental organization
TAC	Total Allowable Catch

1. INTRODUCTION

This paper describes the requirements for development of management systems for domestic fisheries, and focuses on community-based management for artisanal fisheries. It draws on examples from the Fisheries Management Science Programme (FMSP) of the United Kingdom Department for International Development (DFID) to highlight particular issues of interest to managers, who are the target audience.

The management of both domestic and foreign fishing should be based on a well-defined strategy that aims to achieve the objectives described by Government policy. A management strategy is the framework within which operational management plans will function. Such plans should be developed specific to discrete management units, which may relate to the resource (e.g., a particular species) or fishery (e.g., a particular vessel or gear category, domestic or foreign). A management system describes the administrative and physical activities and mechanisms by which the management plans are implemented. Monitoring, control and surveillance (MCS) broadly describe these activities:

Monitoring is the collection and collation of relevant information through (i) direct assessments of the fisheries, and (ii) research. Evaluation of that information and feedback of outputs (usually through an annual review) is used to update the operational management plans. These activities are normally performed by a fishery department. Where community management has been adopted, the fishers will be directly involved in the monitoring and evaluation process.

Control is the implementation of appropriate management instruments in order to regulate the fishery and the resource. Appropriate management instruments may be regulatory measures applied directly to a fishery, such as licensing, or may be fiscal and economic measures to either stimulate or check development of the fishery. Control requires inputs from a number of institutions such as the legislature, licensing departments, the fisheries department, and the department of finance. Communications and education are also important in effecting control, particularly for domestic fisheries. The responsibility for control may be devolved to community institutions.

Surveillance is the observing, policing and enforcement of the implementation of management instruments. In addition to involving the authorities (fishery department, police, coast guard or navy) surveillance, especially of artisanal fisheries, may also involve local fishing communities.

Domestic fisheries may include both semi-industrial commercial fisheries exploited by a national fleet, and artisanal fisheries. The term *_artisanal_* here refers to small-scale fishers with low capital investment using low-level technology, distinguishing them from more capital intensive technologically advanced semi-industrial domestic fisheries. The term *artisanal*, however, does not exclude commercial fishing (for profit), and includes subsistence fishing (for personal and family food requirements only). The emphasis of the current paper is primarily on artisanal fisheries. Whilst limited data for management of commercially important artisanal and semi-industrial domestic fisheries may be available, effective operational management plans are rare, and there is room for improvement. Information contained in this paper will also be relevant to their management.

Artisanal fisheries have particular characteristics which may complicate the task of managing them, but which must be considered in formulating management policy and strategies. Conventional stock assessment methods are frequently prohibitively expensive and difficult to perform due to the complexity of species and variety of harvesting methods. Information available for management is often limited and conventional means of surveillance and enforcement are usually impractical and costly. As a result, artisanal – and especially subsistence fisheries – are frequently inadequately or undermanaged by centralized governmental institutions.

In the absence of successful examples of conventional contemporary management for artisanal fisheries, new approaches are being explored. An area of potential is the development of strategies based on co-management, where the responsibility and authority to manage a fishery is shared between the Government and the local fishers/community (Pomeroy and Williams, 1994). Models exist from which new co-management strategies, operational management plans and appropriate management systems may be derived. There are models based on traditional community management, and contemporary models of co-management. In certain parts of the world traditional community-based systems of control have evolved which may assist in the effectiveness of resource management if combined with appropriate scientific advice relating to the biology and life history characteristics of a particular resource. Such models should be studied in order to describe the useful elements of the management system, such as institutional arrangements, or the application of appropriate management instruments, which could be transferred and applied elsewhere. Contemporary examples of successful co-management, perhaps from agriculture or forestry, can be studied to provide a basis for the development of similar systems for fisheries management.

In tropical developing countries, population pressures often exert particularly high demands on the resources available, and poverty and overfishing are common. Often, an entire community may rely upon fishing as its chief source of livelihood, lacking alternative means of employment. Other users frequently place additional pressure on domestic fishery resources or their habitats. Habitat destruction and pollution, leading to diminution of the fishery resource, is common.

Given the complexity of many artisanal fisheries, it is important to develop effective fishery management systems and operational management plans for them. It is important to recognize that in defining these plans and systems within the framework of national policy, objectives, strategy and legislation for fisheries, this does not automatically imply a top-down approach to management. These activities and institutional arrangements are essential whatever the approach to management adopted. The policy may well require a contemporary, regulatory top-down approach to management, or it may propose co-management whereby much of the responsibility and authority for management is devolved to fishing communities. The management system, however, will have to be appropriate to local conditions to ensure that it is practical and enforceable. Co-management is one approach appropriate to artisanal fisheries. The management strategy must also take account of the competing demands for resource use (fishery and the environment). An integrated approach to the management of artisanally exploited multi-species, multi-gear fisheries is required, involving a combination of different management tools.

2. FISHERIES MANAGEMENT OBJECTIVES, POLICY AND THE LAW

Fisheries management strategies must be designed to meet national policy objectives¹. Such policies relate to three broad categories of objectives: economic, social and biological. Particularly in the case of domestic fisheries, social objectives are a high priority, but it is essential that emphasis be placed on the objective of sustainable resource use and protection of the marine environment, since there are biological limits to the level of removals any resource can sustain. Typical management and development objectives relate to:

- conservation of biodiversity or sustainable biological and economic resource exploitation, or both;
- equitable resource distribution: food provision, wealth generation, commercial and recreational interests;
- prevention of resource-use conflicts;
- revenue and foreign exchange generation; and
- employment.

A number of international conventions and codes of conduct exist which, if ratified by a particular country, define management obligations and should be reflected in national policies. Those directly relevant to the management of domestic, and particularly marine fisheries, include:

• *United Nations Convention on the Law of the Sea (UNCLOS)*. Amongst others, this sets out the rights, duties and responsibilities of States to conserve and manage natural resources so

1. Community management objectives may differ from national objectives, and will need to be reconciled in any co-management strategy. Conservation is not necessarily the primary objective of control in traditional community-based management systems (see Section 5.1), and education will be important factor in developing an understanding of its importance by fishing communities.

that they are not endangered by overexploitation, and to protect and preserve the marine environment.

€*Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks* (1995 UN Agreement; abbreviated title). With regard to conservation and management measures, the Agreement requires that, amongst others, states cooperate on: application of the precautionary approach; sustainable resource use; and effective MCS for shared pelagic and demersal resources. For inland fisheries, river systems may cross national boundaries and similar international agreements are required.

