Guidelines for Designing Data Collection and Sharing Systems for Co-Managed Fisheries:

PART II: TECHNICAL GUIDELINES

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INTEGRATED LAKE MANAGEMENT

Guidelines for Designing Data Collection and Sharing Systems for Co-Managed Fisheries

FAO FISHERIES TECHNICAL PAPER

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PART II: TECHNICAL GUIDELINES

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Front Cover: Fishers weighing Nile Perch (*Lates niloticus*) on the shores of Lake Victoria, Uganda
Photo: Ashley Halls.

Abstract

The increasing shift towards co-management has prompted managers to reflect upon their new roles and reconsider their information requirements. Whilst a vast pool of useful literature already exists that can help guide co-managers design and implement data collection programmes to support their evolving needs, much of it has been written in the context of other sectors or with little emphasis on designing systems specifically for co-managed fisheries.

This Technical Paper forms the second of a two-part set of guidelines that attempt to meet the growing need among co-managers for guidelines to help design and implement appropriate and cost-effective data collection programmes or systems.

Part I: A Practical Guide has been written specifically for co-managers and facilitators working in the field and offers simple and practical advice on helping stakeholders identify their information needs in relation to their management objectives and responsibilities, and developing collaborative ways of collecting and sharing the information in the most effective way.

Part II: Technical Guidelines provide more technical detail on each of the sections in the Practical Guide, including: examples of the types of data that might be of interest to different stakeholders; data collection methods and sources; the design of sampling programmes, and some guidance on data analysis and interpretation. They are expected to appeal to Department of Fisheries and extension staff, research agencies and academic institutions, but they will also provide field practitioners with an additional resource that can be referenced when necessary.

Together, Parts I and II draw together relevant elements of the literature, the output of previous DFID-funded research, as well as the experiences and expressed needs of co-managers currently designing or preparing to design their own data collection systems. The guidelines are, however, intended to complement, rather than replace, existing relevant manuals and guides already published in this and other FAO publication series.

These Technical Guidelines begin by identifying four basic categories of information that are typically required to support the information-dependent management roles that key stakeholders might typically take responsibility for under co-management arrangements, and illustrate important pathways to facilitate information delivery and exchange. These four categories are: (1) Information to formulate and evaluate national fisheries policy and development plans including performance of the co-management policy itself; (2) information to formulate and coordinate management plans; (3) information to implement management plans including enforcing rules and regulations and resolving conflicts and (4) information to evaluate and improve local management plans.

Examples of data types and variables that might be selected by co-managers corresponding to these four main categories of information are provided in Section 3 together with a description of important factors that will influence their selection. Section 4 provides a brief overview of the types of data sources and collection methodologies that might typically be available or applicable. Important concepts including participatory monitoring and evaluation, sampling and stratification are explained along with important factors to consider when choosing among different sources and methods. Summary tables provide further guidance on what sources and methods might be appropriate for each data type of interest.

Finally, Section 5 describes an eight-stage participatory design process involving stakeholder analysis, local management plan formulation, identification of common stakeholder data needs and shortfalls, data collection and sharing strategy design, the development of information networks, the design of data recording and management systems, and finally implementation and refinement. The section cross-references material presented in Sections 1-4 and includes links to other sources of useful information and advice.

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Preparation of this document

These guidelines (Parts 1 and 2) represent the main outputs of two collaborative research projects funded under the Department for International Development's (DFID) Fisheries Management Science Programme (FMSP): Fisheries Data Collection and Sharing Mechanisms for Co-Management (R8285) and Evaluation and Uptake Promotion of Data Collection Guidelines for Co-Management (R8462). Full details of both projects can be found at http://www.fmsp.org.uk/.

The goal of project R8285 was to provide co-managers with guidelines to develop appropriate cost-effective systems or guidelines mechanisms for the collection and sharing of data and information necessary to improve the sustainable management of their resources. The project involved a series of participatory research activities with the following collaborating institutions and projects (and their respective partners) representing a range of stakeholders operating at different levels in the management hierarchy (e.g. local, sub-national, national, and regional): MRAG Ltd, London; the Food and Agriculture Organization of the United Nations (FAO), Rome; WorldFish Center, Malaysia and Bangladesh [Community Based Fisheries Management (CBFM) Project and Fisheries Co-management Research Project (FCMRP)]; Mekong River Commission (MRC) [Mekong River and Reservoir Project]; the DFID-funded Sustainable Fisheries Livelihoods Project (SFLP); the DFID-funded Integrated Lake Management (ILM) Project, Uganda; and the DFID-funded Regional Fisheries Information System (RFIS) Project [including the Tanga Coastal Zone Conservation and Development Project]. All the research partners were actively engaged or interested in designing or improving data collection systems to support co-management either as part of their mandate or under their own projects and programmes in countries including the Lao People's Democratic Republic , Cambodia, Thailand, Viet Nam, Bangladesh, Uganda and the United Republic of Tanzania. Project collaborators prepared "System Requirement Reports" (SRR) using a pre-defined format to report details of existing data collection systems, stakeholder needs, capacity, available resources, and opportunities. A total of 18 reports, downloadable at http://www.fmsp.org.uk/r8285.htm were prepared on the basis of literature reviews, focus group discussion, consultation exercises and workshops involving staff from regional management bodies, departments of fisheries and associated research institutions, local management institutions, and resource users. This process not only helped build capacity but aimed to ensure that the project outputs, including these guidelines, were demand-driven, maximizing the likelihood of their uptake by target institutions. The content of the reports were presented, discussed and synthesized at the project's "Guidelines Development Workshop" held at the MRC headquarters in Phnom Penh, in April 2004, attended by more than 25 representatives of the collaborating institutions and their project/programme partners (see Guidelines Development Workshop Report at http://www.fmsp.org.uk/r8285.htm). The recommendations arising from this workshop, together with a synthesis of the relevant literature and outputs from earlier FMSP research, particularly projects R7042, R7335, R7834 and R8293 formed the basis of the first draft of these guidelines.

The utility of the guidelines was assessed at the Huay Luang Reservoir in Udon Thani Province, Thailand, under the "Management of Rivers and Reservoir Fisheries in the Mekong Basin Component (MRRF)" of the MRC Fisheries Programme in January 2005. Here, a two-stage workshop was implemented with 55 representatives of local resources users, the local management institution (Or Bor Tor) and administrative levels of government. The guidelines proved effective for identifying common data

and information needs among the stakeholder groups and helped them identify and agree upon a data and information collection and sharing strategy that was summarized graphically. This multistakeholder planning exercise also raised awareness among government bodies of the widespread interest of resource users to diversify their livelihoods to include tourism-related income generating activities. These field-testing activities also identified that a simplified version of the accompanying *Part 2: Technical guidelines* was required to provide all stakeholders, but particularly intermediaries working alongside resource users, with the opportunity to fully utilize the relevant and helpful tools contained in them. An earlier version of this *Part 1: Practical guide* was therefore written to address this need.

Project R8462 undertook further evaluations of both parts of the Guidelines involving stakeholder workshops and focus group discussions in Bangladesh under the Fourth Fisheries Project (FFP), and the Community Based Fisheries Management Project (CBFM); and during a second phase of testing in Thailand under the MRC's MRRF Project in the Lower Mekong Basin (see Guidelines Evaluation Reports available at http://www.fmsp.org.uk/r8462). Subsequent revisions and improvements were made to both Parts 1 and 2 of the Guidelines.

Abstract

The increasing shift towards co-management has prompted managers to reflect upon their new roles and reconsider their information requirements. While a vast pool of useful literature already exists that can help guide co-managers design and implement data collection programmes to support their evolving needs, much of it has been written in the context of other sectors or with little emphasis on designing systems specifically for co-managed fisheries.

This Technical Paper forms the second of a two-part set of guidelines that attempt to meet the growing need among co-managers for guidelines to help design and implement appropriate and cost-effective data collection programmes or systems.

Part 1: Practical guide has been written specifically for co-managers and facilitators working in the field and offers simple and practical advice on helping stakeholders identify their information needs in relation to their management objectives and responsibilities, and developing collaborative ways of collecting and sharing the information in the most effective way.

Part 2: Technical guidelines provide more technical detail on each of the sections in the *Practical guide*, including: examples of the types of data that might be of interest to different stakeholders; data collection methods and sources; the design of sampling programmes, and some guidance on data analysis and interpretation. They are expected to appeal to Department of Fisheries and extension staff, research agencies and academic institutions, but they will also provide field practitioners with an additional resource that can be referenced when necessary.

Together, Parts 1 and 2 draw together relevant elements of the literature, the output of previous DFID-funded research, as well as the experiences and expressed needs of co-managers currently designing or preparing to design their own data collection systems. The guidelines are, however, intended to complement, rather than replace, existing relevant manuals and guides already published in this and other FAO publication series.

These *Technical guidelines* begin by identifying four basic categories of information that are typically required to support the information-dependent management roles that key stakeholders might typically take responsibility for under co-management arrangements, and illustrate important pathways to facilitate information delivery and exchange. These four categories are: (1) Information to formulate and evaluate national fisheries policy and development plans including performance of the co-management policy itself; (2) information to formulate and coordinate management plans; (3) information to implement management plans including enforcing rules and regulations and resolving conflicts and (4) information to evaluate and improve local management plans.

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Finally, Section 5 describes an eight-stage participatory design process involving stakeholder analysis, local management plan formulation, identification of common stakeholder data needs and shortfalls, data collection and sharing strategy design, the development of information networks, the design of data recording and management systems, and finally implementation and refinement. The section cross-references material presented in Sections 1 to 4 and includes links to other sources of useful information and advice.

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Abbreviations

AFC	Annual Fish consumption
APFIC	Asia-Pacific Fishery Commission
ARTFISH	Approaches, Rules and Techniques for Fisheries Statistical Monitoring
BMU	Beach Management Unit
BS	Bureaux of Statistics
BS	Biological Sampling
CAS	Catch Assessment Survey
CBFM	Community-based Fisheries Management
CBO	Community-based Organization
CCRF	Code of Conduct for Responsible Fisheries
CDF	Comprehensive Development Framework
CE	Complete Enumeration
CECAF	Fishery Committee for the Eastern Central Atlantic
CES	Costs and Earnings Surveys
CFDO	Community Fisheries Development Office
CIFA	Committee for Inland Fisheries of Africa
CITES	Convention on International Trade in Endangered Species
CNRS	Center for Natural Resource Studies
COPESCAL	Commission for Inland Fisheries of Latin America
CPUE	Catch Per Unit Effort
CSD	Commission on Sustainable Development
DFID	Department for International Development
DFO	District Fisheries Officer
DFR	Department for Fisheries Resources
DoF	Department of Fisheries
EEZ	Exclusive Economic Zone
ER	Export Records
FAO	Food and Agriculture Organization of the United Nations
FCMRP	Fisheries Co-Management Research Project
FEU	Fishing Economic Unit
FIDI	Fishery Information, Data and Statistics Unit
FMC	Fisheries Management Committee
FMSP	Fisheries Management Science Programme
FPBC	Finance, Planning and Budgeting Committee
GIS	Geographic Information System
GRT	Gross Registered Tonnage
GVP	Gross Value of Production
HIPC	Heavily Indebted Poor Countries
IAD	Institutional Analysis and Design
ICLARM	International Center for Living Aquatic Resources Management
IDAF	Integrated Development of Artisanal Fisheries
IFAD	International Fund for Agricultural Development
IIRR	International Institute for Rural Reconstruction
ILM	Integrated Lakes Management
IMF	International Monetary Fund

IOFC	Indian Ocean Fishery Commission
IOTC	Indian Ocean Tuna Commission
ISCFV	International Statistical Classification of Fishery Vessels
ISSCFC	International Standard Statistical Classification of Fishery Commodities
JSA	Joint Staff Assessment
LAGBIMO	Lake George Basin Integrated Management Organisation
LB	Logbook
LMI	Local Management Institution
LS	Landing Sheet
MDD	Minimum Detectable Difference
MDG	Millennium Development Goals
MFARMC	Municipal Fisheries and Aquatic Resource Management Council
MP	Management Plan
MRAG	Marine Resources Assessment Group
MRC	Mekong River Commission
MRRF	Mekong River and Reservoir Fisheries
NGO	Non-governmental Organization
NRM	Natural Resource Management
NSSD	National Strategy for Sustainable Development
OBT	Or-Bor-Tor
OECS	Organization of Eastern Caribbean States
PAPD	Participatory Action Plan Development
PFMI	Provisional Fisheries Management Institution
PFSA	Participatory Fish Stock Assessment
PME	Participatory Monitoring and Evaluation
PRA	Participatory Rural Appraisal
PRS	Poverty Reduction Strategies
PRSP	Poverty Reduction Strategy Paper
PS	Purchase Slip
PSU	Primary Sampling Unit
RFIS	Regional Fisheries Information Systems
RMC	Regional Management Committee
RMP	Routine Monitoring Programme
RRA	Rapid Rural Appraisal
SADC	Southern African Development Community
SFLP	Sustainable Fisheries Livelihoods Project
SL	Sustainable Livelihoods
SLA	Sustainable Livelihoods Approach
SP	Sampling Programme
SRR	System Requirement Reports
STREAM	Support to Aquatic Resources Management
SWOT	Strengths, Weaknesses, Opportunities and Threats
TCZCDP	Tanga Coastal Zone Conservation and Development Project
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNCLOS	United Nations Convention on the Law of the Sea
UNDP	United Nations Development Programme
WECAFC	Western Central Atlantic Fishery Commission
WFC	WorldFish Center (former denomination: ICLARM)
WSSD	World Summit for Sustainable Development

1. Introduction

1.1 THE NEED FOR GUIDELINES

Fisheries, particularly the small-scale type characterized by the use of low technology fishing gear over a limited range, are fundamentally important in many regions of the developing world, providing important sources of protein and livelihoods for coastal and rural communities.

The management of these fisheries has been undergoing a paradigm shift during the last two decades moving away from situations of laissez-faire management, revenue orientated access systems, or focus on maximizing resource and economic output using rules or regulations selected on the basis of quantitative (single-species) bio-economic model-based predictions, set and enforced by a centralized (government) administrative authority, towards more decentralized, collaborative and participatory approaches to sustainable management and development. This shift towards *co-management* comes as policy makers increasingly recognize that the underlying failures associated with the earlier approaches have often social, economic and institutional, rather than technical, origins. Moreover, the very diverse nature of many small-scale fisheries frequently characterized by multispecies assemblages exploited seasonally by dispersed resources users employing numerous different gear types, often makes the application of conventional "top-down" management approaches and models both inappropriate and unrealistic.

The use of data and information remains fundamental to the co-management process despite this change in emphasis, but now data collection systems or programmes must be designed to support the diverse needs of a range of potential stakeholders, tailored according to their objectives, capacity and available resources.

Significant demand for advice and guidelines for designing and implementing data collection systems to support the co-management of fisheries resources was recently highlighted as part of DFID Fisheries Management Science Programme (FMSP) development activities (see MRAG, 2002). This review identified a number of key elements for consideration including identification of key information requirements for co-management, and evaluation of alternative cost-effective mechanisms for collecting data such as participatory modes.

This demand is further reflected in several ongoing or planned projects, programmes and associated activities with a focus on improving data and information for co-management such as the DFID-funded Fourth Fisheries Project (FFP), the Regional Fisheries Information System (RFIS) Programme for the South African Development Community (SADC) and the Integrated Lakes Management (ILM) Project in Uganda. The FAO and Mekong River Commission (MRC) are also in the process of developing programmes to strengthen fisheries information systems in the Lower Mekong Basin with the aim of elucidating the role of inland fisheries in national economies and rural livelihoods of the poor. These programmes are intended to provide models for future work on improving fisheries statistics in other countries advocating co-management policies. The MRC is also working with communities and Department of Fisheries (DoFs) staff at more than 20 project sites to establish information requirements and feedback systems to support evolving co-management arrangements in the region. Similar activities are being planned under the WorldFish Centre's ongoing "Fisheries Co-Management Research Project" (FCMRP), which is working closely with local

communities at sites in Bangladesh and Cambodia where participatory data collection systems are being piloted.

The 2003 FAO Strategy for Improving Information on Status and Trends of Capture Fisheries (FAO Strategy–STF) was adopted by FAO Members and endorsed by the UN General Assembly in 2003. The Strategy–STF is a voluntary instrument that applies to all States and entities. Its overall objective is to provide a framework, strategy and plan for the improvement of knowledge and understanding of fishery status and trends as a basis for fisheries policy-making and management for the conservation and sustainable use of fishery resources within ecosystems. It specifies required actions under nine major areas, with a primary emphasis on the need for capacity building in developing countries. Other required action areas relevant to co-management include data collection systems specifically for small-scale fisheries and multispecies fisheries, expanding the scope of information on status and trends of fisheries (including ecosystem considerations for management), criteria for ensuring information quality and arrangements for the provision and exchange of information. In 2004 FAO launched a project within the FishCode Programme to support implementation of the Strategy–STF. http://www.fao.org/fi/fishcode-stf.htm

Whilst a vast pool of literature already exists that can help guide co-managers design and implement data collection programmes to support co-management, much of it has been written in the context of other sectors or with little emphasis on designing systems specifically for co-managed fisheries.

1.2 AIM AND SCOPE OF THE GUIDELINES

The Guidelines, presented in two parts, attempt to draw together relevant elements of this pool of literature, as well as the experiences and expressed needs of co-managers currently designing or preparing to design their own data collection systems.

The accompanying *Part 1: Practical guide* has been written specifically for co-managers and facilitators (intermediaries) working in the field such as non-governmental organizations (NGOs), international aid agencies, extension and development projects and research institutions that often have skills in training, extension, communication and research to assist both government and local stakeholders with their responsibilities for fisheries management and facilitate communication between them. They offer simple and practical advice on helping stakeholders identify their information needs in relation to their management objectives and responsibilities, and develop collaborative ways of collecting and sharing the information in the most effective way.

These *Part 2: Technical guidelines* provide more technical detail on each of the sections in the *Practical guide*, including: examples of the types of data that might be of interest to different stakeholders; data collection methods and sources; and, the design of sampling programmes and some guidance on data analysis and interpretation. They have been written primarily for relevant government departments typically the Department of Fisheries (DoF), their administrative sub-divisions or levels, and associated research institutions operating at the district, provincial, national and regional levels. These *Technical guidelines* will also offer field practitioners an additional resource that can be referenced when necessary.

Together, they draw together relevant elements of the literature, the output of previous DFID-funded research, as well as the experiences and expressed needs of co-managers currently designing or preparing to design their own data collection systems. The Guidelines are, however, intended to complement, rather than replace, existing relevant manuals and guides already published in this and other FAO publication series including Caddy and Bazigos (1985); FAO (1999); Sparre (2000), and Stamatopolous (2002; 2004). We therefore recommend that these and other documents referred to in the following sections be read in conjunction with these guidelines. To minimize the duplication of material and to keep the guidelines as brief as possible, links to Web sites

where relevant literature and resources can be accessed or downloaded, are provided throughout the manual.