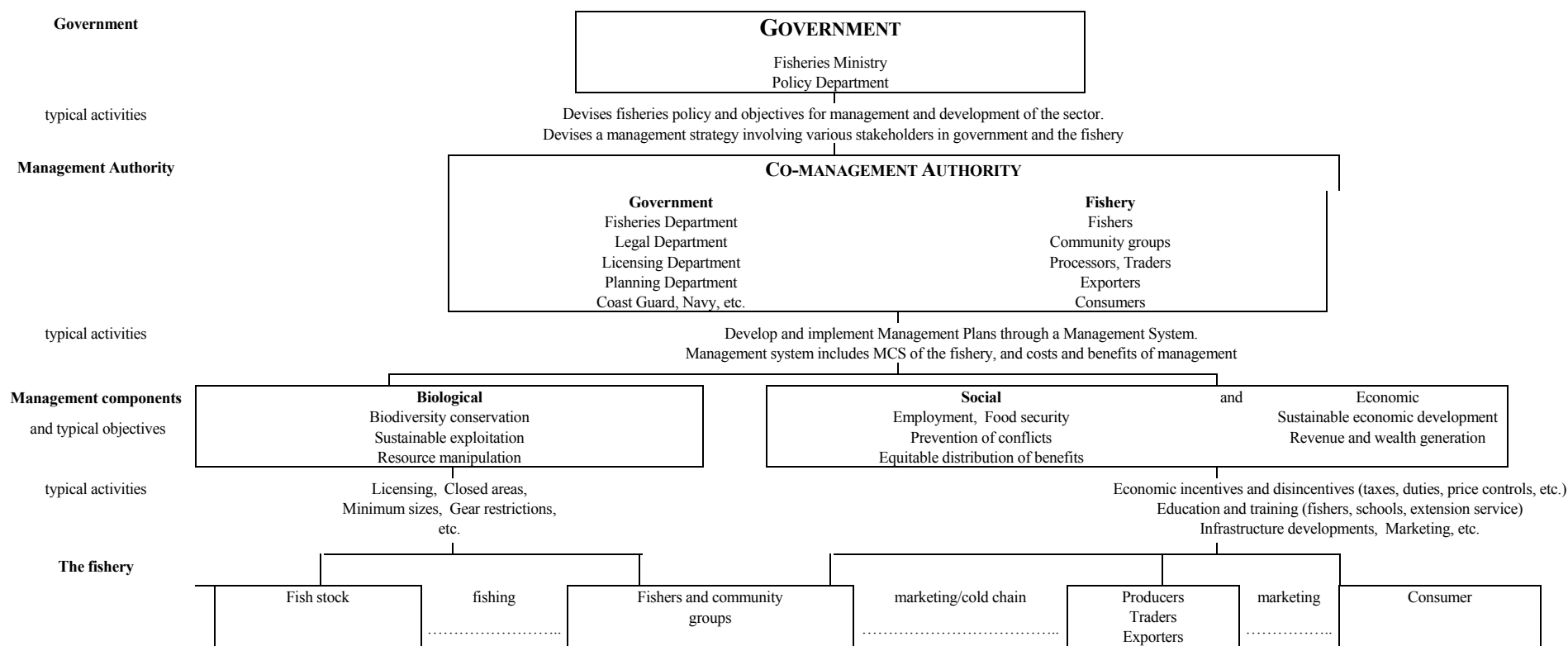
€The *FAO Code of Conduct for Responsible Fisheries* (FAO, 1995a). This sets out responsible practices for conservation, management and development of living aquatic resources whilst recognizing the nutritional, economic, social, environmental and cultural importance of fisheries.

€The *Precautionary Approach to Fisheries* (FAO, 1995b). This outlines procedures to control the exploitation of new or lightly exploited species with particular emphasis on the collection of adequate fisheries and scientific data from the fishery. It also requires a pro-active management approach.

The means of achieving national fisheries objectives is generally through the implementation of management plans. National fisheries legislation must make provision for the implementation of management controls and should be sufficiently simple that changes to management planning can be made without the need for the revision of the basic legislation, i.e., implementation of the law through the mechanism of new regulations, or through terms and conditions applied to licences. In drafting or revising such legislation, inconsistencies with ratified international agreements should be avoided. Legislation for domestic fisheries must be realistic and enforceable, and will thus be dictated by local circumstance. Contemporary (top-down) centralized management through regulatory controls may not always be appropriate, particularly for the artisanal sector. However, alternative institutional arrangements for management, such as through co-management, or the allocation of property rights, including marine tenure, must also be recognized in national legislation.

A summary of the stakeholders in the fisheries sector and the targets of management actions in relation to different policy objectives for the sector are illustrated in Figure 1. Given the large number of stakeholders, a clear communications strategy is important, particularly for artisanal fisheries, and a coordinating body (e.g., a co-management authority) is required. That body will be responsible for reconciling national and community objectives for management.

Figure 1. Summary of the stakeholders in the fisheries sector, indicating the target groups for different management and development actions: fisheries management involves managing the whole fishery, not just the fish stock.



3. THE LOCAL MANAGEMENT CONTEXT

3.1 Characteristics of domestic fisheries

In defining policies and objectives for the fisheries sector, and management and development actions to achieve those objectives, it must be recognized that the management context of domestic fisheries is socially and technically complex. This is especially true of artisanal fisheries.

Artisanal fisheries, as defined in this paper, relate to small- to medium-scale fishing units. Generally, a large number of species over several taxa are targeted, using a multiplicity of vessel categories and gear types. These are subject to technological change over time, and may interact with each other. The nature of the ecology of the resources varies considerably, from sedentary to highly mobile migratory species across a range of habitat types, requiring a range of management approaches. Management is conventionally based on single-species resource assessments, and is complicated in the multi-species context.

The multi-gear nature of the fisheries, with different fishing efficiencies, costs and earnings, complicates analysis of economic performance. Fishing may be for subsistence or commercial gain. In the face of declining resources in a multi-species fishery, fishermen are able to switch to alternative resources, thus maintaining their income, but also maintaining a situation of overcapitalization in the fishery.

There tend to be widely dispersed landing sites and fishing communities, often with poor communications, rather than a focus on large ports.

Government legislation frequently allows open access. This can potentially lead to interactions and resource use conflicts, both within and between different categories of resource user (see Section 3.2 below), and with industrial offshore fisheries where particular stocks are fished by both. If management interventions are proposed, the different resource users will have varying levels of commitment to resource conservation and management. Equity of access and alternative opportunities must be considered in policy formulation. In some parts of the world, such as Oceania, systems of marine tenure have developed as part of wider land tenure, restricting access to certain inside groups as well as outsiders. Discrete social systems have evolved and some form of control of marine resources is often a feature of these (see Section 5.1 below).

3.2 The need for management and management guidelines

Management or development action necessary for different fisheries will depend upon the level of resource exploitation. The *Precautionary approach to fisheries* provides management guidelines which are relevant to fisheries across a range of exploitation levels, and, as is common in artisanal fisheries, for those where adequate data for management purposes are lacking⁷⁶. It makes particular recommendations for artisanal fisheries, and those recommendations are reflected in the following discussion.