It is hoped that these Guidelines will promote the participatory design of data collection and sharing systems that will help local stakeholders to make informed and empowered choices and decisions concerning the co-management of their resources to improve their livelihoods. Systems developed on the basis of these guidelines are also expected to meet the information needs of government required to evaluate policy and development plans, meet reporting responsibilities and obligations and help support and coordinate local management activities.

It is hoped that the Guidelines will also help re-emphasize many of the core principles, concepts and approaches described in the earlier manuals and guides described above as a means to help managers improve the general quality of statistics collected from small-scale fisheries whether they are co-managed or not, particularly those inland in regions such as South East Asia[1] – one of DFID's most important geographic targets.

While much of the material used to generate these guidelines was compiled on the basis of literature and the experiences of co-managers in South and South-East Asia and East Africa, we believe that the guidelines will be applicable to co-managed small-scale fisheries globally.

1.3 STRUCTURE AND USE OF PART 2: TECHNICAL GUIDELINES

Following this section, these *Part 2: Technical guidelines* are structured around four other main sections and three annexes to answer four key questions: **who** needs data collection systems, and **why** (i.e. for what purposes), **what** data need to be collected to generate this information and **how** might you design a data collection system that meets the needs of relevant stakeholders (Figure 1).

Section 2 describes the co-management process and key stakeholders that might be involved, and identifies four basic categories of information required to support important information-dependent management roles that the key stakeholders might typically take responsibility for under co-management arrangements. Important information pathways to facilitate the delivery and sharing of data and information to support these management roles and information requirements are also illustrated. In effect, Sections 1 and 2 therefore aim to answer the **who** and **why** questions.

What data are required to generate these four categories of information is the subject of Section 3. The section begins with an explanation of some basic terms, concepts and ideas concerning information, indicators, data types and variable and decision-making processes. Four sub-sections then follow, providing examples of data types and variables that might be selected by co-managers corresponding to the four main categories of information identified in Section 2. Important factors to consider when selecting these data variables are also explained.

Section 4 begins to address the question of **How** to design a data collection system by first providing a brief overview of the types of data sources and collection methodologies that might typically be available or applicable. Important concepts including participatory monitoring and evaluation, sampling and stratification are explained and important factors to consider when selecting sources and methods described. Summary tables provide guidance on what sources and methods might be appropriate for each data type of interest.

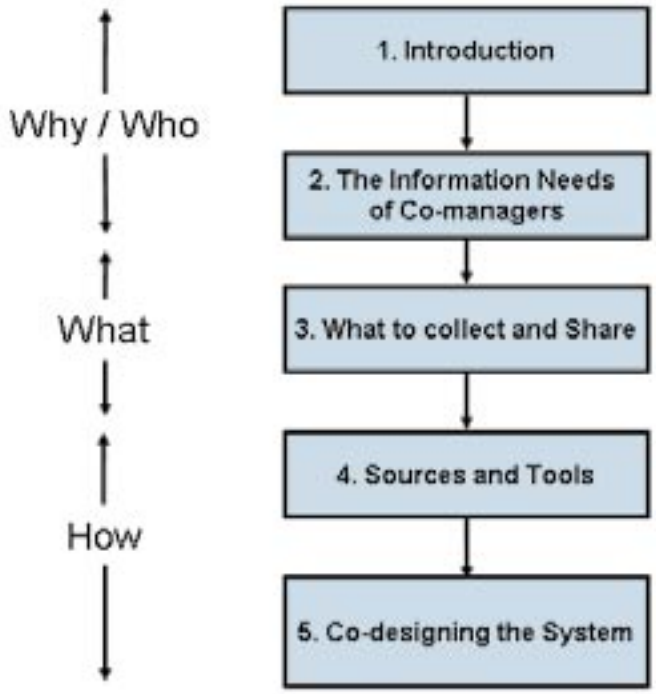
Finally, Section 5 describes an eight-stage participatory design process that cross-references the material presented in chapters 1 to 4 and aims to answer the remaining elements of the **how** question. Guidelines, advice, tips and sources further information

[1] See Coates (2002) for a review of the status of inland fishery statistics in this region.

are provided to guide the process involving stakeholder analysis, local management plan formulation, identification of common stakeholder data needs and shortfalls, data collection and sharing strategy design, the development of information networks, the design of data recoding and management systems, and finally implementation and refinement.

We stress that these guidelines are not prescriptive but rather offer a "toolbox" of options from which readers may wish to pick and choose according to their requirements and local context. The Guidelines are not a compendium of data collection methods. Some guidance on analytical procedures to evaluate management performance is provided but readers are advised to refer to relevant biostatistical analysis and FAO stock assessment manuals for this purpose including Sparre and Venema (1992) and Hoggarth *et al.* (2005).

FIGURE 1
The structure of the guidelines



2. The information needs of co-managers

2.1 INTRODUCTION

Data collection is the recording of one or more **data variables** (catch, price, fish length…etc) from members of a population of **sampling units** (e.g. vessels, households, fishers…etc). **Information** is the product of data that have been acquired, analysed, and interpreted for use. In the context of this manual we define a **data collection system** as the combination of the tools, data sources, sampling design and activities to deliver the necessary data and information to support the *roles* of co-managers.

Developing an understanding of management roles and who takes responsibility for them in the context of the co-management process is fundamental for designing effective and appropriate data collection and sharing systems. We therefore begin this paper by describing the (co-)management process and the typical roles and responsibilities of co-managers, before introducing broad categories of information that are likely to be required by co-managers to support their roles and responsibilities. Data to generate this information is examined in the following Section 3.

2.2 THE MANAGEMENT PROCESS

The management process has been defined by FAO (1997) as being:

> *"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 accomplishment of other fisheries objectives".*

It is a **process** by which fisheries **policy** is pursued or becomes **operational**. Fisheries policy describes the broad directions or goals on how resources are to be utilized and managed including any co-management arrangements. Fisheries policy also often reflects national legislation, the broad development and poverty reduction goals of governments as well as obligations resulting from international or regional management and development agreements, or ratifications of conventions, codes of conduct or voluntary instruments – many of which have management, monitoring and reporting obligations associated with them (see Section 3.2.4).

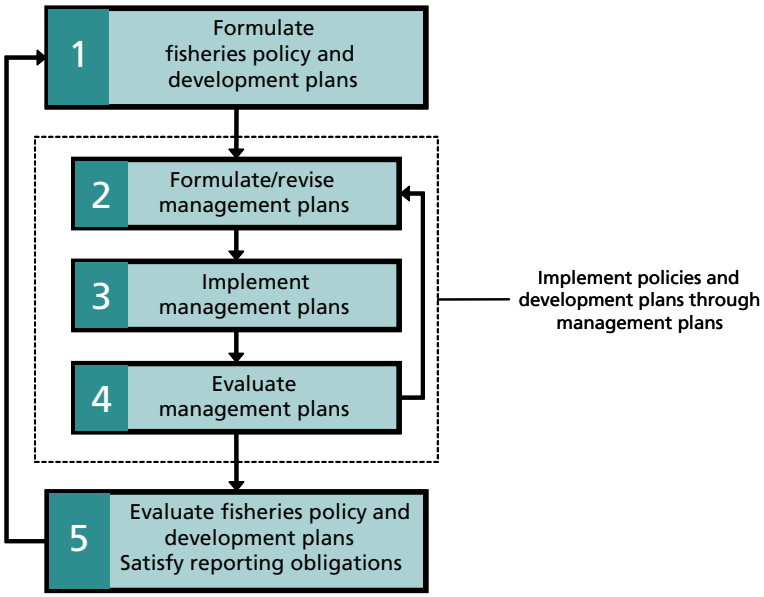
BOX 1

Example of a Fisheries Policy Statement

"Increase fish production; alleviate poverty by expanding employment opportunities and improving socioeconomic conditions of fishers; fulfill the demand for animal protein; achieve economic growth through foreign exchange from fish exports; maintain ecological balance, conserve biodiversity, ensure public health and provide recreational facilities".

(Inland fisheries of Bangladesh; Ministry of Fisheries and Livestock, 1998).

FIGURE 2
The five main activities that form the management process



The broad goals stated in fisheries policy must be tailored for a specific fishery or resource, but the objectives set for each should be **consistent** with the policy. Typically, the broad goals are divided into four subsets: biological, ecological, economic and social, where social includes political and cultural goals (Cochrane, 2002), concerning issues such as food security, the maintenance of biodiversity and the maximization of employment opportunities.

Such goals are refined and translated into operational objectives for each fishery or resource via **management plans**. The process of management requires managers to take **responsibility** for a number of key activities (Figure 2):

1. Formulating, monitoring and evaluating fisheries policy and development plans

The formulation of national fisheries policy and objectives within the macro-policy and macro-economic (multisectoral) context including the coordination of fisheries with other sectors of the economy having an impact on the fishery. These policies should reflect not only the broad development and poverty reduction goals of governments, but also any obligations resulting from international or regional management and development agreements or ratifications of conventions or code of conduct (see later).

2. Formulating and coordinating management plans (MP) for each fishery, resource or management unit

This involves the setting and recording of management objectives that collectively meet the goals and commitments set out within the national fisheries policy and development plans (see 1.) as well as the often-conflicting biological, economic and social objectives of the various stakeholders who will be affected by the management of the resource. The management plans also effectively serve as a reference and information source for those stakeholders involved in the management of the resource, summarizing the state of knowledge of the resource, its environment and the fishery, the management strategy, details of the monitoring and evaluation approaches adopted, and agreed management roles and responsibilities.

The development of management plans for all resources or management units permits a spatially coordinated approach to management, whereby interactions and externalities among fisheries or units and other sectors of the economy can be monitored, evaluated, and ultimately avoided or managed. This is discussed further in Section 3.3.10.

3. Implementing management plans

This involves the actions required to ensure that the management plan is put into operation and operates efficiently. These include monitoring (collecting) and collating data and information necessary to evaluate the performance of the management plan, enforcing measures (rules) designed to achieve the objectives set out in the plan and resolving conflict.

The design of monitoring programmes, particularly with respect to the choice of indicators and variables to be monitored should also take account of any monitoring and reporting obligations resulting from international or regional management and development agreements, or ratifications of conventions, codes of conduct or voluntary instruments (see Section 3.2.4). The implementation of the plan might also involve conflict monitoring and resolution either between different fisheries/management units or between fisheries and other sectors of the economy that impact on the fisheries (e.g. agriculture, transport, industry, etc).

4. Evaluating and improving management plans

The evaluation of the management plan performance typically involves comparing *management performance indicators* against agreed *criteria or targets* set in accordance with the stated management objectives. This performance evaluation exercise is typically undertaken on an annual basis, and followed by a review or adjustment of the plan based upon the outcome of the evaluation. Such evaluations often combine *performance indicators* and *explanatory* variables in quantitative models to help guide the adjustment of the plan (see Section 3.1.1).

5. Evaluating and improving policy and development plans

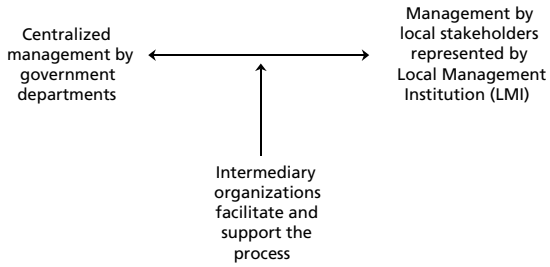
Similar to activity (4.) this typically involves comparing macro *policy performance indicators* against agreed criteria or targets set in accordance with the stated policy and development objectives. Under co-management arrangements, this will include evaluating the performance of co-management policy itself (see later).

2.3 THE CO-MANAGEMENT PROCESS

The management process described above has conventionally focused on maximizing resource and economic output using rules or regulations often selected on the basis of quantitative (single-species) stock assessments and management models, and set and enforced by a centralized (government) administrative authority. This conventional approach to management has frequently failed to deliver desired management and development objectives. Reasons for failure include the lack sufficient resources and institutional capacity to adequately implement and evaluate management plans and enforce rules and regulations among the widely dispersed resource users. Conventional management approaches also often fail because the strategies and plans imposed upon the resource users are inappropriate both from ecological or institutional perspectives.

Fisheries policy-makers increasingly recognize that the underlying causes of over-exploitation and environmental degradation have often social, economic and institutional origins. This has led to widespread policy support for the principles of decentralized and participatory management and development in fisheries. Two approaches, often pursued in unison, have emerged in response.

FIGURE 3
The co-management spectrum



The first is a suppression of national authority through economic or integrated management organizations often operating on a regional scale. Examples include the Mekong River Commission and the South African Development Commission. The second is the trend towards sharing responsibility for management roles with local stakeholders typically represented by some Local Management Institution (LMI), and often facilitated or supported by "intermediary organizations" (Hoggarth *et al.,* 1999) such as non-governmental organizations (NGOs), research institutions or donor projects and programmes. Decentralization of management responsibility may therefore occur both in an upward and downward direction in the institutional hierarchy, with increasing emphasis on communication and flexibility and devolvement of the responsibility for decision-making. Co-management may represent different degrees of sharing responsibility for management roles, anywhere along the line between fully centralized government management, and totally independent self-management by the LMI (Figure 3).

The position adopted along the line will invariably reflect the nature and scale of the management problems and the abilities, interest and capacity of each partner.

Recent developments in the co-management literature argue that only *cooperative* co-management where genuine empowerment and user participation in setting management objectives on equal terms with government is "true" co-management. The usefulness of these Guidelines is not restricted to those situations of true collaborative co-management, but recognize the wide array of possible co-management arrangements, and evolving arrangements, and aim to guide those involved to design appropriate and context-specific systems for information collection and sharing.

Frequently cited advantages of co-management include:

- increased sense of ownership encouraging more responsible exploitation;
- policy and practice are sensitive to local socio-economic and ecological constraints;
- appropriate and relevant policy is honed by local knowledge and expertise;
- participation in decision making engenders a collective ownership ethic;
- increased compliance through perceived legitimacy and local peer pressure; and
- greater incentives for reliable monitoring via the user

As well as providing a potentially more appropriate institutional framework in support of the management process, co-management also satisfies many of the core principles underlying existing and emerging (fisheries) and development policy including the Code of Conduct for Responsible Fisheries (CCRF), Poverty Reduction Strategies (PRS), and National Strategies for Sustainable Development (see Sections 3.2.3 and 3.2.4).

BOX 2
Sharing responsibility

Under co-management arrangements, policy and development objectives are pursued by sharing responsibility for the formulation, implementation and evaluation of local management plans.

2.3.1 Who does what?

Under co-management arrangements, the previously centralized management institution, typically the Department of Fisheries (DoF) or other government Departments, and their administrative sub-divisions or levels (for example regional, provincial, district) are likely to take responsibility for a number of *new, or share responsibility for existing roles* with a Local Management Institution (LMI) representing the interests of local stakeholders including resource users, in pursuit of policy and development objectives.

Who takes responsibility for each role will depend upon their capacity, in other words their resources, skills, rights and motivation. See Hoggarth *et al.* (1999) or Garaway and Arthur (2002) for further details.

Government departments

All administrative levels of government (e.g. national, regional, provincial and district), typically within the Department of Fisheries, will have a role in fisheries management. Depending upon the structure of the government, other departments, for example the Department for Agriculture or Livestock, may be assigned, or share with the department of Fisheries, responsibility for these roles. These administrative levels may include:

- local officers who interact directly with the LMI and are responsible for various monitoring and conflict resolution activities, and for enforcing government legislation etc.;
- regional or provincial level officers who might help formulate and coordinate management plans and activities with LMIs, help facilitate communication among them and grant licences or access rights. Provincial level offices or local government units may have a high degree of autonomy;
- the Minister who has ultimate responsibility for formulating fisheries policy in line with national development goals and international obligations.

Dedicated offices may also exist within fisheries departments to deal with issues and activities associated with co-management such as the Community Fisheries Development Office (CFDO) in the DoF, Cambodia.

Many governments and their respective administrative levels may need to be *convinced of the benefits of co-management* before making changes to existing management legislation or promoting it as policy and practice on a larger (national) scale. Therefore, in addition to their existing roles of formulating, monitoring and evaluating fisheries policy and development plans, *new* roles of government departments may also include *monitoring and evaluating the performance of the co-management policy itself*, and making refinements and adjustments where necessary.

New roles of government departments may also include formulating local management plans with LMIs to ensure that management *objectives are consistent with policy goals or objectives*, and that the rules and regulations or management interventions (including stocking practices) selected by the LMI in pursuit of their objectives *comply or are consistent with existing national legislation*. The monitoring of management plans also allow governments to *coordinate the management activities* of LMIs and thereby minimize conflicts and promote integrated approaches to management.

Another important role of government departments might be providing local managers with information or technical advice to formulate management plans or pursue *alternative livelihoods*. Facilitating communication and learning among LMIs in support of adaptive approaches to management plan performance evaluation (Section 3.5.4), as well as to help evaluate the co-management policy (Section 3.5.8) are other important new roles that government departments may adopt. Effective communication is fundamental to build trust among stakeholders and encourage their continued participation in the co-management partnership.

Government departments are also likely to continue to have important monitoring and enforcement supporting roles at the local level. Indeed, if monitoring programmes undertaken by the LMI *do not meet the policy needs or obligations* of the government then *parallel independent monitoring programmes* (see information flow (1) in Figure 4 below) may need to be undertaken by the appropriate administrative levels of government departments.

BOX 3
Examples of LMIs

Examples of LMIs include Beel or River Management Committees (B/RMC) in Bangladesh, Beach Management Unit (BMUs) in Uganda and the United Republic of Tanzania, Reservoir Fisheries Management Committees (RFMC) in Lao People's Democratic Republic , Community Fishery in Cambodia, Fishing Union in Viet Nam, Or-Bor-Tor (OBT) in Thailand, and Municipal Fisheries and Aquatic Resource Management Councils (MFARMCs) in the Philippines.

Local management institutions

The local management institution (LMI) typically comprises a committee representing the interests and welfare of local stakeholders including fishers, fish traders, processors, farmers, land-owners, water users, nursery owners, gear manufacturers, and people who provide credit and other services. They may be responsible for the co-management of the resources within a defined water body (e.g. lake or reservoir), section of river, or stretch of coast or lake shoreline.

Committee members often comprise elected village representatives including village headmen. Local government staff may represent the government on the committee, provide technical advice and support and ensure that management plans are formulated within the overall framework of the countries legislation.

Decisions on how to manage individual fisheries grounds are generally beyond the capacity of any national organizations. Key roles of the LMIs therefore often centre upon the formulation, implementation and evaluation of the *local* management plans with the support of administrative levels of government departments and intermediary organizations. These roles are likely to include setting local objectives, selecting and enforcing rules and regulations, designing and implementing stocking or habitat rehabilitation programmes, and monitoring and evaluating the outcomes of their management activities.

LMIs may also be responsible for resolving conflicts locally, contributing local knowledge (see Box 4) or participating in data collection programmes to help governments coordinate local management activities, formulate and evaluate national fisheries policy and development plans, comply with reporting obligations and inform intersectoral planning decisions.

Representatives of LMIs, and government departments may also form higher-level management decision-making bodies or committees when overarching management plans or the coordination of management plans of more than one Committee is required. Examples include "Cluster", "Central" and "Lake-Wide" Committees (see below).