76. The DFID FMSP project *Management strategies for new or lightly exploited fisheries in developing countries* also provides useful guidelines for management where data are limited.

In developing operational management plans for fisheries, it is necessary first to identify the management unit. Management Units may be resource or fishery specific, and the following factors should be considered:

- €Are the resources the targets of single-species fisheries (resource-specific management unit)?
- €Are they exploited by a single gear type or a relatively limited number of gear types (fishery-specific management unit)?
- €Are they commercially important?
- €Can an indicator species or a *_guild_* of fishes that have similar responses to exploitation by a gear category be identified that will have similar management characteristics?
- €Will it be feasible to monitor the fishery and the results of regulations introduced as part of a management plan?
- €Can management regulations be enforced?

Two broad categories of domestic capture fisheries in the tropical regions of the world may be defined from which management units – each with different management requirements – may be derived:

- (i) a complex of multi-species, multi-gear fisheries exploited primarily by subsistence fishers (i.e., fishery-specific management unit); and
- (ii) commercially exploited fisheries, at both the artisanal and semi-industrial to industrial level (i.e., resource-specific management units).

The primary management problems in artisanal/subsistence fisheries are the prevention of overfishing of the multi-species complex of finfish and invertebrates and, in some areas, rehabilitation of the resources and control of subsequent exploitation at or below sustainable levels. Management problems are compounded by the fact that fishing communities and fishery resources are geographically dispersed and isolated, leading to difficulties in acquiring data for stock assessment, in formulation of management advice, and in enforcement of management regulations. Small-scale subsistence and artisanal multi-species, multi-gear fisheries need to be considered as a whole complex, and practical and enforceable strategies for managing them need to be derived. Community-based co-management strategies are particularly appropriate.

Many high-value commercial fisheries also focus on components of the artisanally exploited multi-species complex, and they are frequently exploited by the same people (e.g., fisheries for invertebrates such as clams, trochus and *bêche de mer*, and also high value finfish, such as aquarium fish, the export markets for live serranids, or bank and deep slope fisheries for snappers and groupers). The distinction in the case of export markets is that external market demands place additional pressures upon the resources over and above the domestic demand, either competing for the same resource, or sometimes resulting in the development of new fisheries (e.g. *bêche de mer*). These fisheries typically lack an information base, the fishery having developed rapidly due to export market demand. Pro-active management and the application of the precautionary approach in the absence of adequate data for management are required to protect the resource from overfishing. There may therefore be management requirements that are specific to the individual resource base rather than being applicable to the multi-species complex as a whole. For such resource-specific management units, a more contemporary approach to management may be appropriate.

The characteristics of artisanal fisheries (see Section 3.1 above) clearly affect the way in which interventions, research and management in fisheries should be planned. The fishery

resources will obviously be put at risk if these features are not fully taken into account. These characteristics also complicate efforts to unequivocally demonstrate overfishing, and thus it may be necessary to implement management advice in the face of considerable uncertainty as to the stock status. A precautionary approach is required. For individual operational management plans, the following guidelines are appropriate:

- ∄The primary objective of government policy should be sustainable resource use and protection of the marine environment. Social and economic objectives for fisheries should be developed within the limits imposed by the biological parameters.
- ∄Government policy should recognize demands from other resource users, and – where possible – an integrated approach to management should be adopted, such as Coastal Zone Management. This should be reflected in operational management plans which consider alternatives to fishing, or alternative means of controlling fishing intensity, such as value addition to raise incomes.
- ∄Management actions should be pro-active rather than reactive, should be based on the best available information, and not deferred until more information is available. In developing fisheries, management plans should be developed and implemented early on to avoid the possibility of overfishing.
- ∄Management plans should incorporate experimental design where appropriate to assist in the identification of appropriate management solutions (adaptive management).
- ∄The profile of the fishing fleets and their interaction (domestic vs foreign; coastal vs offshore) should be considered, and if management plans for different sectors of a fishery exploiting a common resource exist, they must be compatible, and integrated.
- ∄Annual reviews of management plans should occur, enabling changes in the light of new information, including revision of data gathering, control and surveillance procedures when necessary.
- ∄The management system should be cost effective (costs and benefits must be commensurate with the value of the fishery), but adequately funded.

For artisanal fisheries in particular, the following guidelines are also important:

- ∄Some areas should be closed to fishing to provide refuges for fish stocks, and to protect habitats.
- ∄The strategy and management plans should be based upon the principles of co-management, with delegation of some of the decision making to local communities, but within an appropriate legislative framework, to ensure coordination between government bodies and to avoid conflicts with resource users. Where co-management based on traditional systems is adopted, management should build on existing practices as appropriate.

3.3 Institutional and technical resources for management

3.3.1 Institutional resources

For adequate fisheries management, areas where institutional resources need to be committed are:

- licensing (control);
- enforcement (monitoring and surveillance);
- communications and education;
- research, monitoring and evaluation for biological and economic assessment of stock status and potential; and
- data handling and information management;

Such resources will not only be located within fishery departments, but also with other agencies, as indicated in Section 1. In community-based management approaches, the fishing community and local institutions take on the responsibility for some of those actions. The management system will describe how those agencies and the fishing community interact and will define the information flows between them. Where a complex institutional structure exists (e.g., at different levels: national, regional, village), a nested or zoned arrangement, or combination, is appropriate. It is important to stress that, in the absence of adequate institutional capability, or poor functionality of management systems, domestic fisheries management plans cannot effectively be implemented. Thus, in developing a management strategy it is essential at the outset to ensure that this capability and systems functionality exists. Important factors include, amongst others:

- adequate human and financial resources;
- appropriately skilled and motivated workforce, and provision for their training;
- a defined communications strategy; and
- clearly defined mandate indicating the roles and responsibilities of different organizations and participants in the system, and in the case of community management, formal recognition by government of the right to manage.

Management plans must either be commensurate with existing institutional capability, or must justify the additional financial and human resources required to implement them. Improvements to functionality of management systems, which need not imply additional resources, will also need to be identified for adequate implementation of management plans. An assessment of institutional capability is thus essential, and bureaucratic reorientation may be necessary before management can be implemented.

3.3.2 Technological requirements

Detailed discussion of the technological requirements for management are beyond the scope of this paper, but range from the simple provision of transport for fisheries staff through to sophisticated vessel monitoring systems. The information gathered through the MCS processes may be maintained simply as a paper-based system, or may be incorporated into a computerized fisheries information management system. For domestic fisheries, due to their complexity, technological requirements could be vast, but are seldom available. It is important to consider:

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- the compatibility and integration of national domestic inland, coastal and offshore systems, and any regional systems;
 - the physical environment, to determine appropriate technologies and the capacity and requirements for surveillance and enforcement;
 - the human geography to determine the capacity and requirements for surveillance and enforcement; and
 - costs and benefits.

3.3.3 Fisheries information management systems

Fisheries information is gathered and maintained by a number of agencies. Clearly there is a need for efficient transfer of information between these agencies, and for the development of appropriate information management systems for management to be effective.

The use of computer technology to develop integrated fisheries information management systems is central to this, and a feasible option. Commercially available systems are currently being developed. At one level, information *within* organizations should be integrated in a computerized information system. At a higher level, to enhance communications *among* organizations, individual systems require integration into a wider fisheries information management system. This avoids duplication of effort and greatly increases the efficiency and speed of communications. It is possible to build-in restrictions on access to the information contained in the system, so that different users may only have access to relevant information, if that is required. The extent to which such technologically advanced approaches are appropriate for artisanal fisheries is the subject of a DFID FMSP project, *Information systems for co-management of artisanal fisheries*.

3.4 Data requirements for management (monitoring)

3.4.1 Resource (biological) information

Fishery resource assessment involves the application of statistical and mathematical calculations to make quantitative estimates of the current resource situation and to make predictions about the reactions of fish populations to alternative management choices. A number of tools exist to assist managers in this process, including production models, analytical yield per recruit models, length frequency data analysis models, and BEAM4, specifically designed by FAO for artisanal multi-species, multi-gear fisheries. Typical data requirements are catch and effort, and biological information on the life histories of target species.

Catch and effort data are required to provide information on the level of exploitation of fishery resources and to enable estimates of yield per unit fishing area, which is a valuable guide for comparison with similar regions elsewhere. Production models enable the estimation of resource abundance from these data. Biological information on exploited fish resources is essential for monitoring the status of the fishery and in order to apply management guidelines using more complex fishery stock assessment models. Management is usually based on a single species, and the application of these models to local circumstances is another problem faced by managers in relation to artisanal fisheries. See Polovina (1992) for a review of the application of single-species models to the multi-species case.

In addition to data typically gathered for fisheries assessments, it must be recognized that the management of some fisheries requires the collection of other forms of information. For example, environmental characteristics are especially important for the management of inland floodplain fisheries. Detailed discussion is beyond the scope of this paper, but it is important to recognize that data requirements must be tailored to the particular management problems of each fishery.

Commonly for artisanal fisheries, the limiting factor in the process is the paucity of fisheries data or any other information available from the fishery on which to base management decisions.

Fisheries data are collected from resource surveys (experimental fishing); catch and effort monitoring, either through creel surveys or logbook assessments; biological assessments of landed fish; and from ship-based observer programmes. Munro and Fakahau (1993) describe a systems approach to the collection of this data in order to provide the basic information on which to manage a fishery. Specific data requirements for biological resource management, and the means of collecting them, are available from fisheries texts (e.g., Gulland, 1977; 1983).

For artisanal fisheries, financial and human resources may be limited for data collection. Alternatives to the direct involvement of fisheries departments in catch and effort monitoring potentially include:

- ∅ data collection through fishermen's organizations and devolution of data collection to the fishing communities (See Section 5.1, below);
- ∅ better utilization of existing data collection activities of non-governmental organizations (NGOs); and
- ∅ utilization of government institutions already established at the village level (such as primary schools, through teachers and child involvement in data gathering linked to education requirements identified in the curriculum), with quality controls built in.

Fisheries departments should also prioritize and target resources at key species or habitats to obtain scientific information that may be more widely applicable.

3.4.2 Social and economic information

In addition to biological data, in order to effect fisheries management there is a need to gather social, economic and market data. To adequately evaluate the different fisheries and vessel types, costs and earnings data are required to determine the return on investment of the fisheries. Such evaluation, however, is complicated and may not always be appropriate in artisanal fisheries due to the multi-gear situation, where vessels switch target species frequently. However, particularly for the commercially exploited species (management units), some economic evaluation is essential.

In order to evaluate potential socio-economic impacts of management measures, typical data that are required include:

- ∅ the number of fishermen by boat, gear and fishery (resource) category;
- ∅ the number of _commercial_ and subsistence fishermen, and their catches by resource;
- ∅ the number of fishermen with the ability to switch resources and fishing method, and the number who are dedicated to a particular method or resource;
- ∅ vessel ownership and loan arrangements, credit facilities, public or private;

whether fishing is the primary source of income, and the contribution made by the fisherman to his family's net income;

market characteristics; and

institutional and legislative arrangements;

Other useful information relates to constraints faced by fishermen in changing employment or in investing in alternative fishing activities. Are there competing demands for labour or a lack of alternative opportunities? The management policy must take into account other sectors of the economy which affect resource users and their ability to move in and out of the fishing sector.

Additionally, where traditional management systems are examined with a view to incorporation into a co-management strategy with Government, information specific to those systems will be required. The DFID FMSP project, *The Performance of Customary Marine Tenure (CMT) in the management of community fishery resources in Melanesia*, provides an example of the types of socio-economic data required. In that project, the purpose of monitoring was to determine the structure of local institutions and local interaction with the resource base, i.e., to describe the existing feedback mechanisms to decision-makers. Additionally, the project aimed to describe useful new information that could easily be accumulated and assimilated by the community itself to assist in its management decisions. Such information is useful for developing co-management with the collaborating communities, and also to describe useful elements of the local model that may be transferred elsewhere.

The social and economic contexts of the CMT systems under consideration were assessed using both a semi-structured appraisal approach and standard questionnaires. Interviews covered a range of key informants in each community, as well as groups and individuals selected in order to cover respondents from different gender, age and socio-economic groups in the community. Information was gathered on, *inter alia*:

existing marine tenure arrangements and their historical basis;

village institutions;

feedback mechanisms and decision-making procedures, and the extent to which traditional knowledge of resources has been used in the decision making;

local people's attitudes and opinions regarding marine resources and their management;

patterns of use of marine resources (seasonal and historical);

traditional knowledge of fish species, and of the means of exploiting them; and

features of the local economy and market which affected fisheries activity. These included external institutional arrangements such as national policy and legislation on matters of tenure, and influences arising from adjacent land use or fisheries.

3.5 Costs and benefits of management

The costs and benefits of management should be determined in order to justify expenditure on the various components of the management system. Costs may be quantified reasonably accurately (e.g., staff, capital equipment for MCS activities, recurrent costs, etc.) but benefits are less simple to evaluate, particularly where they result in social rather than economic returns. Some factors to consider are given below.

- ∅ Without management, stock collapses are a real possibility. There will be a direct biological cost through the loss of biomass of fish and a loss of biodiversity. There will be social and economic costs due to the collapse of the fishery. Severely depleted areas may result in other deleterious indirect effects, for example, affecting significantly important economic activities such as tourism.
- ∅ Overcapitalization results in declining returns to individual fishermen/owners even if the resource is not threatened (social and economic costs).
- ∅ Benefits are a healthy resource base and viable fishery contributing to national food security, employment generation and the economy.
- ∅ For export fisheries, by demonstrating that resources are sustainably managed, States can benefit from recent procedures proposed by the Marine Stewardship Council, which call for labelling on fishery products indicating management status. This may be expected to lead to value addition.