Intermediary organizations

This category of stakeholders covers a range of independent organizations including NGOs, international projects, aid agencies, extension and development projects, research institutions. However, this category might also include intermediary or *sub-national* management bodies as the Lake George Basin Integrated Management Organisation (LAGBIMO) – a lake-wide management institution comprising representatives from both LMIs and various administrative levels of government.

These organizations often have specific skills in training extension, communication and research that can assist both government and LMIs with their responsibilities for fisheries management. Indeed, these organizations may even help establish LMIs. Projects or agencies may also provide *initial support*, such as developing skills or providing credit that can help LMIs and government build their *capacity* to manage. Key roles of these organizations might include helping local managers formulate and evaluate their management plans by *providing knowledge and advice* and helping *design and* implement effective data collection systems. Other important related roles might include developing communication networks and *facilitating information sharing*

BOX 4

Mekong fish migrations and the use of local knowledge

Knowledge about the life history of fish, particularly with respect to the timing of migrations, migration routes and the location of spawning areas is crucial for determining the potential impacts of water management projects on fisheries in large rivers such as the Mekong. Under the Assessment of Mekong Fisheries – Fish Migrations and Spawning Habits and Impacts of Water Management Component of the MRC Fisheries Programme (AMFC), the local ecological knowledge of some 355 expert fisherman operating at 113 locations along the length of the Mekong River was compiled using interview and questionnaire techniques to generate a detailed basin-wide synopsis of the spawning and migration behaviour and habitat preferences of 45 important fish species (Poulsen and Valbo-Jørgensen, 2000). The results of the study including maps, pictures and species descriptions have been made available on an interactive CD. See www.mrcmekong.org for further details.

TABLE 1

Typical roles of co-managers and intermediary organizations

KEY CO-MANAGEMENT ACTIVITIES	SUB-ACTIVITIES	GOVERNMENT	INTERMEDIARIES	LMI
1. FORMULATE /REFINE FISHERIES POLICY & DEVELOPMENT PLANS	Formulate fisheries policy and development plans	√		
	Allocate financial and human resources	√		
	Ensure fisheries are adequately valued	√	√	√
	Formulate co-management policy	√		
2. FORMULATE/REFINE & COORDINATE LOCAL MANAGEMENT PLANS	Set objectives		√	√
	Ensure objectives are consistent with policy & development goals	√	√	
	Agree rules & regulations/ decide upon interventions e.g. stocking	√	√	√
	Ensure rules/regulations are consistent with national legislation	√	√	
	Provide technical advice and information	√	√	
	Provide local knowledge and advice			√
	Coordinate local management plans	√	√	√
3. IMPLEMENT LOCAL MANAGEMENT PLANS	Enforce rules and regulations including access restrictions	√		√
	Monitor local management plan performance against objectives		√	√
	Share local knowledge and experiences			√
	Facilitate the sharing of local knowledge and experiences	√	√	
	Stocking water bodies	√	√	√
	Monitor fisheries policy and development plan performance	√	√	√
	Monitor the performance of co-management policy	√	√	√
	Monitor local management activities	√	√	
	Monitor and resolve conflicts	√	√	√
4. EVALUATE LOCAL MANAGEMENT PLANS	Evaluate local management plan performance	√	√	√
	Information sharing and among unit evaluation and learning	√	√	√
5. EVALUATE FISHERIES POLICY & DEVELOPMENT PLANS	Evaluate fisheries policy and development plan performance	√	√	
	Evaluate co-management policy performance	√	√	

NB There may be many other roles that must be assumed by co-managers that have been omitted such as establishment of LMIs and appropriate legal and institutional frameworks (enabling environment) for management (see Hoggarth *et al.* 1999 for details), capacity building, provision of infrastructure, managing savings and credit programmes etc. However, the table above encapsulates the most important roles within the context of this manual.

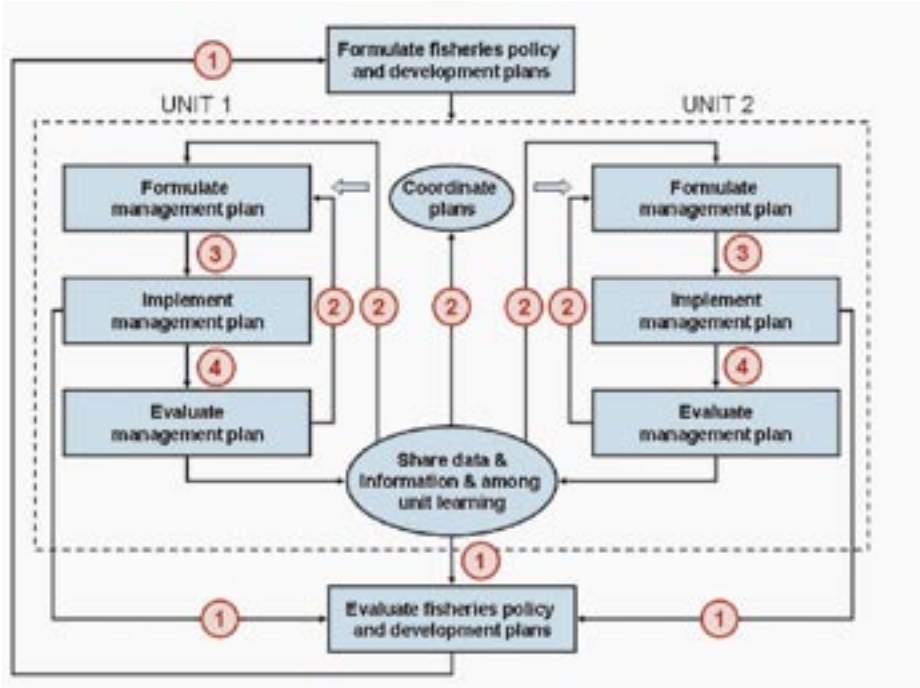
among LMIs. Table 1 summarizes who might take responsibility for the various co-management roles described above.

2.4 THE FOUR CATEGORIES OF INFORMATION

Information is required to support the five management activities described above. Information for both formulating and evaluating fisheries policy and development can

FIGURE 4

The use of the four main categories of information in the context of co-management illustrating opportunities and benefits of information sharing. For the sake of clarity, only two co-management "units" or co-managed fisheries are shown. In reality, hundreds of units may exist.



be combined into a single category (1) because of their similar nature, leaving **four** categories of information:

1. **Information to help formulate and evaluate national fisheries policy and development plans.** This will also include information to evaluate the success of co-management policy and any data and information required to meet reporting management and reporting obligations.
2. **Information to formulate and coordinate management plans.**
3. **Information to implement management plans.** This will include data and information for enforcing rules and regulations and monitoring and resolving conflicts.
4. **Information to evaluate and improve management plans**

Exactly what data are collected by whom to meet these information requirements will depend on who takes responsibility for each activity as well as the policy goals, management objectives and capacity (including motivation) of the main stakeholder groups. These four categories of information in the context of the co-management process are illustrated in Figure 4 below together with opportunities for information sharing.

The next section provides details of the typical data required to generate these four categories of information, and examines in more detail opportunities for information sharing. Guidelines for selecting appropriate sources and methodologies to provide these data are described in Section 4. Section 5 describes a participatory approach to designing context specific data collection systems including guidelines for establishing the information sharing pathways illustrated above.

3. What to collect and share

3.1 INTRODUCTION

Section 2 described four broad categories of information required by managers to support the co-management process. This section provides more detailed guidance on the types of data required to generate this information and examines in more detail opportunities for information and data sharing.

The choice of data collected by co-managers will be influenced by a variety of factors. The primary influence will be the selected *indicators* used to evaluate *performance* in relation to various management and policy objectives, as well as any *explanatory variables* selected to *explain* the performance or outcome.

3.1.1 Indicators and explanatory variables

An indicator is a variable, pointer or index. Indicators are employed to evaluate the performance of management policies and plans implemented to meet various objectives or goals. Numerical indicators are typically calculated from *data variables*. Some important variables such as catch may themselves be used as (*status* or *default*) indicators. Some data variables are vital to a wide variety of indicators. Other more *qualitative* indicators may be assigned scores or values using subjective judgements. *What data* are collected is therefore largely dependent upon the *objectives or management or policy*, but other factors will also be important in deciding what to collect (see below).

Although measuring and monitoring indicators of outputs or outcomes is necessary, they cannot, by themselves inform managers whether or not the particular outcome can be improved or increased, or what measures could be taken to make improvements. For example, monitoring catch rates provides a means of monitoring abundance. If corresponding levels of fishing effort are also monitored, it should be possible to determine how effort should be managed to maximize or sustain yield and catch rates.

To reconcile this problem, *inputs* to the fishery or *explanatory variables* may also be monitored in order to explain the *outputs* or *outcomes*. These inputs and outputs may be combined to form models. These models may be *informal* for example cognized (conceptual) models of the fishery developed through perception, reasoning, intuition, or even superstition. More formal models include *empirical* models developed on the basis of experience or adaptive management (see Section 0); and *analytical* models of the fishery (see Section 3.5.6) with associated target or limit *reference* points (see Caddy and Mahon, 1995). More holistic *frameworks* such as the Sustainable Livelihoods Framework (see Section 5.2.2.1) can be used to help understand the core influences and processes determining livelihood outcomes. These frameworks and models may be expressed verbally, graphically, physically or quantitatively. The choice of model employed will therefore also have an important bearing on the type of data that is collected.

The choice of model or framework will depend largely upon management objectives and institutional capacity. Local communities are more likely to employ informal cognized models or maps to plan their activities and manage their resources (see 5.2.2.4), whilst fishery departments are more likely to have the capacity to collect, collate and analyse data and information to monitor status indicators, build empirical or analytical models or to employ more holistic frameworks such as the SL framework[2].

[2] Particularly with the support of donor projects or programmes.

3.1.2 Other factors influencing the choice of indicators, and data variables

These have already been described by FAO (1999), and therefore we only briefly mention them here so that readers are aware of their potential influence over the choice of indicators and data variables:

- ***The operating characteristics of the fishery***. These will dictate what can be feasibly collected. For example, in multi-gear and multi-species fisheries, it may only be feasible to record effort in terms of man or canoe days. Similarly, fish handling practices may dictate what level of species detail should be feasible. These characteristics should be evaluated prior to the design of a data collection system by means of frame surveys or appraisal of the fishery (see section 5.2.2.3).
- ***The number of uses of a variable***. To maximize data collection efficiency and opportunities for data sharing, it is important to select data types that can be used for the variety of indicators employed by the co-managers. For example, catch data may be used for revenue and food security calculations as well as an indicator of resource depletion when combined with effort data. These potential *overlaps* are examined in more detail in Section 5.1.
- ***The required data collection frequency***. How often the data needs to be collected will depend on their natural rates of change and the cost of measurement. Determining these natural rates of change should become apparent during the appraisal of the operating characteristics of the fishery (see Section 5.2.2). Daily data collection frequency will usually be required for catch and effort data, although for relatively slowly changing variables such as household savings and investments or fish consumption could be collected annually or less frequently for potentially less cost. This will also influence the choice of data collection methodology (see Section 4.5). Data collection should be conducted at intervals sufficiently frequent for the management *purpose*.
- ***The expected or required accuracy and precision of the data.*** The choice of variable will also affect the achievable accuracy and precision. For example, monitoring the amount of cooking oil used by a household during each month will provide less accurate and precise estimates of monthly fish consumption than monitoring the actual weight of fish consumed on a daily basis. These differences in accuracy and precision will have to be considered against differences in monitoring costs and required capacity (Section 5.2.5).
- ***Required standards.*** Where possible, internationally recognized definitions, classifications and codes should be employed for recording fish species, and details of vessels and gears. For example, many fisheries organizations and national authorities utilize the 3-alpha species codes provided in the FAO Standard Common Names and Scientific Names of Commercial Species that is updated annually. When codes are not available, the scientific name should be used (FAO 1999). The FAO species identification guides and FishBase (http://www.fishbase.org) can be consulted for the correct names. The FAO Fisheries Department website at http://www.fao.org/fi should be consulted for further guidance. Many regional bodies such as South African Development Commission (SADC) and the Mekong River Commission (MRC) may also have their own standards for reporting. Internationally agreed standards also exist for many of the indicators for poverty reduction and development planning and evaluation purposes (see Section 3.2.3 below).

3.2 CATEGORY 1 – DATA FOR FORMULATING AND EVALUATING POLICY AND DEVELOPMENT PLANS

Policy decisions are best made in the macro-policy and macro-economic (multisectoral) context. It is therefore important that policy and planning decisions are made in the full knowledge of the role of fisheries in the regional, national and local economy, and the

BOX 5
The Importance of policy information

"[In Lao People's Democratic Republic] The strengthening of the national fishery statistical systems as an integral part of a planning and decision-making process should be a major national fisheries objective in the drive towards sustainable fisheries and food security…Official figures do have a major influence on national policies …donor perceptions and therefore their investment strategies. " (Hartmann, 2004).

implications, costs, benefits and alternatives for use of the resources, before the best policy decisions can be made (Section 3.2.1).

Fisheries policy often reflects national legislation, the broad development and poverty reduction goals of governments as well as obligations resulting from international development agreements, or ratifications of conventions, codes of conduct or voluntary instruments which define various management and (regional) reporting obligations. The most important of these in terms of shaping policy are described below together with their associated data requirements. Other obligations, particular with respect to the provision of data and information are described in Section 3.2.4 including CITES, RAMSAR, Convention on Biological Diversity, etc. Co-management policy itself is also often subject to evaluation. This evaluation process will demand its own suite of data and information (Section 3.2.2).

To be consistent with existing FAO literature, we have adopted a similar format to FAO (1999) to present examples of typical data types and variables.

3.2.1 Data for national policy and development planning

The significance of fisheries with respect to the regional, national and local economy must be understood before the best policy decisions are made in relation to other sectors of the economy. This demands a clear understanding of the position or status of the fishing in the national socio-economy. Policy and development planning decision-making therefore requires information relating to the importance of fisheries in terms of economics, employment and food production, and sometimes in terms of recreational opportunities. Information relating to the costs generated by the fisheries, in particular monitoring, control and surveillance, subsidies and the opportunity cost of the fishery in relation to competing sectors, is also required (FAO, 1997).

A number of key macroeconomic indicators used to guide policy and development planning decisions include:

3.2.1.1 Gross value of production (GVP)

The gross value of production is the product of total production and the price received and provides an indication of the potential economic importance of the fishery relative to other fisheries or industries in a nation, region, province or district. It should include data from both the co-managed and non-co-managed sectors. Estimates of GVP may be required by other relevant government departments to estimate the contribution fisheries makes to the national GDP.

Variables and sources

Primarily from the harvest sector and local, national and regional markets. Opportunities may exist to obtain production estimates from fish consumption data obtained from population census exercises undertaken by other ministries or statistical bureaus, combined with trade data (imports and exports). International price data are also available from various sources such as Globefish (http://www.globefish.org/).

Examples of GVP variables

Data type	Data variables
Production	Landed weight of species from co- and non-co-managed sectors
Unit Prices	Unit price of species

3.2.1.2 Food supply and fish consumption

Fish is a major source of animal protein to people in the developing world. Fish supply and trends in average per capita consumption provides an indication of dependence on fish as a food source at different administrative levels. This information is useful when formulating policies on trade and monitoring food security. Significant trends in per capita fish consumption and fish consumption as a proportion of total protein consumption can be indicative of the ability of fisheries performance in meeting the primary objective of human nutrition.

Total national food supply (tonnes/year) is a product of total domestic production and fish imports minus exports. Fish consumption can be expressed as kg/capita/year but does not provide an indicator of distribution within the population. Ideally, a Gini coefficient should be calculated for fish consumption - that is, the deviation between observed cumulative consumption as described by a Lorenz curve and the cumulative consumption expected from equal distribution (see Section 3.2.2.6).

Average fish consumption per capita may be estimated from the total annual national consumption (AFC) divided by the estimated total population (Npop) where:

AFC (kg y^{-1}) = annual domestic fish production + (annual fish imports minus annual fish exports)

Annual domestic fish production is the sum of the total annual catches all food fish species. The term "food fish" here is taken to represent all catch and cultured products excluding mammals and aquatic plants (FAO, 1999).

Variables and sources

Data originate from the harvesting, processing and marketing sectors. Import and export data and are available from the relevant trade ministry records and population and consumption data fish consumption data may be available from population census exercises undertaken by other ministries or statistical bureaus.

Examples of per capita food supply variables

Data type	Data variables
Landings	Quantity of fish landed from co- and non-co-managed sectors
Fishery imports and exports	Quantity of fish products imported and exported
Conversion factors	Ratio of weight of product to weight of protein by product or species
National population	Numbers of people; fish consumption; average food consumption by food type

3.2.1.3 Employment in the fisheries sector

Artisanal fisheries within the developing world often provide livelihoods for the most vulnerable groups within society. The opportunity cost of fishing may be near zero and displaced or landless groups may use the fishery as a supplementary or last resort source of income and nutrition. Information regarding changes in the total number of people employed in the sector overtime (on a seasonal basis and across sub-sectors) would provide a useful indicator of the value of the fishery to local communities. The number of people employed in the fishery can also provide information on the importance of fisheries and related activities to the regional and national economy.

Variables and sources

There are few examples of reliable statistics regarding fisheries employment in the artisanal sector. Ideally, this information should be generated through routine national

census or statistical collection and reporting systems, or failing this through periodic frame (Section 5.2.2.3) or ad hoc survey exercises (Seki and Bonzon, 1993). Estimating employment is complicated by the diversity and seasonality of economic activities within artisanal fishing communities but classification of fishers could follow the FAO Fisheries Information, Data, and Statistics Service (FIDI) categorization of "full-time", "part-time" and "occasional fishers".[3]

Information on secondary employment such as trading and processing is less likely to be available. Estimates of secondary employment can be made with fixed conversion factors suitable for the fishery and the surrounding economy in question. Seki and Bonzon (1993) recommend separate conversion factors for African inland and marine fisheries (inland fishers x 5, and marine fishers x 3). Similarly, if each fisher is assumed to support 4 dependents on average an estimate of the total population directly or indirectly dependent on the fishery can be made.

3.2.1.4 Balance of trade and foreign exchange earnings

The balance of trade and foreign exchange earnings may be other important indicators of the importance of fisheries to the national and regional economy. See FAO 1999 for details of typical variables and sources.

Examples of employment variables

Data type	Data variables
Number of persons employed in fishery	Employees by primary, secondary and tertiary sectors and by category e.g. full-time, part-time, and occasional in both co- and non-co-managed sectors
Employment in non-fisheries sector	Employees
Unemployment	Unemployment nationally, by region, district
Conversion factors	Numbers of employees in secondary and tertiary sectors per fisher

3.2.1.5 Community dependence

Community dependence on fisheries is usually expressed in terms of percentage dependence on fish for food, protein and income. Indicators might include percentage of total income derived from fishing, or percentage of total protein consumed derived from fish. Variables will include demographic variables of interest (income group, region, age, etc.) and indicators of food security (see above) and income (see below).

3.2.2 Data to evaluate co-management policy performance

Data to evaluate co-management policy performance will depend upon the over-arching fisheries policy objectives of the state and the selected indicators used to monitor performance against these objectives. Evaluating co-management policy may require the monitoring of selected performance indicators *through time*, often in relation to targets or compared against equivalent indicators monitored within the *non-co-managed sector*. Performance indicators may be averaged across co-management units or fisheries, or summarized in appropriate tabulations, frequency distributions or other graphical summaries.

3.2.2.1 Progress towards establishing co-managed fisheries

Indicators may include the number of co-management units established, numbers of fishers participating in co-managed fisheries, the proportion of landings taken by the co-managed sector.

[3] FIDI classifies "full-time" fishers as those receiving at least 90 percent of their income from, or spend at least 90 percent of their time in fishing. "Part-time" fishers receive between 90 and 30 percent of their income, and spend between 90 and 30 percent of their time in fishing. "Occasional" fishers receive less than 30 percent of their income form fishing and spend less than 30 percent of their time in that occupation.

Variables and sources

Management plans should provide a source of data relating to the number of co-managed fisheries as well as the numbers of fishers involved (Section 3.3). Landings data might be generated by monitoring programmes aimed at monitoring resource sustainability (see Section 3.2.2.2) or for evaluating the performance of (local) management plans (see Section 3.5).

Examples of data types and variables used to monitor progress towards establishing co-managed fisheries

Data type	Data variables
Number of co-managed fisheries	Co-managed fisheries by region, province, marine/inland
Number of fishers participating in co-managed fisheries	Numbers of fishers by income group
Landings	Quantity by sector (co- and non-co-managed sectors)

3.2.2.2 Conservation and resource sustainability

Since the achievement of most policy objectives depends upon the sustainability of fish stocks, monitoring their ecological state, particularly in terms of their abundance will always be necessary.

Monitoring *absolute* abundance of fish stocks using biomass survey methods is unrealistic in most cases. More commonly, 'catch per unit effort' (CPUE) is monitored as an *index* of stock (see Section 3.5.1). Maintaining levels of CPUE that both safeguard the future of the stock as well providing high levels of yield is a fundamental goal of management. Monitoring the *relative* values of CPUE among species present in the fishery over time can also be used to monitor the effect of fishing on species diversity and ecosystem integrity. Simply monitoring the number of species landed by the fishery (species richness) could provide a simple alternative to these diversity indices.

The effectiveness of policy in respect to conservation and resource sustainability goals may thus be judged in terms of trends in CPUE and species diversity among co-managed fisheries or sites compared to the conventionally managed sector.

Examples of data types and variables used to monitor conservation and resource sustainability

Data type	Data variables
Identifiers	Co-managed fishery name or ID; management area name, LMI identifiers, region, strata, etc.
Abundance indices	Monthly CPUE by species for a standard unit of effort
Biodiversity indicators	Number and names of species landed

3.2.2.3 Compliance with rules and regulations

Changes in compliance, or *comparisons* of compliance with rules and regulations among co-managed fisheries may provide insights into the effectiveness of co-management policy, particularly with respect to the institutional and decision-making arrangements, enforcement measures, as well as the appropriateness of the selected rules and regulations governing access and fishing operations. Interdisciplinary *explanatory* variables that might be monitored to explain differences or trends in compliance, as well as the other co-management policy and management plan performance indicators are discussed in Section 3.5 below.

Variables and sources

Indicators of compliance should provide measures of the number and type of non-compliance activity and might include the average number of unlicensed boats fishing during a day for a given month; the proportion of fishers employing illegal gear types; or the quantity of fish landed during a closed season. Explanatory variables might include the details of resources devoted for enforcement, and details of sanctions for non-compliance. Data sources include relevant administrative levels of the fisheries department, and the records maintained by the LMI.

Examples of variables for monitoring and understanding non-compliance

Data type	Data variables
Identifiers	Co-managed fishery name; management area name, LMI identifiers, region, strata, etc.
Non-compliance	Number and type
Sanctions for non-compliance	Warning, confiscation of gear/vessel/catch; revocation of licence, fine
Other explanatory variables	Number of guards per unit area; clearly defined boundaries; representation in rule making, legitimacy of decision-making body; local support of co-management arrangements; knowledge of rules and regulations; expenditure on enforcement by local district officers

3.2.2.4 Food security

Food security is likely to be an important indicator of co-management performance, particularly in respect to how it varies among different socio-economic groups. Therefore in addition to the variables identified in Section 3.2.1.2, it would also be necessary to collect demographic variables of interest such as age, ethnicity, income group, region etc. Fish consumption data may also be collected using dedicated household surveys or part of national census exercises. The use of simple indicators such as the "number of days per week or month without fish meals" is common among routine monitoring programmes.

Examples of food security variables

Data type	Data variables
Landings	Quantity of fish landed
Fishery imports and exports	Quantity of fish products bought and sold
Conversion factors	Ratio of weight of product to weight of protein by product or species
Population/Household	Numbers of people; fish consumption indicators; average food consumption by food type; demographic variables (age, gender, ethnicity, etc.)

3.2.2.5 Income

Income is an important micro-economic indicator of management performance, normally assessed at the (local) management plan level and therefore like CPUE, may be of significant interest to the LMI. However, changes to fisher income (and its distribution – see later) may also be of interest at the national level to evaluate performance of co-management policy. This performance may be judged in terms of trends in fisher income or relative levels of income among co-managed fisheries compared to the conventionally managed sector. Income is typically evaluated on the basis of costs and earnings data (Halls *et al.*, 2000).

Variables and sources

Costs are treated as fixed costs or variable costs. Fixed costs are considered as expenditure related to capital (such as investments in gear and vessel) and may be independent of the level of output. Variable costs are continuous expenditure relating to everyday running costs (including fuel, repair, ice, food and crew costs etc). Variable costs would usually include some payment for the right of access to the resource. These costs may include traditional taxes or offerings collected for church/temple/village

Examples of income variables

Data type	Data variable
Fixed costs	Gear, vessel investment; insurance; depreciation
Variable costs (owner operating)	Repair and maintenance of craft; repair and maintenance of gear; food; materials; stocking costs
Variable costs (common operating costs)	Food; traditional taxes and offerings; materials; commission; repair of craft and gear; remuneration to other owners; repayment of loans; stocking costs
Earnings	Fresh fish sales; processed fish sales; sales of fishing inputs; rental of gear; sale of fishing rights; investment

funds and utilized for social and religious purposes or those funds paid to leaseholders and other formal or informal owners or intermediaries.

Cost and earnings data are collected using cost and earning surveys (CES), applied either to the FEU (fisherman/gear/vessel) combination operating from primary sampling units (PSUs) e.g. landing sites, or directly to PSUs in the case of household surveys where the PSU is also the FEU.

Caddy and Bazigos (1985) recommend stratified two-stage sampling with structured interview methods using pre-designed survey forms where FEUs or PSUs are sub-sampled from those selected for the catch assessment survey, if applicable. This "integration principle" improves efficiency, reduces the overall data collection costs and improves the utility of the results obtained. Before any selection is made, the sample units are stratified according to various strata, for example, region, fishery, socio-economic groups, fishing gear/vessel type (sub-sector), investment by unit of gear, etc. A few sampling units are then selected, with equal probabilities, from each strata of interest. Stratifying in this way also allows the calculation of Gini coefficients of income distribution among categories of interest (see below).

Most cost and earnings survey forms are detailed. Targeting the same model households between surveys is preferable as data quality and recall by respondents is likely to be higher and the process of scaling up is simplified (Poate and Daplyn 1990). Such panel survey methodologies are regularly deployed to monitor long-term trends in income (see Dercon and Krishnan, 1998). Ideally, cost and earnings surveys would incorporate all flows into and out of the fishing economic unit (FEU) under scrutiny (fishing unit owner, household, community, etc.).

Changing investment levels is a good proxy indicator of changing economic performance and output (FAO, 1999). Investment can involve the acquisition of greater capacity through additional fishing units or improvements in efficiency of existing fishing units. Relevant data include number of licensed vessels by vessel class and sales recorded by secondary support sectors such as gear-repairers and sellers.

Other proxy indicators of socio-economic status might be utilized if these are designed in preparatory phases of the monitoring programme. Realistic checklists for information requirements can only be established and refined through these preparatory phases and interview or survey strategies must adopt suitable protocol for the sampling of sensitive information. Caddy and Bazigos (1985) recommend the survey of simple proxy indicators of economic well-being e.g. "are incomes high enough to allow fishers, to repair or purchase boats and gears?", "are sources of credit readily available?" Poate and Daplyn (1990) question the reliability of cost and earnings surveys within the agricultural sector and suggest the adoption of suitable proxy:

> *"…. it is prudent for the survey designer to question the wisdom of even trying to collect income, expenditure and consumption data, before embarking on design and exploratory surveys. Unless very high standards of enquiry are achieved the results are likely to be unreliable, and potentially damaging if the users of the data are not aware of their shortcomings. An alternative approach is to avoid the problem of measuring total income or expenditure by concentrating on physical production, which can then be modelled using price and marketing data. Proxy measures of wealth, and access to or participation in social activities such as education, may convey sufficient information about economic well-being. If a survey is unavoidable, we suggest that a small (case) study of a few households under good supervision will provide more reliable and usable data than a large-scale sample survey. Expenditure data are likely to prove more reliable than income data."* (Poate and Daplyn, 1990)

3.2.2.6 Distribution of income/consumption/benefits

The Gini coefficient (G) is a useful means by which to quantify the distribution or equity of benefits, such as income and nutrition among individuals or groups or categories of individuals:

$$G = 1 + \frac{1}{n} - \left[\frac{2}{n^2 y} (y_1 + 2y_2 + 3y_3 ... + ny_n) \right]$$

where $y_1 \ldots ny_n$ represent incomes or annual fish consumption of individuals of each group or category in decreasing order of size, y is the mean income or annual fish consumption of all the groups or categories combined, and n is the number of socio-economic groups or categories under examination.

Distributional equity may be quantified in terms of the deviation in the observed value for G from the expected or desired value (Lorenz 1905). Sen (1976) combined the three aspects of head count, average shortfall from the poverty line, and inequality into a comprehensive and commonly used poverty index:

$$S = H[I + (1 - I)G_p$$

where H is the poverty headcount ratio, I is the average income or fish consumption shortfall of the poor in percentage terms, and G_p is the Gini coefficient of income or fish consumption inequality among the poor.

The calculation of Gini coefficient for income distribution requires fisher household cost and earnings data monitored by panel survey methods (iterative sampling of identifiable model households). Calculation of the Sen poverty index (S) would rely on an identical set of household data.

The distribution of wealth and income form the fishery is likely to be closely linked to access arrangements (see below). This is especially true in heavily exploited fisheries, where the expansion of fishing effort by one group is likely to impact negatively on other groups.

Calculation of the Gini Coefficient (G) to quantify the distribution of nutritional benefits would require detailed information of diet for as many households or groups as possible but stratification according to sub-sector or management unit of interest, and with reference to an appropriate proxy such as fish meals/week, could more realistically be sampled.

In this instance $y_1 \ldots ny_n$ represent individual, group or category annual fish consumption in decreasing order of magnitude; y is the mean individual fish consumption across all individuals, groups or categories; and n is the number of individuals, groups or categories.

To determine the distribution of nutritional benefits from fisheries a panel survey equivalent to that for income should be designed. Representative households must be sampled iteratively to record "number of fish meals" consumed annually and number of dependants (y and n, respectively).

3.2.2.7 Poverty

Indicators of poverty have typically been macro-economic statistics regarding growth, investment, balance of payments...etc, but these have failed to represent distributional aspects of development. Fields (1994) defines poverty as: "…the inability of an individual or a family to command sufficient resources to satisfy basic needs."

The poverty line is the reference point by which to gauge development and is defined by standards set by that country and according to its particular stage in

economic development. Once the reference point is set, the extent of poverty can be gauged by the shortfall between desired and actual income. In acknowledging that the costs of living may differ between regions, some countries have set separate rural and urban poverty lines (e.g. India and Costa Rica).

Fields (1994) suggests the sampling of larger economic units – that is, sampling of households as opposed to the individual. The household unit quickly encompasses more individuals and accounts for the sharing of family income. The frequency of sampling is critical. Long reference periods are more appropriate for capturing long-term trends but data quality suffers from long recall periods. Ideally, sampling would occur on a monthly basis. Poverty lines have been constructed as some fraction of average wage (as in Brazil) but this overlooks access to basic needs and commodities. The most common way to set reference points is to estimate the cost of a basic food basket (the cost of nutritional necessities as defined by calorific and protein content). Most developing nations have established poverty lines according to this type of criteria and will be unique form country to country.

With regards to quantifying the attainment of these reference points the simplest measure is an income head count in relation to this level of poverty. This does not, however, provide information on the distribution of poverty or, in fact, to what degree sections of society are poor. The generation of this level of information requires data on incomes by strata of interest. Ideally, data requirements for poverty evaluation would be derived from household income surveys (see above) conducted on a national scale. Alternatively it may be possible to employ a case study approach (see above) or obtain levels refined measures of income from a national census (Fields, 1994).

Following the work of Amartya Sen and the emphasis on poverty as lacking access to social capital or entitlements, there has been a re-appraisal of the financial treatment of poverty. The sustainable livelihoods (SL) approach adopted by DFID (see Section 5.2.2.1) acknowledges the complexity of the poverty issue. Ideally, a checklist analogous to the sustainable livelihoods approach would be adopted where human, social, natural, physical and financial capital are monitored but recognized as inter-dependent. The problem here, however, is to understand the processes by which these attributes influence one another and the problem of capturing the essence of abstract concepts such as "social capital" (see Serra, 1999). Access to (or exclusion from) basic infrastructure and services provides alternative poverty indicators. Hundreds of indicators have been developed and applied such as "distance to doctor", "distance to clean water", "proportion of children in primary education" etc. As with the design of poverty lines, such indicators can be global but are more suitably developed nationally or on a regional basis (Halls *et al.,* 2000).

Variables and sources

Variables include cost and earnings data and relevant demographic variables of interest. Numerous proxy indicators may be substituted for income data such as gear/ vessel ownership, savings, investments, assets, access to services and credit, material possessions, household assets, etc. Proxy indicators are usually collected infrequently (once every 1-10 years) as part of frame/ socio-economic baseline or may be available from population census data. Indicators of poverty, including guidelines for their data collection are further described below in Section 3.2.3.

3.2.2.8 Access to resources

Access to resources will depend upon national co-management policy as well as local institutional and decision-making arrangements.

Variables and sources

Details of access rights and the basis with which they are governed and regulated should

Examples of access variables

Data type	Data variables
Identifiers	Co-managed fishery name; management area name, LMI identifiers, region, strata…etc
Access rights	Nature of access granted to stakeholders (e.g. open, reciprocal, restricted, etc.)
Institutional and decision-making arrangements	Rules for membership, and procedures for making decisions both formal and informal that govern access to and use of the resource based upon demographic characteristics, (e.g. gender, age, income group etc) or community of residence.

be explicitly defined in the local management plan (see Section 3.3). Data sources are mainly from the LMI, intermediaries and the government fisheries agency itself.

3.2.2.9 Conflict

Conflicts can occur between the whole range of stakeholders, at a range of geographical levels and manifest themselves in a variety of ways. Although conflict is not an exclusively modern characteristic of fisheries, its study and quantification in this context has only recently been attempted (Neiland and Bennett, 1999). The DFID-funded project "Management of conflict in tropical fisheries" (R7334) developed a typology of conflict which may help document change in the nature or severity of conflict within the fishery sector. The project also developed methods to identify conflict and its frequency of occurrence.

The characteristics of conflict between fisheries will differ according to setting. Which conflicts are seen as key and particularly disruptive by government and community may also be unique. However, disputes tend to focus on issues of access and exclusion (e.g.. ethnicity, in the case of Muslim and Hindu river fishers in Bangladesh and, in the Turks and Caicos Islands, access rights granted to foreign fishers). Where conflicts such as these are persistently disruptive it should be possible to record the incidence of disputes. Sometimes, an arbitration process might be formalized and institutionalized (as is the case with Ghana's Community-Based Fisheries Management Committees), and process documentation in the form of minutes must be made available for all cases heard by the committee or mediating body concerned. Where such a process has not been formalised, sources of conflict data may have to be improvised. In the Turks and Caicos Islands, the Fisheries Advisory Committee is required to document grievances and disputes identified by fishers within Fishery Management Plans drawn up for each fishery (Halls *et al.,* 2000).

Variables and sources

Where ad hoc monitoring programmes are devised in relation to ongoing development projects, information is often collected regarding conflict. Impact monitoring is designed to record if conflicts have increased, decreased or, in fact, been introduced by programme activities themselves. For instance, within the WorldFish Center Community-Based Fisheries Management Project in Bangladesh, historic records of ongoing disputes and dialogue are recorded in the minutes of Local Management Committee meetings.

If this process documentation needs to be reduced further to simplify the process of data collection, then incidence of conflicts by type could provide simple indicators (see table below).

The incidence of each conflict should ideally, be determined on a seasonal basis since movements of fisher groups into and out of the fishery may follow seasonal patterns and dictate the nature of fisher-fisher interaction. Conflict data may be available from NGO facilitated community group/project records and minutes, or from local court records. Alternatively, the data could be collected with ad hoc studies employing semi-structured interview techniques with representatives of the LMI or other local stakeholders.

Examples of conflict variables

Data type	Data variables
Identifiers	Co-managed fishery name; management area name, LMI identifiers, region, strata, etc.
Incidence of conflicts	Number of conflicts or conflict events by type e.g. verbal confrontation; physical confrontation; injuries or deaths; incidents of gear damage; incidents of vessel damage; legal / tribunal cases (including both formal and informal / traditional village courts).
Reasons/explanations	Reasons/explanations for dispute or conflict and resolutions

3.2.2.10 Co-management costs

Costs are an important measure of co-management policy performance, particularly when compared against the benefits (e.g. improved income, equity, food security, etc. – see above) arising from the implementation of the policy. Contrary to popular belief, the costs of co-managing a fishery may exceed those for more conventionally managed fisheries, particularly if the state continues to have a significant role in monitoring and enforcement activities. Initial costs may be met through donor projects or programmes. Long run costs might be met from access or licensing activities.

Variables and sources

The co-management costs will include all those required to fund the various roles adopted by the government and local stakeholders (see Table 1). Categories of costs include including administration, monitoring, research, evaluation, enforcement and opportunity costs incurred by local stakeholders (see Section 5.2.5.6 which discusses the importance of opportunity costs in relation to the design of data collection systems).

The primary sources are the administrative levels of government, the LMI and local stakeholders.

Examples of co-management cost variables

Data type	Data variables
Costs to government	Surveillance costs, monitoring costs, enforcement costs, training costs, administration costs, research costs.
Costs to the LMI and its associated stakeholders	Opportunity costs associated with participation in co-management activities (monitoring and enforcement activities, participating in meetings and workshops, and participatory monitoring programmes)

3.2.2.11 Explanatory variables for co-management policy performance evaluation

Since broad co-management policies are likely to be translated into more context-specific local institutional and decision-making arrangements and management strategies, which may themselves differ significantly among individual co-management units or fisheries, developing an understanding of the effects of co-management policy on performance may only be achievable through local level comparisons. Opportunities exist to make these comparisons and build understanding as part of the evaluation of local management plan performance. Section 3.5.8 provides examples of the types of explanatory variables that might be used for this purpose in relation to the co-management policy performance variables and indicators described above. This section also contains guidelines for constructing predictive models.