In addition to direct long-term benefits of management to the fishery and fishing communities, there may also be associated indirect benefits. For example, conservation benefits development of eco-tourism, enabling greater revenue generation from the resource. Other benefits include multi-purpose use of facilities employed in MCS, such as for safety at sea. Management controls, however, may also have short-term negative impacts on fishing communities that are excluded from a resource. It is important to take all factors into account when evaluating the system.

As discussed in previous sections, there are particular problems associated with implementing management plans for artisanal fisheries due to their particular characteristics. Some additional problems are considered below.

- ∅ The human and financial resources available to fishery departments for management of domestic fisheries are frequently limited.
- ∅ Domestic fisheries, particularly those of an artisanal and subsistence nature, are frequently undervalued in national statistics. They provide valuable food security, against which the cost of import substitution should be considered, and they provide employment, thus lessening the demand on social systems.
- ∅ In contrast, domestic fisheries tend not to generate a substantial economic rent.

These factors frequently limit the degree of management effort expended on domestic, and particularly artisanal fisheries, by central governments. For each fishery, therefore, it is necessary to consider the costs and benefits of different management solutions. Sophisticated and costly management instruments applied through regulations will not be appropriate for small-scale or low-value fisheries.

In some cases it is possible to cover the entire cost of a management system through generating revenue from licence fees (*_user pays_* principle). Licence fees may be set according to two broad criteria:

- ∅ those that are used to recover resource rent such that all management costs, including monitoring and evaluation, are covered; and
- ∅ those that simply serve to enumerate fishers through a minimal cover charge.

The former is generally more applicable to high value, and particularly foreign fisheries, rather than most domestic fisheries. If applied at all to artisanal fisheries, licence fees usually fall into the latter category. The cost of management of domestic and low-value resources may, however, be offset by revenues derived from other more valuable fishery resources.

Finally, it has been stated that regulation alone will not be sufficient for management and development of domestic fisheries. The application of fiscal and economic measures by means of incentives and disincentives will also have both direct and indirect costs and benefits to fisheries and the wider economy, and these must also be considered.

4. APPROACHES TO MANAGEMENT

4.1 Background

Access rights to fisheries resources may take a number of forms, and the form adopted in a Government management strategy affects which management approach is appropriate.

∅Open access fisheries are those without any management action imposed on them, and effectively no property rights have been recognized (see Bromley (1992) for discussion of property rights). Ownership is claimed by the state in the case of domestic fisheries. High-seas fisheries are also open access.

∅Ownership of the fishery can be retained by Government as state property. Management would be applied through various means, including licensing, catch or gear controls, closed areas and seasons. Individual fishers have no direct investment in the resource (apart from gear/opportunity costs) and would aim to maximize short-term gains;

∅Rights-based approaches involve recognizing or transferring ownership of the resource to the fishers (common-property regimes, or as private property). This is more likely to foster long-term stewardship of the resources by the *_owners_*. Government retains the right to advise on management and apply controls where necessary. Such approaches can encompass the traditional common-property regimes that have evolved in a number of countries (e.g., in Melanesia, Brazil and Japan). It can also include contemporary rights-based systems based on Individually Transferable Quotas (ITQs) or Individually Transferable Efforts (ITEs), such as have been developed particularly in New Zealand, Canada and Australia.

Management of fisheries involves the processes of MCS as part of an integrated management strategy. Whatever the form of management to be adopted for domestic fisheries, it is appropriate to develop a strategy and operational management plans that outline the inputs from the various stakeholders in the fishery. Such resource or fishery management plans should be commensurate with the social, economic, biological and technical situation, and may differ for different management units and particularly for the artisanal and commercial fisheries. Administration Guidance documentation should be prepared for reference by the various stakeholders in the fishery.

4.2 Adaptive management

In addition to monitoring fisheries, research should be applied to answer specific management questions. Research can be strategic (for example a trawl survey to quantify the abundance of a resource) or adaptive (that is, experimental, e.g., the application of different sizes of closures for different durations to establish the best criteria for future management planning). Adaptive management is particularly appropriate in the case of artisanal fisheries in order to identify and develop suitable management tools. In partnership with Government (or NGOs), monitoring

systems may be designed to allow fishing communities to appreciate the effects of fishing and of management actions. Suitable management controls and instruments can be identified and applied locally. Government's role is likely to be the provision of specialist scientific advice.

4.3 Management controls

Fisheries are managed to ensure they will continue to yield net benefits to the community in relation to national policy objectives, and this frequently requires the imposition of some form of control on fishing activity. In general, controls on fishing activity operate directly or indirectly through a variety of management instruments implemented through a management plan. The technical management instruments available are generally the same for management regimes applied to both state and common property through community-based co-management, but the institutional framework will differ. Economic controls are likely to have less impact on subsistence and small-scale artisanal fisheries than on commercial fisheries.

Management controls include restrictions on catch and effort, the size of fish caught, the duration or period of fishing, and fishing locations. These are applied by means of management instruments that act directly or indirectly on fishers or the fish stock. Examples of these management instruments include, amongst others:

Direct management instruments:

- Total Allowable Catch (TAC);
- ITQs;
- licensing by number and size of vessel, with conditions of license;
- minimum size limits;
- gear controls;
- area-based seasonal closures, and other short-term fishing bans;
- permanent closed areas;
- temporary rotational closed areas; and
- enhancement or stocking.

Indirect management instruments:

- improvement of economic efficiency of fishing unit;
- development of alternative resources;
- price controls;
- economic incentives and disincentives;
- targeted fishing of areas with larger fish and avoidance of nursery areas; and
- export controls.

These management instruments are generally applicable to all fisheries. However, certain special situations, such as some inland fisheries, may require additional or alternative management instruments. Some of the instruments are suitable for single-species fisheries, but inappropriate for multi-species, multi-gear fisheries⁷⁷. Whatever the situation, these tools must be adapted to suit the

77. A DFID FMSP project, *The management of multi-species tropical fisheries*, developed guidelines for effort controls in multi-species fisheries.

local conditions. The objectives for management and the human, financial and technical resources available must be considered when selecting appropriate management instruments. For artisanal fisheries, the FAO *Precautionary Approach to Fisheries* (FAO, 1995b and 1996) highlights the need to introduce areas closed to fishing as a management instrument. Protected (closed) areas are widely promoted for a variety of reasons. However, the benefits of reserves to fisheries have yet to be quantified, and will depend on how they are designed and implemented. If utilized as one of a range of management instruments implemented through a community-based co-management strategy where the potential for compliance is increased, then reserves may be a useful management tool for complex multi-species, multi-gear fisheries where other technical management instruments alone are inappropriate.

4.4 Enforcement and Surveillance

To be effective, fisheries management controls and regulations must be enforced. Legislative measures may be appropriate for sophisticated commercial fisheries, but generally in the case of artisanal fisheries it is important to reduce the need for conventional surveillance. Alternative methods need to be used to encourage compliance and thus reduce the need for confrontational enforcement, particularly in the light of the costs of management and limited resources generally available. Important factors in achieving these aims are:

- educating the community by dissemination of information through the media, fisheries extension workers, introduction of conservation into the school curricula, posters, etc.;
- promoting co-management strategies, supported by appropriate legislation, for example, through the adoption of existing community-based management, development of new common-property-rights-based management regimes, development and encouragement of fishermen's associations, use of community-appointed fish wardens and Coast watchers or the extension of existing community policing institutions to fisheries enforcement;
- selecting appropriate management instruments, such as closed areas rather than limited licences, gear controls which are complementary to size limits, and undertake pilot studies to test acceptability of control measures before committing them to legislation or introducing them to fishing communities; and
- considering the point at which controls are enforced. For example, for small-scale fisheries exploited by artisanal fishermen, control and enforcement of middlemen may be more appropriate than that of widely dispersed fishermen.

5. COMMUNITY-BASED MANAGEMENT

5.1 Co-management

Given the complexity of artisanal fisheries and the costs of centrally imposed management and regulation, co-management is increasingly being promoted as the way forward.

Pomeroy and Williams (1994) have defined a number of criteria for successful co-management:

- clearly defined boundaries;

- the members of the community are clearly identifiable, form a cohesive group, and include the active participation of most individuals that will be affected by management decisions, and a core group exists to take responsibility for the management process;
- benefits of community-management exceed costs;
- fishers have prior experience of traditional community-management;
- management rules should be simple, with monitoring and enforcement shared by all fishers;
- national legislation exists which formally recognizes the area subject to tenure, and the right of the community to organize and make management decisions;
- decentralization and delegation of authority is established in Government policy (and reflected in the management strategy and management plans adopted); and
- a coordinating body is established with community and government representation to monitor management arrangements and resolve conflicts.

It was suggested in Section 1 that new community-based co-management strategies and operational management plans could be developed utilizing existing models from both traditional (e.g. the CMT systems in Melanesia) and contemporary examples (e.g. successful examples currently applied in other areas of natural-resource management). An adaptive management approach may be adopted and, through experimentation, appropriate management systems *fine tuned* through the process of feedback from monitoring and evaluation and regular review of the operational management plan.

It should be stressed that co-management is not an alternative management instrument. It is an alternative institutional mechanism for implementing management instruments. That is, an alternative to contemporary centralized administration, or to traditional or customary community-administrative mechanisms. The introduction of a system of co-management alone cannot be expected to result in significant management benefits. The selection and implementation of appropriate management instruments is still essential. Government-based fisheries managers must recognize, however, that co-management involves them in giving up the *right* to impose controls on a fishery, although certain rights may be retained by Government if conditions dictated a need to safeguard a resource. A shift to this type of management will involve a re-orientation of duties and responsibilities of managers.

5.1.1 *Co-management and traditional tenure*

Considerable interest exists in developing traditional management systems based on CMT, and combining them with scientific advice (Christy, 1982; Hviding and Ruddle, 1991; Douman, 1995; Pomeroy, 1994). However, if existing traditional management systems are to be the basis of co-management initiatives for artisanal fisheries, it is necessary to ask, "Exactly how effective are existing attempts at community management?" There are several criteria by which one might seek to assess the potential of this approach to fisheries management, including biological sustainability and social equity. Within each of these broad criteria there are a number of issues (often controversial) that need to be addressed. These issues are currently being examined through a DFID FMSP project investigating fisheries management based on CMT in Melanesia (Fiji and Vanuatu). The following section will draw upon observations made during this project.

Biological sustainability

Management Boundaries: Do management measures based on marine tenure relate to biological distributions of fish stocks?

There appears to be little evidence that this is the case and given the social and political influence on the establishment of community-fishing-rights areas (CFRAs), this is not surprising. Specific conservation problems are likely to arise when numerous uncoordinated management activities are imposed over a single biological stock, although the effect will be largely dependent on the level of fishing intensity in adjacent CFRAs. In both Fiji and Vanuatu, CFRA boundaries largely relate to claims to land and marine space based on historic tribal distributions and not to any underlying ecological unit. If the development of management using traditional institutions is to be fostered, there is a requirement that the management of adjacent CFRAs is fully coordinated. Where contemporary commercial fisheries use many CFRAs in the course of normal fishing activities, there may be a need for superimposing a *_scientific management boundary_* over a number of CFRAs. It is clearly important that the positive aspects (such as sense of ownership) of individual customary management units are maintained, but, in the face of current fishing pressures, conservation activities should be coordinated between these units.

Management Activities: Do management measures recognise key life cycle events (are they based on *_scientific_* criteria such as spawning seasons or size at maturity), or is conservation an indirect result of other functions of marine tenure?

The nature and timing of the majority of cultural activities now undertaken by customary managers in Melanesia appear to be related to important social events rather than the life-cycle events of the exploited resources. Principal among these is the creation of closed areas to mark the death of an important member of the community or to further an elders claim to chiefly status. While these closures will probably indirectly reduce fishing mortality, they are not, according to local sources, designed specifically to do so, or at least the origins of their introduction has been lost with the passing of generations. However, there are numerous examples in both Fiji and Vanuatu where customary managers are now introducing conservation-based management activities specifically based on recently acquired knowledge of life cycles. For example, in Vanuatu a number of communities are involved in management of trochus resources explicitly formulated (in a co-operative agreement with the fisheries department) around the life cycle of this valuable mollusc. These events are partly in response to the concerted educational efforts by fishery departments and NGOs in the region and partly due to growing perceptions across the full spectrum of stakeholders that resources are in decline.

Management success, enforcement: How do customary systems cope with increased stress (population pressures, commercialization, immigration and emigration)? How effective is surveillance and enforcement both within the community and for outsiders poaching community resources?

Successful management activities (and by implication the success of the customary system itself) are more likely to be found where resources remain plentiful or where communities remain cohesive. However, it is clear that in communities that are evolving from a subsistence-based economy to one that is cash-based, the success of all management activities are threatened. There are two problems. One is that with increasing economic activity, individuals are becoming more independent of the community than was historically typical. This independence can reduce the authority of community institutions, especially those based on figureheads, such a chief or elders, who were traditionally keepers of knowledge essential to the survival of all members of the community. A second major problem associated with developing economies is the increasing mobility of fishers, particularly of those from migrant communities with no primary access rights. This increased mobility is generally in response to local depletions caused by the increased fishing

power of modern technologies. This itself is due to increasing demand associated with economies with significant division of labour.