3.2.2.12 Process monitoring

The indicators described in this Section 3.2.2 have so far been relevant for monitoring the *outcomes* of co-management policy. However, it is also important to monitor the policy itself and how it is implemented in order to *understand* and *improve* the policy outcomes. The influence and outcomes of co-management policy will be reflected

in local management plans as well as records/diaries documenting the outcomes of meetings and workshops held between the co-managers. Intermediary organizations such as research institutions, development projects and NGOs are often in a good position to take responsibility for this *process* monitoring. "Process monitoring should provide a means of developing stakeholders' capacity for participation and not as a means for allocating blame for management failure" (Hoggarth *et al.*, 1999).

3.2.3 Data requirements for development and poverty reduction evaluation

The extent to which fisheries departments will have involvement in the monitoring and evaluation of poverty reduction strategies and development activities will vary. Most indicators used for monitoring progress towards poverty reduction and development are of cross-sector relevance. Their inclusion in fisheries sector data collection systems will therefore depend largely upon the degree of livelihood dependence on fisheries and the roles and responsibilities of the management authority. The fisheries sector may be involved in their collection and monitoring to contribute towards national efforts or to provide evidence of the effects of fisheries sector policy or interventions on achieving these goals.

Data required to monitor several of the proposed or recommended indicators, may often already be collected for monitoring the performance of co-management policy on poverty, conservation and sustainability (see Section 3.2.2). For example, data on the numbers of fishers below the poverty line could be used to help compile "percentage of the population living below the poverty line" for National Strategies for Sustainable Development (NSSD) purposes (See Section 3.2.3.3). Annual catch by species is vital for many indicators and can provide the indicator for theme 17 of NSSD. Similarly, data relating to areas or reserves that have been set-aside for the purposes of maintaining or conserving fish diversity as part of a local management plan could be used to help compile the Millennium Development Goal (MDG) indicator: "ratio of land protected to maintain biological diversity to surface area" (see Section 3.2.3.1).

Therefore, before establishing new (fisheries sector-based) data collection systems specifically to monitor progress with respect to Poverty Reduction Strategy Papers (PRSP), MDG and NSSD, it is worthwhile first reviewing, with respect to each indicator, currently available data collected to monitor the performance of co-management policy and (local) management plans (see Section 3.5 and 5.2.4). This being said, it may not be possible or appropriate to compile these indicators on the basis of separate contributions from different sectors such as fisheries. Instead *ad hoc* surveys or a regular census may be preferred, conducted by the relevant government department or line Ministry, such as a national statistical office, statistical bureaus or administrations, and possibly funded by donors such as the World Bank, the US Agency for International Development and the UK Department for International Development.

For any of the indicators described below, there may be a wide range of data sources available within the country, and whilst each source should be critically reviewed, existing data sources and reporting systems should be used where possible, particularly where line ministries have their own statistical systems. For example, the fisheries management authority may have relevant data relating to the areas or reserves set aside for the purposes of maintaining or conserving fish diversity which will be required to help compile the "ratio of land protected to maintain biological diversity to surface area" where the surface area corresponds to that of the State and its territorial waters (up to 12 nautical miles).

3.2.3.1 Millennium Development Goals

In September 2002, 189 countries, including 147 Heads of State adopted the United Nations Millennium Declaration, which sets out a number of international development

goals that have come to be known as the Millennium Development Goals (MDG). The aim of these goals is "to create an environment – at the national and global levels alike – which is conducive to development and the elimination of poverty." By the year 2015, all 191 United Nations Member States have pledged to meet the MDG. The eight goals were chosen to monitor progress at the global level and guide development assistance; they are not meant to determine which goals individual countries should choose.

Forty-eight indicators have been identified to monitor progress towards these goals and targets. Full details of each indicator including rationale, method of computation, gender issues and guidelines for collecting data to compile the indicators are available at: http://www.developmentgoals.org/mdgun/MDG_metadata_08-01-03_UN.htm.

3.2.3.2 Poverty Reduction Strategies

Since 1999, Poverty Reduction Strategy Papers (PRSP) provide the basis for assistance from the World Bank and the International Monetary Fund (IMF) Fund as well as debt relief under the Heavily Indented Poor Countries (HIPC) initiative. Developing or strengthening a poverty reduction strategy is on the agenda of about 70 low-income countries as a requirement for receiving debt relief under the enhanced HIPC Initiative and concessional assistance from the World Bank and International Monetary Fund (IMF). In effect, PRSP translate the World Bank's Comprehensive Development Framework (CDF) (http://www.worldbank.org/cdf) principles into practical plans for action (Box 6). These PRSPs fundamentally shape policy both within and across sectors and therefore are also likely to have a significant bearing on the design of [fisheries co-management] data collection and sharing systems.

There are **five core (CDF) principles** underlying the development and implementation of poverty reduction strategies. The strategies should be:

- **country-driven**, involving broad-based participation by civil society and the private sector in all operational steps;
- **results-oriented**, focusing on outcomes that would benefit the poor;
- **comprehensive** in recognizing the multidimensional nature of poverty;
- **partnership-oriented**, involving coordinated participation of development partners (bilateral, multilateral, and non-governmental);
- based on a **long-term perspective** for poverty reduction.

There is no blueprint for building a country's poverty reduction strategy. Rather, the process should reflect a country's individual circumstances and characteristics. Nevertheless, the core principles underlying the PRSP approach suggest that PRSPs should have:

- **A description of the participatory process that was used:** A PRSP will describe the format, frequency, and location of consultations; a summary of the main issues raised and the views of participants; an account of the impact of the consultations on the design of the strategy; and a discussion of the role of civil society in future monitoring and implementation.
- **Comprehensive poverty diagnostics:** A PRSP would begin by describing who the poor are and where they live using existing data. Building on this description, the PRSP could analyse the macroeconomic, social, structural and institutional constraints to faster growth and poverty reduction.
- **Clearly presented and costed priorities for macroeconomic, structural, and social policies:** In light of a deeper understanding of poverty and its causes, the PRSP will set out the macroeconomic, structural, and social policies that together comprise a comprehensive strategy for achieving poverty reducing outcomes. It is important that policies are costed and prioritized as far as possible so that they are not reduced to becoming a "wish list".
- **Appropriate targets, indicators, and systems for monitoring and evaluating progress:** A PRSP will define medium and long-term goals for poverty reduction

BOX 6
The Comprehensive Development Framework

The Comprehensive Development Framework is an approach by which countries can achieve more effective poverty reduction. It emphasises the interdependence of all elements of development – social, structural, human, governance, environmental, economic, and financial. It advocates: a holistic long-term strategy; the country in the lead, both "owning" and directing the development agenda, with the Bank and other partners each defining their support in their respective business plans; stronger partnerships among governments, donors, civil society, the private sector, and other development stakeholders in implementing the country strategy; and a transparent focus on development results to ensure better practical success in reducing poverty.

outcomes (monetary and non-monetary), establish indicators of progress, and set annual and medium-term targets. The indicators and targets must be appropriate given the assessment of poverty and the institutional capacity to monitor. It is also necessary that they are consistent with policy choices in the strategy. Finally, a PRSP would have an assessment of the country's monitoring and evaluation systems and would include participatory mechanisms wherever possible.

A Joint Staff Assessment (JSA) evaluates the soundness of each PRSP in terms of whether or not the strategy presented constitutes a sound basis for concessional assistance and debt relief from the IFIs. The CDF and the PRSP are the way forward to enhance country ownership and the achievement of the Millennium Development Goals.

Data and information requirements in support of PRSPs are discussed in detail in the "Sourcebook". The Sourcebook has been compiled to provide guidance and analytical tools to countries and country teams developing poverty reduction strategies. It is a collection of broad policy guidelines, examples of international best practice, and technical notes covering data and information requirements and monitoring and evaluation programmes. The Sourcebook is available on the Web, free of cost, at http://www.worldbank.org/poverty/strategies/sourctoc.htm, and further updates may be found at that address. The Sourcebook was also published in bound form in two volumes in October 2001 (e-mail prsp_sourcebook@worldbank.org.). Participatory approaches to monitoring poverty are described at http://www.worldbank.org/poverty/strategies/chapters/monitoring/pmeprsnt.pdf.

3.2.3.3 National Strategies for Sustainable Development (NSSD)

The United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in 1992, recognized the pressing environment and development problems of the world and, through adoption of Agenda 21, produced a global programme of action for sustainable development into the 21st century. Agenda 21 states that countries should adopt national strategies for sustainable development (NSSD), which "should build upon and harmonies the various sectoral economic, social and environmental policies and plans that are operating in the country" (Dalal-Clayton and Bass, 2002).

Since UNCED, governments have made extensive efforts to integrate environmental, economic and social objectives into decision-making by either elaborating new policies and strategies for sustainable development, or by adapting existing policies and plans. To assist in this process, an International Forum on National Sustainable Development Strategies was held in Ghana in November 2001. The Forum adopted a guidance document containing a number of recommendations on approaches for integrating the

principles of sustainable development into policies and programmes of both developed and developing countries (*ibid*).

The World Summit for Sustainable Development (WSSD), held in August 2002, urged that: "States should: Take immediate steps to make progress in the formulation and elaboration of national strategies for sustainable development and begin their implementation by 2005".

Data and information requirements for NSSD

Indicators for monitoring progress towards sustainable development are needed in order to assist decision-makers and policy-makers at all levels and to increase focus on sustainable development. The Commission on Sustainable Development (CSD) has developed a set of 58 indicators (and accompanying methodology sheets) from which countries can choose from according to national priorities, problems and targets. See http://www.un.org/esa/sustdev/natlinfo/indicators/isdms2001/table_4.htm.

Further advice and information concerning the formulation, implementation and monitoring of National Strategies for Sustainable Development can be found in the *Resource Book* at http://www.nssd.net/res_book.html - contents

3.2.3.4 Rationalizing poverty and development indicators

The types of data and information required to monitor development and poverty reduction performance at the national level for PRSP and NSSD, and globally in respect to the MDG are likely to have much in common. Indeed, many of the indicators for monitoring progress towards achieving the MDG have been recommended for monitoring progress towards reducing poverty as part of PRSP. With DFID support PARIS21 – a task team to consider how the international statistical community can improve their support for monitoring progress towards development goals – is currently examining ways in which monitoring efforts in respect to MDG and PRSP could be rationalized, as well as identifying the key constraints to improving data availability and quality (see http://www.paris21.org/htm/task/impmdg/TOR_mdgprsp.pdf**).**

3.2.4 Data to meet management and reporting obligations

Fisheries policy is often shaped and influenced by obligations resulting from international development agreements, or ratifications of conventions, codes of conduct or voluntary instruments that define various management and reporting obligations.

3.2.4.1 Conventions and Codes of Conduct

Chief amongst the international instruments is the United Nations Convention on the Law of the Sea (UNCLOS III). This convention sets the legal context for all subsequent international arrangements and agreements relating to the use of the oceans and seas (Cochrane, 2002).

The FAO Code of Conduct for Responsible Fisheries (CCRF) is a voluntary agreement which sets out principles and international standards of behaviour for responsible practices with a view to ensuring effective conservation, management and development of living aquatic resources, with due respect for the ecosystem and biodiversity. This includes the *precautionary approach* to fisheries management that requires managers to be cautious when the state of the resource is uncertain, for example when fishery data are insufficient or unreliable. The precautionary approach is thus a powerful incentive for the collection of reliable and relevant fisheries data (FAO, 1999). The code also emphasizes the importance of participation and contains provisions to protect small-scale fishers' livelihoods from conflict with larger-scale commercial interests, as well as providing the necessary framework for maintaining or enlarging small-scale fisherfolks "action space". It also supports the role of community in bringing about development and resource conservation. Paragraph 7.1.2 of the Code

BOX 7
Code of Conduct for Responsible Fisheries (CCRF)

"Conservation and management decisions for fisheries should be based on the best scientific evidence available, also taking into account traditional knowledge of the resources and their habitat, as well as environmental, economic and social factors. States should assign priority to undertake research and data collection to improve knowledge of fisheries" (CCRF 6.4).

of Conduct emphasizes the importance of involving legitimate interested parties in the management process (Cochrane, 2002), including the use of traditional knowledge:

The FAO Code of Conduct for Responsible Fisheries (CCRF) (FAO, 1995) sets out a number of obligations on States to conserve stocks and avoid over-exploitation. To achieve this, they are required to collect data so that decisions are based upon the best scientific evidence available (FAO, 1999). Rather than being prescriptive about the data and information that should be collected, broad obligations are set out (Box 7). The precautionary approach to fisheries management requires managers to be cautious when the state of the resource is uncertain, for example when fishery data are insufficient or unreliable (FAO, 1999).

3.2.4.2 Straddling and migratory stocks

This precautionary approach is embodied in the CCRF as well as the 1995 United Nations (UN) Fish Stocks Agreement. The latter is a binding instrument which applies the precautionary approach both on the high seas and within Exclusive Economic Zones (EEZ) for straddling and highly migratory stocks. Annex 1 of this agreement specifies the minimum data requirements that Flag States are obligated to collect (and share) for the management and conservation of these resources. The basic requirements include:

- catch numbers or nominal weight by species, and fishing effort by fishery, fleet and location;
- where appropriate, length, weight, age and sex composition of the catch, and other biological information supporting stock assessments e.g. growth, recruitment, distribution and stock density, and make available the results of relevant research including abundance surveys, and oceanographic and ecological studies; and
- vessel data and information for standardizing fishing effort (see Sections 5.2.2.3 and 3.4.1).

Because of the characteristics of these resources (highly migratory with poorly defined boundaries) they are not suited to local (community) management. These resources are therefore likely to be most effectively monitored and managed through coordination by the states involved.

3.2.4.3 Convention for the International Trade in Endangered Species (CITES)

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) is an international treaty which was drawn up in 1973 to protect wildlife against over-exploitation and to prevent international trade from threatening species with extinction. Member countries (146) act by banning commercial international trade in an agreed list of endangered species and by regulating and monitoring trade in others that might become endangered. Exports of endangered species (see Appendixes I to III of the Convention) require a valid export permit containing the information set out in Resolution Conference 10.2 (formerly Appendix IV of the convention). The production of these data is likely to be the responsibility of a country's customs and export departments.

3.2.4.4 Convention on Biological Diversity

The Convention on Biological Diversity was established in 1993 in response to the world community's growing commitment to sustainable development. The objectives of the convention are "...the conservation of biological diversity, the sustainable use of its components and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources, including by appropriate access to genetic resources and by appropriate transfer of relevant technologies, taking into account all rights over those resources and to technologies, and by appropriate funding". Countries that have ratified the agreement are obliged to identify and monitor through sampling and other techniques "...components of biological diversity important for its conservation and sustainable use" and "Maintain and organize, by any mechanism, data, derived from identification and monitoring activities" (Article 7). However, no advice is given with respect to required measures or indicators of diversity. Several measures or indicators are likely to be appropriate to the fisheries sector based either upon catches (e.g. species richness, presence/absence etc) or abundance data (e.g. CPUE data) (Section 3.2.2.2).

3.2.5 Data requirements in support of memberships to regional management bodies

International reporting responsibilities usually exist as a result of either membership to one or more commissions set up to harmonies and promote rational and responsible management of fisheries resources on a regional or global level, or ratification and compliance with international conventions or codes of conduct.

Membership to many of the regional bodies or programmes, agencies, organizations and commissions such as the Organisation of Eastern Caribbean States (OECS), Integrated Development of Artisanal Fisheries (IDAF) programme; Southern African Development Community (SADC) and the Mekong River Commission (MRC), often requires the provision of data and information. These data may be specific, determined by a combination of the nature and structure of the local or regional fisheries and the objectives for management and development.

More generic information requirements to meet the reporting responsibilities of the main international commissions and conventions are described below:

FAO Regional Fishery Commission Requirements

Countries that are members of FAO regional fishery commissions including the:

- Asia Pacific Fishery Commission (APFIC);
- Fishery Committee for the Eastern Central Atlantic (CECAF)
- Committee for Inland Fisheries of Africa (CIFA)
- Commission for Inland Fisheries of Latin America (COPESCAL)
- Indian Ocean Fishery Commission (IOFC)
- Indian Ocean Tuna Commission (IOTC)
- Western Central Atlantic Fishery Commission (WECAFC)

These commissions have been established to promote management of fish stocks in the commission or convention area. Members of the UN or any of these commissions are required to report to the FAO Fisheries Department the following information (FAO, 1999):

(i) *Nominal (liveweight) catch statistics for the countries' flag vessels* that fish in the area.[4] These should be broken-down by species classified in accordance with the FAO Common and Scientific names (See Section 3.1.2). Routine monitoring programmes (RMPs) are the main sources of these data.

[4] Data concerning the nominal catch of fish included within FAO species group 36 (tunas, bonitos and billfishes) are reviewed in collaboration with regional tuna agencies ICCAT, IATTC, IPTP, SPC, etc.

(ii) *Annual production of fishery commodities, imports and exports*. These should be expressed in terms of country, volume, value and processing method in accordance with the FAO International Standard Statistical Classification of Fishery Commodities (ISSCFC) (see FAO, 1999 for further details). The production of these data is likely to be the responsibility of a country's customs and export department.

(iii) *Fleet statistics* Member countries are also required to complete a questionnaire each year detailing their fleet statistics. These refer to the "...number and total tonnage of fish catching, processing, and support vessels utilized in commercial, subsistence and artisanal fisheries by size of vessel measured in gross registered tonnes (GRT) and by type of vessel according to the International Statistical Classification of Fishery Vessels (ISCFV)" (FAO, 1999). These data are generally available from frame surveys (Section 5.2.2.3) and or vessel registers (Section 3.4.1) and included in management plans (Section 3.3).

(iv) *Employment statistics.* Employment statistics are also requested each year by means of a questionnaire. These refer to the number of workers according to the time devoted (full-time, part-time, occasional) to fishing and aquaculture, by gender (FAO, 1999). Employment statistics are typically collected by means of frame surveys and population censuses undertaken by government line agencies such as Bureaus of Statistics (BS) and should also be included in management plans.

3.3 CATEGORY 2 – DATA TO FORMULATE AND COORDINATE LOCAL MANAGEMENT PLANS

The concept of management plans was introduced in Section 2.2. Management plans (MP), usually presented in a report or logical framework format (see 5.2.2.4), serve as a reference and information source for those stakeholders involved in the management of the resource. The formulation of the plan must therefore be undertaken with the full participation of these stakeholders (see Section 5.2). Local stakeholders are also likely to be the main source of much of the information required to formulate the plan. Categories of information in the plan might include those below. Berkes *et al.* (2001) also describe typical elements of management plans (see http://web.idrc.ca/en/ev-28061-201-1-DO_TOPIC.html).