Traditional tenure systems attempting to keep pace with economic and social development also face problems resulting from community and state institutional inertia. This problem manifests itself in two ways. Firstly, some customary managers are using their traditional powers to grant access, in exchange for what is often personal financial gain, to outsiders against the wishes of the majority of those with primary access rights. This can lead to conflict between local fishers and outsiders, but, perhaps more importantly, it can lead to an erosion of the traditional system itself; a wider social problem exacerbated by the significant changes underway in Melanesian society. Secondly, there is inertia within state institutions, including within fishery departments. There is often a failure to recognize the impacts of increasing commercial gains to be made from fisheries and they fail to provide customary managers with legal back-up in access disputes. There are examples where communities have essentially taken the law into their own hands. Clearly it is more efficient to have local policing and this is one of the perceived advantages of the co-management approach. However, the parameters within which this policing operates, and their legal basis, need to be clearly defined. Finally, state institutions may also fail to recognize that, in more complex economies, customary managers have a responsibility to the wider national economy in terms of sustainable food provision. In some cases there is a need for state institutions to take a harder line towards traditional managers who are needlessly squandering resources.

Social Equity

Does community-management disadvantage certain sectors of society (e.g., the young or old, women, the poor)?

The issue is how to optimize the functioning of community institutions to ensure that the objectives of management are met. This is more likely to occur when there is consensus within the community. Traditional communities usually rely on the decisions made by one or a few senior individuals within the community. The increasing individuality resulting from economic development tends to make this approach less likely to succeed. While there are obvious advantages to having what Pomeroy and Williams (1994) describe as a *_core group_*, it is perhaps inevitable that the means by which this core group is established needs to be updated. This is especially true where the majority of fishers are not members of the core group but are the ones who have to follow management decisions. Where co-management is being established, the composition of the coordinating body (with both Government and community representatives) should include those with intimate knowledge of the fishery (i.e., the fishers) as well as senior members of the community. In order to avoid inequity resulting from management activities, all groups should ideally be consulted to gain a better understanding of how management may affect these groups.

These findings suggest that customary management practices based on a system of marine tenure may well be adaptable to co-management for a conservation aim. However, the following cannot be ignored:

- ∅ Government bodies responsible for providing management advice based on fisheries science must recognize that conservation may not currently be the primary aim of local resource custodians.
- ∅ Economic pressures may lead to a breakdown of customary controls. It is essential that a consensus be achieved within any community with respect to resource management measures. Alternative institutional arrangements may need to be considered.
- ∅ A clear understanding is required by the fishing community of the aims of co-management for conservation. Feedback mechanisms to reinforce the benefits of management to

community participants will also be important in the success of community-based co-management systems. This implies the monitoring and evaluation of the fishery, and the need to involve fishing communities in the data gathering process, as is the case in Fiji and Vanuatu. Again, extension services are important in coordinating the flow of this information.

☞Communication, training and education are essential components for success. Local extension services may be important in this respect.

☞Due to the cultural basis of traditional community-based management systems, their direct transferability to other areas for the development of new co-management systems will be limited. Nevertheless, these examples contain elements that would be useful elsewhere.

5.1.2 Contemporary models of co-management

Feedback mechanisms that demonstrate the outcome of management actions are central to contemporary models of co-management. Examples of such feedback mechanisms have been developed by NGOs in Bangladesh in fisheries or agricultural projects involving community participation in the collection of information, and in the co-management of natural resources. These examples provide models that potentially may be useful elsewhere, not only for data gathering, but also for decentralization leading to fisheries co-management at the community level. One example is an integrated rice-fish farming project called NOPEST, implemented by CARE (Bangladesh). Simple community data-collection methods have been introduced and graphic means of illustrating the benefits of fish stocking and management developed.

Such participatory approaches that involve feedback mechanisms help to foster community ownership of the data and also awareness of its value. This in itself may lead to some communities being willing to take up a permanent monitoring role, and immediate feedback mechanisms mean that management and development instruments are more likely to be accepted and enforced, and indeed appropriately devised by community participants. However, this example from Bangladesh relates to enhancement and culture fisheries where feedback of results occurs in the short term. For capture fisheries, benefits of management are often apparent only in the longer term, resulting in problems in maintaining enthusiasm for data collection and management systems. Nevertheless, there is potential to test and develop a number of data collection models and feedback mechanisms for management at the community level and to appraise their applicability for nationwide implementation in an adaptive management approach. An example in Bangladesh is the *Community-based Fisheries Management Project (CBFMP)*. See Ahmed, Capistrano and Hossain (1997) for a discussion of co-management experiences in Bangladesh.

The examples of community-management based on marine tenure in Fiji and Vanuatu relate to locations where the local institutional structure is recognized in law. Where this is not the case, community-management based on systems of tenure will require the formation of new common-property rights, involving formal recognition of both new or existing institutions and management boundaries. Another DFID FMSP project which aims to develop selection criteria and co-management guidelines for harvest reserves in tropical river fisheries has assisted in initiating this process in Indonesia. Following on from an earlier project in which the ecological basis for management was established, this project aims to investigate the ecological and social

impacts of different types of reserves in tropical river fisheries, and develop co-management guidelines for their beneficial use in artisanal fishing communities.

The Indonesian Government has active policies for the creation of new riverine reserves, without having clear criteria for their selection or management. Badly planned reserves may restrict fishing opportunities for poor communities without giving compensatory benefits. The project will thus answer a clear local demand for guidance on inland capture fisheries management.

At a recent stakeholder workshop, the Indonesian Government indicated its strong commitment to the project by proposing (1) modifications to current legislation to facilitate rapid uptake of project outputs, (2) the creation of a steering committee to ensure the integration of the project with existing programmes, and (3) the establishment of locally funded pilot projects to demonstrate the potential benefits of the co-management guidelines. These important policy, legislative and institutional arrangements are in line with the criteria proposed by Pomeroy and Williams (1994).

Co-management approaches may also be applied to enhancement fisheries where tenure over water bodies is recognised. The DFID FMSP project *Reservoir Fisheries Management in Savannakhet Province, Lao People's Democratic Republic* was aimed at devising management strategies to increase individual and community income, while maintaining the role of reservoirs in providing subsistence and dry-season habitat for natural fish populations. Although these aims were initially seen as conflicting, the research showed that enhanced fisheries may indeed be managed to serve all three aims.

Stocking enhancement was found to be instrumental in the development of community-management systems. Communities introduced fishing restrictions to protect the stocked fish and ensure a good return to communal investment, resulting in a sharp reduction in exploitation of resident wild stocks. Comparative test fishing experiments revealed that stocked community fisheries boasted significantly higher standing stocks of wild fish than open access fisheries. Most community fisheries generated substantial income for the villages, which was used for a variety of infrastructure projects, such as school improvement or irrigation structures. Although aimed at income generation, community fisheries systems were flexible enough to accommodate subsistence use where no alternative fisheries resources were available.

These results show that the benefits from appropriately managed stocking enhancement can be much broader than is often realized, and that institutional factors play a key role in determining the technical as well as the socio-economic outcome of fisheries enhancement. Community-based management was central to this.

5.2 Other rights-based management approaches

As indicated earlier, community-management in the broader sense need not relate to tenure systems, but can relate to contemporary rights-based approaches to management, such as a community of fishers having exclusive rights to a resource through ITQs or ITEs (see Keen, 1983; Townsend, 1992; OECD, 1993; Matthews, 1993). Co-management may or may not feature as an important component, but should be encouraged where possible. These management approaches are most suited to commercial and industrial-scale domestic fisheries. They are not suitable for subsistence artisanal fisheries, but for certain management units harvested commercially by artisanal fishermen, such systems could be adapted.

When fisheries are retained as state property, licences generally relate to a defined season, and the licence holder only retains those rights for the period of the licence. When those rights are transferred to individuals or fishing groups (or companies) in this type of rights based fishery, licensing by government usually remains an annual or seasonal requirement, but the stakeholder must also buy rights to a specific quota of fish or to a specified level of effort. Those

rights may be sold or handed on to other family members. It may be the case that the right conferred does not give ownership of the resource, but that Government retains this and claims royalties on a *_long-term lease_*. In fact, each situation can be different, and these forms of management can be tailored to suit particular local conditions.

ITQs and ITEs have a number of advantages and disadvantages. They successfully address objectives of resource conservation and improvement of commercial economic performance (Clark, 1993) and avoid the *_tragedy of the commons_*. ITQs give fishing companies exclusive right to a guaranteed share of the catch, enabling them to behave economically and efficiently to increase profits without having to compete with other companies to remove the fish as quickly as possible before a total quota is achieved. Because the quota may be removed at any time, a fishing company may manage its operation more efficiently over time and target fish at the optimum period. Since ITQs and ITEs are transferable, they may provide the incentive for less efficient vessels or companies to leave the fishery. Ultimately, the more efficient companies may be expected to acquire the quotas of catch and effort leading to increased profitability from the fishery. This may be retained by the companies or passed on to the public through price controls, commodity taxes or a licensing/management fee. Owners of ITQs and ITEs are less likely to tolerate illegal fishing activities, leading to some self-regulation of the fishery. Collaboration between Government (managers) and the industry tends to improve.

There are a number of disadvantages, and in particular the high cost of managing the system. Catches need to be monitored and enforced, and this may involve both an at-sea presence and a land-based auditing procedure for the various logs of catch and the trading movements. ITEs require less monitoring in this respect. Additionally the TAC or effort level must be determined each year and allowed to vary according to natural fluctuations in recruitment and abundance of the resource. This is based on complex and detailed scientific analysis of the fishery, with its implicit costs. Fishermen tend to resist reductions in quotas or effort even when scientific advice recommends it. ITQs are considered inappropriate for multi-species fisheries where less desirable species may be discarded so that the quota consists only of high-value fish. More complex systems can be applied to multi-species fisheries but have even greater implications for monitoring and control. Similarly, high grading may occur if a different price structure applies to different sizes of the same species: the least valuable size will be discarded. ITQs can lead to false reporting since the logbook returns will always add up to the quota. Where the jurisdiction over the fishery is unclear, reporting of catches can be disguised. Again, this is not a problem for ITEs and is a recommendation in favour of them.

6. CONCLUDING REMARKS

For effective management to meet Government policy objectives for the sector, domestic fisheries require the development of a fisheries strategy and management plans. The management interventions identified in those plans will differ depending upon the degree of exploitation of the resources, and their commercial importance. Artisanal and subsistence fisheries have certain characteristics which pose particular problems for management, especially since the costs of management can be high. Alternative approaches to management are required. Relevant guidelines are provided in the FAO *Precautionary Approach to Fisheries Management* (FAO, 1995b and 1996) and include co-management and closing areas to fishing. Community-management based on traditional tenure systems offers the potential to develop effective co-management controls for this type of fishery. However, existing systems are unlikely to be directly transferable to locations where traditional tenure did not formerly exist. Potential exists to introduce new community-based management elsewhere. Experience gained from models based on traditional tenure systems, and from new management feedback models developed particularly in the agricultural sector, will be useful in this context. An adaptive (experimental) management approach can also be useful.

For artisanal fisheries, community-management approaches based on rights to transferable effort and quotas are only likely to be suitable for the commercially important and biologically suited resources which can be treated as individual management units. For the multi-species artisanal, and particularly subsistence fisheries, these approaches are not considered useful unless feasible alternatives to fishing are available, enabling limited participation in the fishery. Lack of alternative employment opportunities is a frequent problem faced by fishing communities, particularly where there are high population pressures. The fishery is often overcapitalized, but the need to reduce effort by removing a number of fishing units is an unattractive solution to Government because of the social consequences. An integrated approach to management and development is required, including basic research to identify the type of alternative activities that would be attractive to fishing communities, and the extent to which fishers can and will engage in non-fishing activities.

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9. FISHERIES MANAGEMENT SCIENCE PROGRAMME PROJECTS

For more information on the following UK Department For International Development (DFID) Fisheries Management Science Programme (FMSP) projects, please contact the following through MRAG Ltd, 47 Princes Gate, London, SW7 2QA. Fax: [INT+44] (0171) 823 7916; E-mail: <mrag@ic.ac.uk>. MRAG manages the FMSP on behalf of DFID.

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Reservoir Fisheries Management in Savannakhet Province, Lao PDR Project R6338CB. Contact: Caroline Garaway, E-mail: <c.garaway@ic.ac.uk>, or Dr Kai Lorenzen, E-mail: <k.lorenzen@ic.ac.uk>

The performance of Customary Marine Tenure (CMT) in the management of community fishery resources in Melanesia. Project R6436. Contact: Mr Jim Anderson, E-mail: <j.d.anderson@ic.ac.uk> or Dr Chris Mees, E-mail: <c.mees@ic.ac.uk>

Management strategies for new or lightly exploited fisheries in developing countries. Project R.6437. Contact: Dr Geoff Kirkwood, E-mail: <g.kirkwood@ic.ac.uk>

Information systems for co-management of artisanal fisheries. Project R7042. Contact: Mr Simon Holden, E-mail: <s.holden@ic.ac.uk> or Dr Chris Mees, E-mail: <c.mees@ic.ac.uk>

Selection criteria and co-management guidelines for harvest reserves in tropical river fisheries. Project R7043. Contact: Dr Dan Hoggarth, E-mail: <d.hoggarth@ic.ac.uk>