3.3.1 Resource and environment

(i) *The stocks or fishery being considered and the area under the jurisdiction of the LMI.* This might include information on the relative importance of each species exploited measured in terms of catch weight or value determined from local knowledge or by more formal monitoring programmes. Attempts should be made to categories species according to their migratory behaviour (e.g.. sedentary or migratory). Once the plan has been implemented, much of this information will be generated by ongoing monitoring and evaluation activities.

(ii) *Information on environments, habitats or locations critical to the life history* of the stock or species. This information is useful for designing management strategies and might include the location of spawning and nursery areas, migrations routes, and water-bodies where fish survive during the dry season. This information could be assembled on the basis of consultations with local resource users, or based upon the results more formal (spatially referenced) monitoring programmes.

(iii) *Potential catchment influences on the fishery or stock*, identified from maps or satellite images (see Section 3.3.10).

3.3.2 Fishery

A co-managed fishery may simply comprise a number of homogenous fishers operating similar gears in one location, as is the case in some Caribbean fisheries (see Halls *et al.*,

BOX 8
The Fishing Economic Unit (FEU)

The Fishing Economic Unit (FEU) typically comprises the fishing craft (if any), the fishing gear, and the fishermen to carry out fishing operations.

(Bazigos, 1983)

2000). In most cases, however, the fishery will be more complex, consisting of one gear type but operated by teams of fishers belonging to different socio-economic categories; or different types of boats or vessels operating different gear types in different locations. A management plan and its evaluation needs to consider the effects of these different categories of fishing economic units (FEUs) [see Box 8] on the resource and the impact of the management plan on them (FAO, 1997; FAO, 1999).

The management plan should, therefore, contain the following information for each category of FEUs: (i) total numbers; (ii) gear types and technology employed; (iii) some idea of the selectivity of the gears with respect to the species and size of fish caught; (iv) seasonality of fishing; (v) location of fishing; (vi) landing locations; and (vii) socio-economic categories of fishermen and other stakeholders associated with, or dependent upon the different categories of FEUs. Most of this information can be compiled with the help of local resource users represented by the LMI and intermediaries often as part of *frame surveys* or participatory appraisals (see Section 4.3). Once the plan has been implemented, much of this information will be generated by ongoing monitoring and evaluation activities.

3.3.3 Fishers and other stakeholders

Management actions may have a different impact (e.g. the distribution of income) on stakeholders. Attempts should therefore be made to identify distinct socio-economic categories of fishers (professional, subsistence etc), their sub-categories (e.g. women, children) and other stakeholders (fish traders, leaseholders etc) corresponding to or dependent upon different FEUs. This profiling will usually be undertaken as part of a frame survey, participatory appraisals or periodic socio-economic surveys.

3.3.4 Management roles and responsibilities

Details of all stakeholders involved in the management of the resources, including their roles and responsibilities and planned activities (see Section 2.3.1). Stakeholder analysis described in Section 5.2.1 provides a means to identifying stakeholders, their capacity and respective interest in the management of the resource as the basis agreeing these roles and responsibilities and for identifying opportunities for information sharing.

3.3.5 Management plan objectives and current status

This might include: (i) The agreed biological, social and economic objectives for the fishery. These should be consistent with the overarching policy objectives and goals; (ii) The current performance of the management plan in realizing these objectives, and the impact on the resource and its users (biological, economic and social impact); and (iii) Data and information concerning non-compliance. Management objectives and corresponding indicators to evaluate the performance of the management plan are considered in Section 3.5 below.

3.3.6 Management strategy

(i) Details of management control measures (e.g. closed seasons, mesh size regulations, effort restrictions etc) and interventions such as stocking or habitat enhancement/ rehabilitation programmes employed to realize the management objectives. This should include details of user or access rights, existing legislation and sanctions for non-compliance. The rules and regulations may need to comply with national legislation and any management obligations resulting from international or

regional management agreements, or ratifications of conventions, codes of conduct or voluntary instruments (see Section 3.2.4).

(ii) Details of exiting monitoring (data collection), control and surveillance programmes and activities including who is responsible, what information is collected, how, when and where and associated costs. Known strengths and weaknesses of the existing systems should also be documented (Section 5.2.8).

3.3.7 Performance evaluation criteria and decision-making arrangements

Details of the indicators and criteria used to evaluate the performance of the management plan in relation to the specified management objectives, and to adjust or refine the management strategy as necessary. This might also include procedures for consultation and joint decision-making among stakeholders. Details of any models or analytical approaches (including explanatory variables) used to guide decision-making might also be included here (See Section 3.5 for further explanation).

3.3.8 External arrangements, markets and vulnerability context

Details of relevant legislation, cultural factors, markets, (seasonal) prices, trade arrangements, donor assistance, population, economic and technological trends, and the frequency and predictability of natural disasters. All these factors have the potential to affect fisher behaviour and ultimately management performance (see Section 3.5).

3.3.9 Results of any previous management plan evaluations

A summary of the results of any previous evaluations of the management plan should be included to support the re-formulation or revision the plan. This may include the outcome of among fishery or unit comparisons of management performance (see Section 3.5.4).

3.3.10 Data to coordinate local plans

Effective coordination of local management plans by appropriate administrative levels of the fishery department (and intermediaries) to minimize negative interaction among local management strategies is an important role to maximize overall management performance and minimize conflict among LMIs and their communities. For example, in river systems, the use of barrier traps in the channel may need to be coordinated or restricted to minimize conflict among communities exploiting migratory species. Activities that may impact on the environment such as potential destructive fishing practices may also have to be managed in a similar way.

The ability to monitor and coordinate these interactions requires full knowledge of the details of each local management plan. Mapping important attributes of each plan together with details of existing fishing operations and methods by means of a Geographic Information System (GIS), could provide an effective means of identifying potential interactions and identify sites where coordination is required or where enforcement activities should be focused (see de Graaf *et al.*, 2003 and Meaden and Do Chi, 1996 for further guidance). This mapping approach might also be used to identify potential sectoral interactions to facilitate a more integrated approach to management.

3.3.11 Other information

The management plan may also contain details of costs and benefits in order to justify the expenditure on the various components of the management system. Costs may include administration, and staff and capital equipment for monitoring, evaluation, control and surveillance. Benefits are often less easy to quantify, particularly where they result in social or conservation, rather than economic, returns. See Cochrane (2002) for further discussion on the design and implementation of management plans.

3.4 CATEGORY 3 – DATA TO IMPLEMENT LOCAL PLANS

3.4.1 Data for enforcing local rules and regulations

Access restrictions to the resource are a common feature of management plans designed to reduce the overall, seasonal or age-dependent fish mortality rates depending upon their form. Access is often controlled by means of licences allocated to individual fishers, gears and/or boats or canoes (the FEU). In order to effectively enforce such measures, it is necessary for co-managers to maintain up-to-date registers of these licensed FEUs. These registers typically include information relating to the ownership, identity, and fishing power[5] of each FEU. Corresponding licence details of each FEU may be recorded separately and linked to each FEU by means of an allocated fishing unit identification number, and might include details of the licence holder, period of validity and where applicable, the licence fee (required to estimate revenues derived from the fishery) and details of any gear or landing restrictions.

Examples of variables for enforcing local rules and regulations

Data type	Variable
Identifiers	Name and address of each fisher or vessel owner and FEU identification number
Type	Vessel type (e.g. skiff, canoe, boat), and material of construction (wood, fibreglass, steel, etc.)
Power	Sail; engine hp
Size	Length, breadth, gross tonnage
Crew	Number by job description
Gear	Details of the gear type, size, number, mesh size, etc..
Licence or access details	Licence number, period of validity, fee (if applicable); details of gear, landing and access restrictions (e.g. closed areas, seasons etc.)

Information contained within the management plan including details of the rules and regulations themselves, management jurisdiction, access rights and boundaries, will also be relevant (see Section 3.3).

3.4.2 Data for resolving conflict

Data and information to help resolve conflict is contained within the management plan including details of management jurisdiction, management strategy, roles and responsibilities, potential catchment influences on the fishery, access rights and boundaries, procedures for consultation and joint decision-making, and relevant legislation (see Section 3.3).

3.5 CATEGORY 4 – DATA TO EVALUATE AND IMPROVE LOCAL MANAGEMENT PLANS

Both government and the LMI have an interest in monitoring and evaluating local management plans. From government's perspective, monitoring the performance of (a sample of) local management plans may be necessary to evaluate the performance of it's co-management policy (see Section 3.2.2) and may also generate information required for national policy and development planning purposes (see Section 3.2.1). The LMI, on the other hand, is more likely to be interested in monitoring information that it can use to demonstrate the benefits of management activities to its members and to help improve or refine the management plan. However, significant overlap in data requirements is likely to exist between the two main stakeholders for these different purposes thereby providing opportunities for *sharing* the data and the task of *collecting* it (see Section 5.1).

Since we have already examined the requirements of government in the context of local management plan performance monitoring (see Section 3.2.2), we begin this

[5] This information is often required to standardize fishing effort (see Section 3.5.1) and calculate licence fees or quota allocations where applicable.

section by examining the requirements of local managers to evaluate their management plans. We then, in Section 3.5.8, consider how among fishery or management unit comparisons may be used to *understand* outcomes or the effects of co-management policy.

While *formal* monitoring may *not* be regarded as necessary by some LMIs because the outcomes of management activities may be "common knowledge" or self-evident, the results of research activities described in the *Preparation of this document* in Part I suggest that local managers are often interested in actively participating in monitoring programmes, particularly when in view of the potential incentives that exist (see Section 5.2.5.5). Communities are also extremely aware of the significance of environmental influences on their management performance and thus recognize the importance of monitoring environmental variables and habitat status. Data of interest to local managers are likely to fall into two main categories: (i) data to monitor the performance of the plan and (ii) data to explain the performance of the plan.

3.5.1 Data to monitor the performance of the management plan

The data interests of local managers for monitoring management performance will depend largely upon the objectives set out in their plans as well as factors outlined in Section 3.1.2. For example, if the management objective is to maximize the catch of fish species X, then obviously it would be necessary to monitor the catch of species X – the *status* or *default* indicator. Data variables for this indicator might include the landed weight of species X during some time period, or some other measure of the quantity landed such as baskets or numbers of fish landed.

Since the achievement of most local management objectives depends upon the sustainability of fish stocks, monitoring their ecological state, particularly in terms of their abundance will always be necessary.

Monitoring *absolute* abundance of fish stocks using biomass survey methods is unrealistic in most cases. More commonly, 'catch per unit effort' (CPUE) is monitored as an *index* of stock size although the underlying assumption that CPUE is proportional to abundance (Equation 1) may not always be satisfied.[6] Monitoring the *relative* values of CPUE among species present in the fishery over time can also be used to monitor the effect of fishing on species diversity and ecosystem integrity. Simply monitoring the number of species landed by the fishery (species richness) could provide a simple alternative to these diversity indices.

$$CPUE = (biomass).q \qquad (1)$$

where q is the *catchability coefficient*; a measure of the efficiency of the fisherman/gear/vessel combination often described as the fishing economic unit (FEU) – see Section 3.3.2.

Maintaining levels of CPUE that both safeguard the future of the stock as well providing high levels of yield is a fundamental goal of management.

Monitoring CPUE

Catchability varies among gear types according to their attributes and characteristics. For example, a large monofilament gillnet will have a greater efficiency or fishing power than a single hook and line. The *units* used for measuring fishing effort are therefore *critical*. Generally, measures of fishing effort need to indicate how many units of the gear were used, their size, and how long they were fished for. Standard units of effort for different gear types are given in Annex 1.

[6] See discussion on hyper-depletion and hyper-stability in Hilborn and Walters (1992).

When boats form part of the FEU, catching power will also depend upon various attributes and characteristics of the boat including its size, engine power, hold capacity ...etc. These attributes or characteristics provide a basis for categorizing vessels to both help standardize fishing effort (see below) and to provide strata for catch and effort sampling programmes (see Section 4.4.1).

Measures of fishing time for this type of FEU may be less straightforward to monitor than a simple gear operated by an individual fisherman. The actual time spent fishing by some types of FEU, for example, a small skiff used to fish lobster, may account for only a small proportion of the total time available for fishing. Significant proportions of the total time spent fishing may be devoted to time spent travelling to the fishing grounds, time spent searching for the best places to fish e.g. coral heads, and the time required for handling and processing the catch (Total time spent fishing = travel time + search time + setting time + handling time). For this type of fishery, it may be necessary to monitor each component of the total time spent fishing so that more relevant measures of effort to estimate abundance can be calculated, such as the search time and/or the actual time spent fishing (see Annex 1).

Methods to standardize fishing effort across different gears or vessels to allow for the calculation of total or overall effort (and CPUE) are available (see Sparre and Venema 1992). However, this approach if often unrealistic in many co-managed fisheries where more than 100 gears may be used during the course of the year, but where the types of gears used and their catchability varies seasonally in response to the prevailing fishing conditions. In these situations, more crude measures of effort such as number of fishers or the numbers of boats or canoes exploiting the resource may have to be employed. Alternatively, if estimates of CPUE are simply required for monitoring the relative abundance of species *i* in period *k*, then the effort corresponding to a single gear type *j* may be used:

Where several different CPUE estimates are available for a single gear type in a

$$CPUE_{i,j,k}\ (kg/unit\ of\ effort) = \frac{Total\ catch\ of\ species_{i}, taken\ by\ gear_{j}, in\ period_{k}}{Fishing\ effort\ of\ gear_{j}, in\ period_{k}}$$

given period (e.g. from different fishers), an average CPUE figure may be calculated. However, CPUE's should never be averaged across different gear types. For monitoring species abundance where catchability varies seasonally, such as in floodplain fisheries, CPUE estimates for the current year must only be compared with those for the same periods in previous years. Since the timing of the seasons varies between years, CPUE's may best be estimated as the average for each season (e.g. the flood season, the falling-water season and the dry-season) rather than for individual calendar months (Hoggarth *et al.*, 1999). This type of single gear CPUE monitoring is employed on Lake George in Uganda to monitor the abundance of *ngege* (*Oreochromis niloticus*) where CPUE is measured as catch per net (4.5 inch mesh) per night (Lamberts 2004).

BOX 9

Catch and effort monitoring guidelines

The FAO (Stamatopolous 2002; 2004; and Sparre 2000) have produced clear and easily understandable guidelines that should be consulted before designing surveys or sampling programmes to estimate catch and effort data. These guidelines also deal with important related concepts and activities including accuracy, precision, stratification, minimum sample size and frame surveys. The FAO's ARTFISH software (see Section 5.2.7.2) also contains routines to help managers plan and design sample-based catch and effort surveys.

TABLE 2
Examples of local management objectives, and indicators and variables for monitoring management plan performance

Management objective theme	Example indicators	Data types	Example data variables
Yield	Multispecies annual yield (MAY)	• Total catch aggregated across all species • Conversation factors	• Weight • Number • Number of baskets of fish • Weight of fish per basket
	Annual yield of species, *s* (AY_s)	• Total catch for species, *s* • Conversation factors	• Weight of species *s* • Number of species *s* • Number of baskets of fish of species *s* • Weight of fish of species *s* per basket
Resource Abundance/ Sustainability	Catch per unit effort of species, *s* ($CPUE_s$)	• Total catch of species, *s* • Conversation factors • Fishing effort	• Weight of species *s* • Number of species *s* • Number of baskets of fish of species *s* • Weight of fish of species *s* per basket • Hours fishing • Number of traps set • Number of active full and part time fishers
Biodiversity	Species presence and richness (S)	• Catches by species	• Presence/absence of species • Number of species landed
Well-being (Fishers/ Households)	Household income from fishing	• Fixed costs • Variable costs • Earnings	• Gear costs • Insurance • Depreciation • Repair and maintenance costs • Stocking costs • Earnings from fish sales • Earnings from rental of gears • Earnings from sale of fishing rights
	Household assets	• Types of assets	• Number of TVs • Number of Bikes • Presence/absence of tin roofing
	Household fish consumption	• Landings • Sales and purchases • Demographic variables	• Quantity of fish landed • Quantity of fish bought and sold • Number of household members • Age, gender
Institutional performance	Compliance with rules and regulations	• Non Compliance events	• Number and type of non-compliance events
	Conflicts	• Incidence of conflicts	• Number of conflicts or conflict events by type e.g. verbal confrontation, injuries or deaths, incidents of gear damage etc.

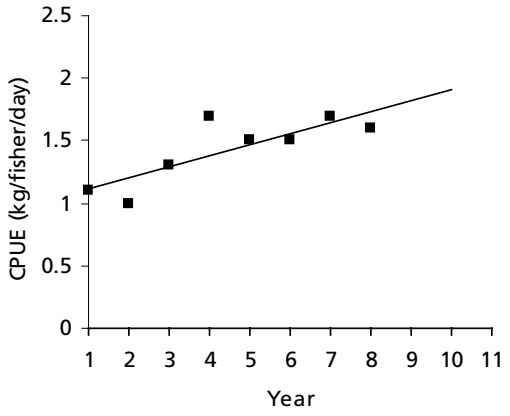
Examples of other data variables in that might be selected to monitor progress in relation to other objectives also are provided in Table 2.

According to the research findings, local managers are likely to share a number of similar objectives with those of government identified in Section 3.2.2 concerning conservation and sustainability, income, food security, equity, access, etc., and therefore may select (or agree to monitor) the same indicators of performance or corresponding data variables (see examples above). Well-designed data collection programmes will therefore seek to maximize this overlap of common data variables through negotiation and the provision of incentives (see Sections 5.2.5.5 to 5.2.5.7).

3.5.1.1 Evaluating management plan performance

Management plan performance monitoring in relation to each objectives is typically undertaken by graphically plotting the value of the performance indicator through

FIGURE 5
CPUE plotted as a function of time



In this example, the probability that the slope coefficient is zero (i.e. no significant upward trend) is less than 1% ($\alpha = 0.01$) implying that the upward observed trend in CPUE is unlikely to simply reflect random variation. The value of the slope coefficient is 0.088 indicating that CPUE is rising by about 0.1kg/fisher/year over the seven year monitoring period.

time and examining the time series to detect trends in the value of the indicator (Figure 5). The significance of trends (either upward, downward) can be tested by fitting regression models to the time series. A trend is typically judged to be significant when the probability that the slope coefficient is zero is less than 5% ($\alpha \leq 0.05$).

3.5.2 Data to explain the performance of the management plan

As already explained in Section 3.1.1 monitoring indicators of the type described in Section 3.5.1 will be necessary for formally evaluating local management plan performance, but they cannot, by themselves, inform co-managers whether or not the performance of the plan can be **improved**, or what measures should be taken to make **improvements**.

To achieve this, *inputs* to the fishery and other *explanatory variables* must also be routinely monitored or adequately recorded in the management plan to *explain* and predict differences in management performance in response to changing levels of inputs or changes to the management strategy and decision-making arrangements.

TABLE 3
Examples of explanatory variables to help explain changes in management performance

Category	Explanatory variable	Example data types	Example data variables
Inputs	Exploitation rate	• Fishing effort • Mortality rate • Extent of poaching	• Gear type and size • Hours fishing; number of traps set; number of fishing days; total number of fisherman; number of gears operated during season x • Mean size of species *s* caught in month x, with gear x • Number of incidents of poaching during period x
	Stocking density	• Quantity of fish stocked • Stocking area	• Weight or number of fish stocked • Area of stocked waterbody
	Stocking size	• Size of fish stocked	• Mean length of fish stocked
	Habitat alteration activities	• Habitat enhancement measures	• Cumulative weight of brushpile added to water body • Cumulative length of canal dredged • Quantity of fertilizer added to waterbody • Reserve area
Environment	Production potential	• Water transparency • Carbon fixation	• Secchi depth • g C m^{-2}
	Floodplain hydrology	• Maximum flooded area • Minimum water area	• Maximum area of floodplain inundated • Water area at end of dry season
	Lake hydrology	• Lake level	• Water level during month x
	Pollution	• Pollutant levels	• Concentration of pollutant x
Management strategy and decision-making arrangements (described in management plan)	Control measures	• Gear bans • Landing size restrictions • Reserves	• Gear ban implemented (Y/N) • Landing size restrictions implemented (Y/N) • Reserves implemented (Y/N)
	Representation	• Fisher representation in rule making	• Low; medium; high
	Sanctions	• Sanctions for non-compliance	• Yes; No
	Legitimacy	• Legitimacy of local decision-making body	• Low; medium; high

These inputs might include the amount of fishing (exploitation rate), the quantity of fish stocked and measures of habitat enhancement activities (Table 3). Natural and human-induced variation in the environment, such as changes to water availability and quality, must also be taken account of when assessing management performance.

Other important explanatory variables are the measures implemented as part of the management strategy including details of any gear, landing and access restrictions; closed seasons and reserves. For the more socio-economic related objectives such as compliance with rules and regulations or conflict, relevant explanatory variables might include the institutional arrangements, such how management decisions are made, who is involved, who monitors and enforces the rules, and what sanctions exist for non-compliance. These explanatory variables should already be recorded in the management plan (Section 3.3).

3.5.2.1 Selecting appropriate explanatory variables to monitor

It is often easy to identify factors and covariates that are likely to affect production-related outcomes. For example, when attempting to maximize village fish production (and related outcomes such as income) from stocking activities, variables such as stocking densities, size of stocked fish, and environmental variables such as secchi depth (an indicator of system productivity) might be monitored. Selecting variables to explain changes to the incidence of poaching or conflict may be more challenging and context specific.

Local managers are likely to be best positioned to identify important explanatory variables guided by their intimate knowledge and understanding of resource, environment and local institutional arrangements. Further guidance might be offered by intermediaries or administrative levels of government on the basis of established ecological theory and analytical frameworks (see below).

A *hypothesis matrix* (Table 4) provides a useful means of summarizing important explanatory variables that are believed to affect management performance. Matrices of this type can therefore help *priorities* the selection of variables for inclusion in monitoring or baseline data collection programmes (see Section 5.2.3).

3.5.3 Linking performance and explanatory variables – empirical models

Empirical models provide managers with a tool to help determine whether the performance of a management strategy can be **improved** or what measures should be taken to make **improvements**.

Empirical models describe the statistical relationship between two or more variables of interest, providing, in most cases, a deterministic output for a given input. The selection of variables for inclusion in the models is guided by established theories, models and frameworks (see below).

Typically, the models comprise a single dependent response variable (performance variable in this context), and one or more independent variables (explanatory variables in this context). The models are usually expressed graphically and/or quantitatively by means of mathematical expressions. They are typically categorized as either linear or non-linear based upon the form of the relationship between the response and explanatory variables (response model).

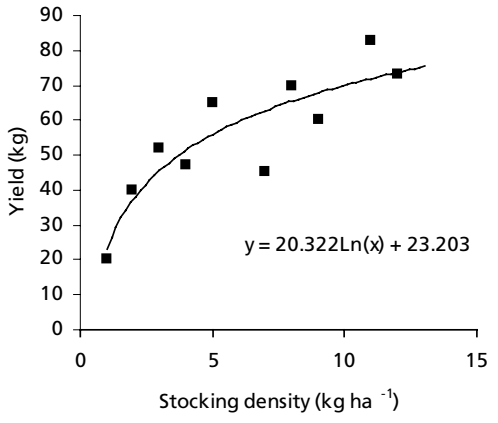
An example of an empirical model is illustrated in Figure 6 linking yield with stocking density. Here the relationship is logarithmic which can be fitted using non-linear least squares or simple linear regression after first log-transforming the variables. On the basis of such a model, managers may decide there is little gain from stocking their water body above densities of approximately 5 kg ha^{-1} y^{-1} due to the rate of diminishing returns.

Stocking densities may not be the only factor affecting yield. For example, other factors, such as levels of primary production may also affect yields from stocked

TABLE 4
Example of an hypothesis matrix for aiding the selection of sets of explanatory variables to explain observed differences in management performance indicators between years

		Management performance indicators								
Category	**Explanatory variables**	**Multispecies annual yield**	**Annual yield of species, *s***	**Catch per unit effort species, *s***	**Species presence and richness**	**Household income from fishing**	**Household assets**	**Household fish consumption**	**Compliance with rules**	**Conflicts**
Inputs	Exploitation rate	√	√	√	√	√	√	√		√
	Stocking density	√	√	√	√	√	√	√		
	Stocking size	√	√	√	√	√	√	√		
	Habitat alteration activities	√	√	√	√	√	√	√		√
Environment	Production potential	√	√	√	√	√		√		
	Floodplain hydrology	√	√	√	√	√		√		
	Lake hydrology	√	√	√	√	√		√		
	Pollution	√	√	√	√	√		√		
Management strategy & decision-making arrangements	Legitimacy / widely accepted								√	√
	Management measures	√	√	√	√	√			√	√
	Representation in rule making								√	√
	Sanctions for non-compliance								√	√

FIGURE 6
Example of an empirical model describing the relationship between yield and stocking density



water bodies. Including an indicator of primary production in the model (e.g. mean Secchi depth during the stocking period) to account for this natural variation might improve the predictive capacity of the model. Since in this case we are dealing with more than one explanatory variable, multiple linear regression (MLR) methods would be appropriate to fit the model provided that the expected response was also linear after appropriate transformations if necessary.

So far we have discussed constructing empirical models of ***scale*** measured performance indicators such as yield or CPUE using ***scale*** measured explanatory variables (or covariates) such as fishing effort or stocking density. What if the manager is, in addition to fishing effort or stocking density, also interested in the determining the simultaneous effect of important ***categorical*** explanatory variables (or factors) such as management controls (e.g. gear bans, size restrictions, closed seasons, etc.) on the performance indicator? (see Table 5 for other examples of scale and categorical variables).

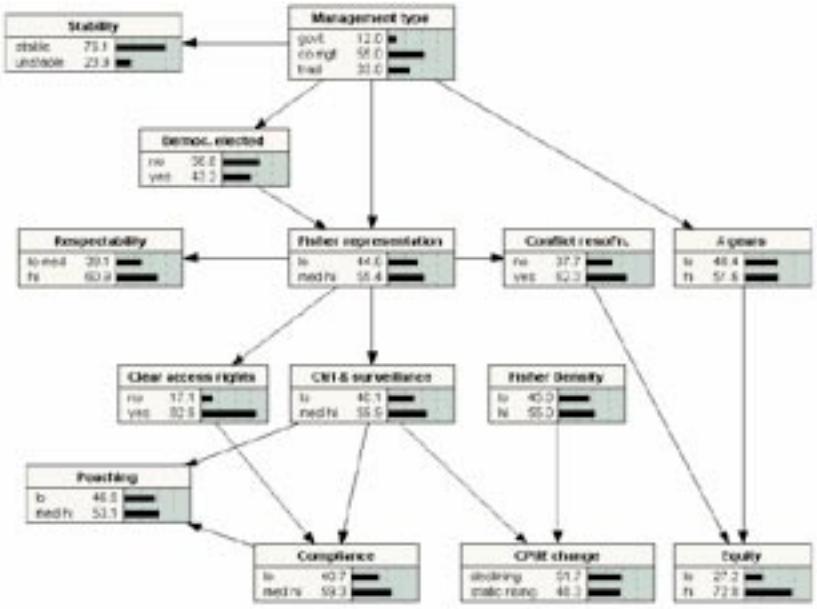
In this case, the use of the **General Linear Models** (GLM) approach would be applicable. GLMs are similar to regression models but can deal with both factors (fixed and random) and covariates. The factor variables effectively divide the population into groups.

When managers or researchers are interested in the response of categorical performance indicators to changes in scale and categorical explanatory variables, then

TABLE 5
Examples of scale and factor indicators and variables

	Examples of scale indicator/ variables	Examples of factor (categorical) indicator/variables
Performance indicators	• Total catch • CPUE • Income	• Equity: low; medium; high • Empowerment: low; medium; high • Conflict: low; medium; high
Explanatory variables	• Fishing effort • Stocking density • Secchi depth	• Management controls: gear ban; reserve; closed season • Sanctions for non-compliance: yes; no • Fisher representation in rule making: low; medium; high

FIGURE 7
An example of a Bayesian network model



Source: Halls *et al.* (2002)

Bayesian networks (BNs) may be useful. These models comprise nodes (random variables) connected by directed links (Figure 7). Prior probabilities assigned to each link (established via tables of conditional probabilities) determine the status of each node. Conditional probabilities can be generated from cross-tabulations of the data or by using subjective probabilities encoded from expert opinions. Bayesian networks having the advantage over GLM models that they can model complex and intermediate pathways of causality in a very visual and interactive manner to diagnose strengths and weaknesses in management systems and for exploring 'what if' scenarios. The Netica software for constructing BNs is user-friendly, inexpensive, and easy to learn (see http://www.norsys.com/).

Halls *et al.* (2002) provide detailed guidelines for building models of co-management performance using GLMs and BNs which can be downloaded from http://www.fmsp.org.uk/r7834.htm. These are also included in Chapter 14 of Hoggarth *et al.* (2005). The guidelines include examples of models fitted to data compiled from co-management projects worldwide, as well as guidance on identifying sampling units, important variables, data levels and cleaning, exploratory analysis, sample sizes, and sensitivity analysis. More general guidance on GLMs can be found in McCullagh and Nelder (1989).

Table 6 provides a guide for selecting the most appropriate modelling approach based upon the expected response model and the number and type of variables to be

TABLE 6
Guide to selecting appropriate empirical modelling approach (number of variables in parentheses)

Response /performance variable	Explanatory variable	Response model	Appropriate method
Scale (1)	Scale (1)	Linear	Simple linear regression [1]
Scale (1)	Scale (1)	Non-linear	Non-linear regression[1]
Scale (1)	Scale (>1)	Linear	Multiple linear regression[1]
Scale (1)	Scale (>1)	Non-linear	Non-linear regression[1]
Scale (1)	Scale and Categorical (≥1)	Linear	General linear model
Categorical (≥1)	Scale and Categorical (≥1)	Linear or non-linear	Bayesian networks[2]

[1] Other methods such as maximum likelihood may also be used.
[2] Scale variables must first be grouped into class intervals.

included. Haddon (2001) provides useful guidance on fitting models to data illustrated with many spreadsheet examples.

3.5.3.1 Adapting and improving the plan

The empirical models of the type described above will evolve and their predictive capacity will improve through time as plans or strategies are adapted in response to the results of monitoring and evaluation activities. This cyclical *passive* form of adaptive management (see Box 10) may require several years of monitoring and evaluation at specific locations or waterbodies. There is also the risk that the best strategies will not be found because changes made to the plan may be too small to detect them. *Evolutionary* or *trial-and-error* adaptive management, where different strategies are tried more or less at random in the hope of accumulating experience about which one is best, may lead managers to eventually stumble upon the best strategy that may never have been identified on the basis of empirical models developed upon the basis of historical data. However, this form of adaptive management can be haphazard and wasteful (Hilborn & Walters 1992).

A number of alternative approaches are available to help managers evaluate and improve their management plans:

(i) Passive adaptive management use among fishery or management unit comparisons
(ii) Active adaptive management
(iii) Analytical models
(iv) Bayesian methods

Each of these alternative approaches is briefly described below.

3.5.4 Passive adaptive management use among fishery or unit comparisons

Refining and improving management plans and strategies on the basis of empirical models developed for specific locations or waterbodies could take years of formal monitoring.

BOX 10
Passive adaptive management

- Monitors and evaluates the result of changes to the management plan or strategy
- Compares the outcome with that in other places, or in previous times, and thus
- Refines or adjusts the management plan based upon feedback and learning

Appropriate administrative levels of government and intermediary organizations have the capacity to help accelerate this passive adaptive learning process by comparing management performance indicators and explanatory variables among sites, locations, fisheries or management units and feeding back lessons of success and failure to local managers or LMI via meetings, appropriate information networks, and media such as posters, radio transmissions, etc. (see Figure 4, Section 5.2.6). The prospect of enhanced learning capacity, achieved by sharing experiences may provide a strong *incentive* for LMIs to participate

in more formal data collection programmes (see Section 5.2.5.5) that may also meet many of the needs of higher level managers (see Section 3.5.8).

Formal comparisons or the development of empirical models using the shared data (see below) and subsequent feedback may not even be necessary. Simply facilitating communication among LMIs by establishing, promoting and supporting appropriate communication networks or fora for sharing ideas and experiences may prove adequate without any formal comparisons (Section 5.2.6).

Because of the potential array of different management strategies and starting points that might be adopted at different sites or management units, this approach can overcome many of the problems associated with passive and evolutionary adaptive management adopted at specific locations or by individual fisheries (see Section 3.5.3.1).

BOX 11
Learning lessons in Cambodia

"[In Cambodia] the CFDO expressed a great need for success and failure stories of community fisheries establishment and management…" (Felsing, 2004a).

BOX 12
Exchange visits in the United Republic of Tanzania

"[In Tanzania] village (exchange) visits have been regularly used as a way of raising awareness but also of bringing in new ideas to what may otherwise have remained a closed system. Representatives have been exposed to activities in neighbouring villages…and even to activities across the border in neighbouring Kenya" (Purvis, 2004).

3.5.1.1 Quantitative comparisons and model development

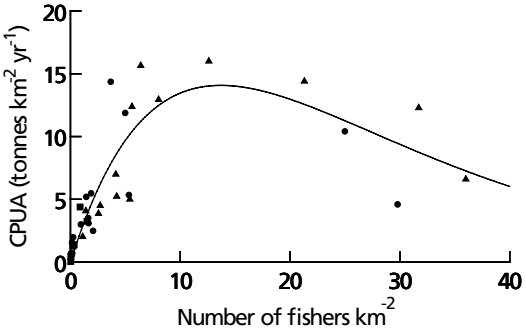
Whilst the "among fishery or co-management unit comparisons" described above may be undertaken informally, for example, on a case study basis, it has long been recognized (Pollnac, 1994, 1998) that there are limits to what management can learn from *qualitative* case studies alone: "Numerous attempts have been made to summaries case studies…; nevertheless, decision makers are still faced with a bewildering array of allegedly crucial factors, with no way of evaluating their relative importance or interrelationships. It is clear that systematic, quantitative research is needed to provide a solution to this problem" (Pollnac, 1998).

Opportunities exist to develop quantitative empirical models of management performance from comparisons of case studies, fisheries or management units that can be used to guide management decision-making in respect of particular objectives. This kind of research could be undertaken by institutions such as fisheries departments, research institutes or other organizations with the necessary resources and institutional capacity.

Constructing empirical models of this type requires among fishery or co-management unit comparisons of a *common* set of *quantitative* indicators of both management performance and explanatory variables of the type described in Sections 3.5.1 and 3.5.2 above. Some variables such as catch and effort may have to be ***normalized*** by expressing them on a per unit area basis to make them comparable among sites. Other additional explanatory variables to those already contained in Table 3 may also need to be recorded to take account of natural environmental variation that is likely to exist among sites or locations. Examples might include the type of ecosystem exploited (river, lake, floodplain, etc.) or descriptors of the production potential of the site (e.g. % coral cover).

To illustrate the concept, suppose a number of local managers were interested in determining the number of "outsiders" they should allow access to their local resources (co-management units) without impacting on their own catches. By monitoring and comparing the total annual landings from their fisheries together with the total number

FIGURE 8
CPUA vs. fisher density for 36 floodplain rivers in Africa (•); Asia (▲); and Latin America (■)



Source: Halls *et al.* (in press).
Curve is a least-squares fit to a modified Fox Production Model.

of fishers participating (including outsiders), it may be possible to construct empirical models of the type illustrated in Figure 8.

In this example, which is based upon a global comparison of floodplain fisheries, catches, measured in terms of catch per unit area (CPUA), can be seen to decline when total fisher densities exceed about 14 km^{-2}. More local comparisons may generate different conclusions.

Multivariate models incorporating a range of different explanatory variables to predict other performance indicators can be constructed in a similar fashion using the General Linear Model (GLM) or Bayesian network (BN) modelling approaches described in Section 0).

3.5.5 Active adaptive management

This involves planned experimentation to identify optimal management strategies, for example optimal stocking densities for waterbodies with different rates of natural productivity. This experimentation approach requires greater organization and planning than the more passive or trial and error approaches, but the information gained should lead to better management and more consistent success. Further details of the approach and guidelines for implementation can be found in Garaway and Arthur (2002) and at the adaptive learning website http://www.adaptivelearning.info/.

3.5.6 Analytical models

Analytical models provide managers with a tool for predicting the effect of management interventions on the basis of established theories of fish population dynamics. They can be useful for answering questions such as: "What minimum mesh size would maximize yield from the fishery?" or "When would be the best month to close the fishery to maximize yield?" Constructing empirical models to answer these questions could take several years of monitoring and passive adaptive management.

In some cases, analytical models can provide answers to these types of questions using biological data sampled over relatively short periods of time. These biological data include fish length, weight, age, sex, and maturity and are used to estimate the population size or age structure, growth and mortality rates and spawning stock biomass as inputs to the models. Most analytical models provide advice only for fisheries that exploit single species. Therefore, they have limited utility for many co-managed fisheries that exploit multi-species assemblages with several gear types in a seasonal manner. For further guidance of analytical models and stock assessment and their data requirements see Hoggarth *et al.* (2005).

3.5.7 Other Bayesian approaches for evaluating local management plans

Medley (2004) describes a participatory approach to estimating levels of effort or catch quotas that maximize yield from a fishery. This Participatory Fisheries Stock Assessment (ParFish) method aims to improve the parameter estimates of production models of the type illustrated above by integrating the local ecological knowledge and experience of fishers into a Bayesian-based stock assessment. Local knowledge concerning catch rates, stock recovery time and stock size is elucidated using structured interview and questionnaire techniques. Prior knowledge of parameter values generated elsewhere or from earlier assessments can also be incorporated into the assessments along with model parameters estimated from depletion experiments and time series of catch and

effort – effectively supporting an adaptive management approach. Further details of the methodology including guidelines and software are available at http://www.fmsp.org.uk/r8464.htm.

Analogous to the empirical modelling approach described above, local managers applying ParFish methodology might also mutually benefit from communication networks designed to support the sharing of knowledge, experiences and data among co-management units exploiting similar resources with similar technology. Sharing the results of depletion experiments, interview data and the outcome of previous assessments would promote a continually growing pool of common *prior knowledge*. Guidance notes for developing communication and information sharing networks is provided in Section 5.2.6 below.

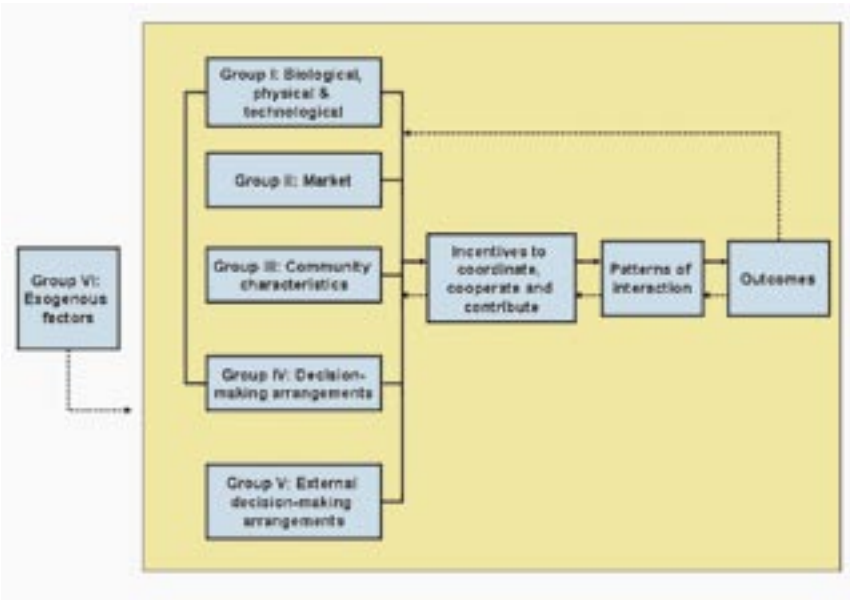
3.5.8 Evaluating co-management policy

The among fishery or co-management unit comparisons described in Section 3.5.4 also provides administrative levels of government with an opportunity to develop *understanding* of the effects of co-management *policy* on co-management performance (see Figure 4) and thereby also change *policy* in an adaptive manner.

By comparing important indicators of policy performance such as fish abundance (CPUE), food security, income, distribution of benefits, access to resources, conflicts, etc. (Section 3.2.2) against corresponding hypothesized explanatory variables monitored at or recorded for each co-management unit or fishery, it should be possible to draw conclusions about the effectiveness of existing policy either on a case-study basis or by building multivariate empirical models of *policy* performance using the General Linear Model (GLM) or Bayesian network (BN) modelling approaches described in Section 0. These models should also be able to provide insights into what changes to policy might be required to achieve desirable policy outcomes.

The selection of explanatory variables for inclusion in such comparisons or models of co-management policy can be guided by the Institutional Analysis and Design (IAD) Framework (Figure 9). Here, explanatory variables are described as "attributes"

FIGURE 9
Institutional analysis and design framework



Source: ICLARM (1998)

or "arrangements" that interact to produce outcomes or performance indicators. See Oakerson (1992) for a detailed explanation of the interactions. ICLARM (1998) and Pido *et al.* (1996) identify six main groups of attributes and arrangements (explanatory variables).

Like the SL, the IAD framework is not a "cause and effect" model, but rather helps to logically structure information, identify and understand potential interactions and outcomes and test hypotheses. Managers may therefore find the framework useful for constructing a hypothesis matrix (see Table 7) to summaries hypotheses for testing or for summarizing explanatory variables selected for inclusion in multivariate models.

Since many of the *explanatory* variables should be recorded in the management plan (Section 3.3), negotiating a *standard* management plan format, should ensure

TABLE 7

Hypothesis matrix summarizing potentially important explanatory variables in relation to co-management policy performance indicators. Ticks are only for illustrative purposes. Some may not be applicable, whilst other ticks may be appropriate.

		Co-management policy indicators							
Category	**Example explanatory variables**	CPUE[1]	Food security	Income	Distribution of benefits	Poverty	Access to resources	Conflict	Compliance with rules & regulations
Group I: Biological, physical and technological attributes	Production potential	√	√	√		√			
	Abundance/Biomass		√	√		√		√	√
	Ecosystem type	√	√	√		√			
	Water body type	√	√	√		√			
	Rule enforcement potential	√						√	√
	Environmental health	√	√	√		√			
	Habitat descriptors	√	√	√		√			
	Exploitation intensity	√	√	√		√		√	
	Stocking density	√	√	√		√			
	Habitat alteration activities	√	√	√		√		√	
Group II: Market attributes	Economic value of resource			√		√			√
	Market facilities/infrastructure		√	√		√			
	Cost of marketing (market fees)			√		√			
	Price control mechanism		√	√		√			
Group III: Fisher community characteristics	Social cohesion				√			√	√
	Dependence on fishery for livelihood			√		√		√	√
	Level of local (ecological) knowledge	√				√			
Group IV: Decision-making arrangements	Legitimacy / widely accepted						√	√	√
	Membership to decision-making body				√		√	√	√
	Clear access (property) rights				√	√	√	√	√
	Management controls	√	√	√	√	√	√	√	√
	Representation in rule making				√		√	√	√
	Formal performance monitoring							√	√
	Sanctions for non-compliance				√			√	√
Group V: External decision-making arrangements	Enabling legislation for co-management				√		√	√	
	Local political/institutional support				√			√	
	Effective coordinating body							√	
Group VI: Exogenous factors	External financial assistance			√		√			
	Capacity building support from NGOs			√		√			√

that a common set of explanatory variables is available for comparison. A common set of policy performance indicators may also need to be negotiated with LMIs if participatory monitoring approaches are employed to provide the data (Section 5.2.5). Indeed, McArthur (1997) as cited by Estrella and Gaventa (1998) argues that the utility and cost-effectiveness of participatory monitoring approaches may be open to question unless site-specific research and innovations can provide the bases for planning and development at higher institutional levels. Alternatively, these indicators will have to be monitored under *parallel monitoring programmes* undertaken by the appropriate administrative levels of government (see Figure 4). Examples of indicators that might be selected for each explanatory variable group are given by Pido *et al.* (1996); Pollnac (1998); Preikshot and Pauly (1999); Berkes *et al.* (2001) and Ehler (2003). A selection of these is provided in Table 8.

TABLE 8
Examples of explanatory variables and their indicators for comparing co-management policy performance indicators among co-management units, sites or locations.

Category	Example explanatory variables	Example Indicators	Units	Notes
Group I: Biological, physical and technological attributes	Production potential	Water transparency (Secchi depth)	m	May not be valid indicator in rivers
		Primary production	0;1;2	g/C/m/2 year: Low <150 (0); medium 150-300 (1); high >300 (2)
	Abundance/Biomass	Annual catch per fisher	Tonnes/fisher	All species combined or specify for each target species.
	Ecosystem Type	Ecosystem Type	0;1;2..n	River (0); fringing floodplain (1); beel (2); lake (3)
	Water body type	Permanence	0;1;2	Seasonal (0); perennial (1); both (2)
	Rule enforcement potential	Area under co-management per fisher	km2/fisher	or km of coastline/fisher (specify)
	Environmental health	Health of critical habitat	0;1;2	Low (0); medium (1); high (2)
	Nutrient recycling	Depth of reserve, lake, fishing area	m	
	Habitat descriptors	% Coral cover	%	
	Exploitation intensity	Fisher density	N / km2	or km of coastline (specify)
		Number of villages	N	
		Mean size of fish caught in month x, with gear x	cm	
	Stocking density	Stocking density	kg/ha	
	Habitat alteration activities	Habitat alteration activities	0 - 5	Destructive (0); none (1)……beneficial (5)
Group II: Market attributes	Economic value of resource	Mean unit value of target species	US$/kg	
	Market facilities/infrastructure	Transport/infrastructure/landing sites	0;1;2	Poor (0); medium (1); good (2)
	Cost of marketing (market fees)	Cost of marketing (market fees)	0;1;2;3	None (0); low (1); medium (2); high (3)
	Price control mechanism	Price control mechanism	0;1	No (0); yes (1)
Group III: Fisher community characteristics	Social cohesion	Social cohesion	0;1;2	Low (0); medium (1); high (2)
	Dependence on fishery for livelihood	% of household income derived from fishing	%	
	Level of local (ecological) knowledge	Level of local (ecological) knowledge of fishers	0;1;2	Low (0); medium (1); high(2)
Group IV: Decision-making arrangements	Legitimacy / widely accepted	Legitimacy of local decision-making body	0;1;2	Low (0); medium (1); high (2)
	Membership to decision-making body	Democratically elected	0;1	No (0); yes (1)
	Clear access (property) rights	Clear access (property) rights	0;1	No (0); yes (1)
	Management plan	Present/carried out	0;1	No (0); yes (1)
	Management controls	Mesh/gear size restrictions	0;1	No (0); yes (1)
		Gear ban(s)	0;1	No (0); yes (1)
		Closed seasons	0;1	No (0); yes (1) if yes specify month(s) closed
		Reserve area as a % of total management area	%	
	Representation in rule making	Representation in rule making (fishers)	0;1;2	Low (0); medium (1); high (2)
	Formal performance monitoring	Formal performance monitoring by community	0;1	No (0); yes (1)
	Sanctions for non-compliance	Sanctions for non-compliance	0;1	No (0); yes (1)
Group V: External decision-making arrangements	Enabling legislation for co-management	Enabling legislation for co-management	0;1	No (0); yes (1)
	Local political/institutional support	Local political/institutional support	0;1;2;3	Anti (0); Weak (1); indifferent (2); strong (3)
	Effective coordinating body	Nested structure	0;1	Absent (0); Present (1)
Group VI: Exogenous factors	External financial assistance	Expenditure on community	$/year/fisher	
	Capacity building support from NGOs	Support for community from NGO's	0;1;2;3	none (0); weak (1); medium (2); strong (3)

4. Data sources and methods

Data collection sources and methods to meet most of the data requirements described in Section 3 have already been described by FAO (1999, Chapter 6). Whilst wishing to avoid duplication, an overview of this material is included here for the sake of completeness, to raise awareness of the range of potential sources and methods that might be employed in a data collection system, and to highlight factors that might affect their selection. Compared to FAO (1999) however, greater emphasis is given here to participatory monitoring approaches that are likely to be advocated as part of co-management policy.

As well as FAO (1999) and Sparre (2000), we also recommend that designers refer to FAO Udon Thani Workshop Report (FAO/MRC, 2003) which describes alternative approaches for collecting inland fishery statistics (see Section 4.6.1 below). Useful literature and other sources of information concerning participatory monitoring approaches are provided in Section 4.3.2 below.

4.1 DATA SOURCES

FAO (1999) identifies six categories of data collection sources:

- ***Harvest.*** This level is where the fish is caught and includes landing sites, boats, and the fishermen or fishing households. This will include the LMI and local resource users.
- ***Post harvest.*** This includes sources through which fish pass before reaching the market and includes fish traders, auctions, cold storage, processors and transport networks.
- ***Market.*** All sources through which fish are commercially transferred and includes primary (landing site) and secondary (wholesale, processing and consumer) markets.
- ***Consumers.*** Includes individuals, households, hotels, restaurants…etc.
- ***Government related agencies.*** Any agencies or institutions forming part of the government including customs, trade ministries, research departments of relevant or related ministries, bureaus of statistics, results of national censuses…etc.
- ***Support industry***. These relate to industries which provide raw materials and services such as gear manufactures, bait suppliers, boat builders…etc.

4.2 DATA COLLECTION METHODS

Five basic categories of data collection methods exist (see FAO (1999) for more details):

- ***Registration.*** Typically employed as a depository of information for the purposes of licensing and other access agreements. Advantages: May also provide revenue-related data. Disadvantages: Require well established administrative procedures.
- ***Questionnaires.*** A structured format of questions to be answered by respondents. Advantages: Can provide a low-cost means of collecting data. Disadvantages: Requires high level of literacy, and open-ended questionnaires may be difficult to interpret, and subject to bias.
- ***Interviews.*** Data and information are obtained through enquiry and recorded by enumerators. Interviews can be *open-ended* involving focus groups (5-15 representative individuals) using initial questions and structuring subsequent discussion, or involve a panel or representative stakeholders who are routinely interviewed over a period of time. *Participatory rural appraisal* (PRA) combines

visualization, interview and group work methods that encourage participants to express their views and share information, and stimulate discussion and analysis (see Berkes *et al.,* 2001; Estrella and Gaventa, 1998; Maine *et al.,* 1996). *Structured interviews* are based upon pre-defined forms that seek specific information from the respondent. Advantages: Can be applied to a wide range of data sources and more complicated questions can be asked. Disadvantages: Open-ended interviews require well-trained observers/enumerators. Responses may be subjective or subject to intentional error.

- ***Direct observations.*** Typically by members of the fisheries department or relevant government administration, but may also include members of the fishing community or intermediary organizations. Participant-observation is recommended for learning about local institutional and decision-making arrangements. Advantages: Less prone to measurement error and therefore provides more precise estimates. Disadvantages: Resource intensive.
- ***Reporting.*** Unlike direct observations where fisheries staff or researchers will typically make direct measurements of variables of interest, reporting relies upon fishers and other relevant stakeholders such as fish traders and processors to provide the necessary data and information using some form or pre-defined format such a log-book or ledger. In Bangladesh, local management committees use a "resolution book" to record decisions and recommendations made at meetings (Sultana, 2003). This category also includes market sales records and trade (import and export) records typically available from customs or similar government administration. Advantages: Less resource intensive than direct observations. Disadvantages: Risk of deliberate distortion of data.

4.3 PARTICIPATORY MONITORING AND EVALUATION (PM&E)

Whilst participatory monitoring and evaluation (PM&E) can potentially employ any of the same sources and methods to those described above, it is often regarded as a distinct approach synonymous with co-management and community-based initiatives. Indeed, the approach is often viewed as a prerequisite for the entire process of implementing decentralized small-scale fisheries co-management. We therefore describe its main principles below drawing from a review by Estrella and Gaventa (1998).

The term PM&E is often used to describe a range of closely related approaches including *participatory evaluation, participatory monitoring, participatory impact monitoring, process monitoring, self evaluation and community monitoring*. In practice the differences between conventional and participatory approaches to evaluation are not always obvious. Indeed any of the methods described in Section 4.2 could be employed in the context of PM&E since they could all require some form of stakeholder participation. What distinguishes the two approaches is not necessarily the sources and data collection methods employed, but the *extent* to which *local* stakeholders are *involved* in *choosing* or *selecting* these sources and methods, the variables to be monitored, and ultimately benefit from the outputs and the act of participating.

Externally-led PM&E programmes are organized and initiated externally and conducted by enumerators having no direct involvement or interest in the outcome of the project or management initiative. This is akin to the more conventional application of the methods described above. *Internally-led* PM&E programmes are designed and implemented by the local stakeholders directly involved in the project or management plan. These programmes are perceived as contributing to local capacity building and organizational strengthening and being more likely to be a sustained integral community activity. *Joint* PM&E programmes combine elements of internal and external approaches to evaluate projects or management activities from the perspectives of both "insiders" and "outsiders". By involving a greater diversity of stakeholders, a more holistic perspective is sought. In other words, by involving all the relevant

stakeholders, the outcomes and findings of monitoring and evaluation are expected to cater to information needs of a variety of user groups. The role of outsiders is often to encourage and help insiders set objectives, identify their information needs and monitor and evaluate their activities. In the context of this manual, joint PM&E programmes are therefore recommended for co-managed fisheries, particularly if the data and information needs of higher level managers can also be satisfied (Section 5). As well as participation, the concept of learning is a major principle of PM&E where emphasis is on practical "action-orientated" learning. Participants learn from experience, and thereby gain a greater understanding of the factors that affect their outcomes. When multiple stakeholders are involved in the process, the PM&E also encourages and promotes *negotiation* and builds trust. The process is regarded as empowering and encourages participants to increase their understanding of their own roles and responsibilities. The combination of data sources and methods selected should be relevant to the needs of stakeholders and may evolve is response to changing needs (Estrella and Gaventa, 1998).

4.3.1 Participation in practice

Experience suggests that the extent of participation may vary significantly at different stages of the process, typically with less involvement of local participants at the early design as well as the later analysis and dissemination stages, leaving most of the participation occurring at the data collection stage. Programmes that do not involve local stakeholders in planning and analysis are often referred to as being "extractive" rather than "empowering" and therefore likely to be *unsustainable* and ineffective. Avoiding being "extractive" is a significant but important challenge when designing and implementing PM&E programmes (see Section 5).

Adopting participatory approaches generally require substantial time commitment from many different stakeholders. Time requirements will reduce as experience of the methods is gained and integrated into existing activities and programmes. The approach will also require training in the use of the techniques, greater coordination of human resources, administrative effort and long-term commitment from stakeholders at all management levels. Training workshops in PM&E are often conducted by NGOs or through donor programmes.

4.3.2 Additional sources of information

Participatory analysis, monitoring and evaluation for fishing communities by Maine *et al.* (1996) presents 26 participatory monitoring and evaluation tools for use by local field staff and community members engaged in management activities and projects. The manual can be ordered at http://www.fao.org/.

Berkes *et al.* (2001) describe common methods and approaches employed in fisheries research adapted from Chambers (1997) including seasonal calendars, participatory mapping, transects and observation participant observation, interview approaches and focus group discussions. The book is available online at http://www.idrc.ca/.

PRA approaches, case studies and reviews can also be found at http://www.iied.org/sarl/pla_notes/ or Annex D of IFAD (2002), http://www.ifad.org/evaluation/guide/index.htm. ELDIS (http://www.ids.ac.uk/eldis/eldis.html) is a gateway to information on development and the environment and is an excellent source of information about PM&E with sections and direct links to

BOX 13
Lessons from Cambodia

"[In Cambodia] traditional and local knowledge may provide the cheapest and most feasible way to collect information on the migration patterns of fish species, standard of living of local people, the health of the fishery…and the areas…most suitable for the establishment of fish sanctuaries" (Felsing, 2004a).

other sources on background and PM&E concepts, methods/tools and manuals, indicators, case studies and bibliographies. The Participation Group at the Institute of Development Studies http://www.ids.ac.uk/ids/particip/index.html is another valuable source of relevant information including links to networks in more than 50 countries.

The International Institute for Rural Reconstruction (IIRR) has published a three volume manual on participatory methods in community-based coastal resource management employed by field practitioners in the Philippines, Indonesia, India and other Asian countries. The manual can be ordered at http://www.iirr.org/publicaitonbdate.htm.

4.4 COMPLETE ENUMERATION OR SAMPLING?

An important decision when planning and designing a data collection system is the choice between *complete enumeration* and *sampling*. Complete enumeration involves measuring or recording variables for the entire "population" of data units (e.g. fishers, boats, households, markets…etc) whereas sampling involves measuring just a known proportion or *sample* of these units. Complete enumeration is commonly adopted for frame surveys (see Section 5.2.2.3) and population censuses or when reporting information can be made an obligation of an access or licence agreement thus reducing the cost of this approach (Section 5.2.5.5). Most types of variables can be collected using either approach, and whilst complete enumeration may be seen as desirable, often it is not practical because of resource limitations. Well-designed sample-based surveys can often provide sufficiently accurate and precise enough information at a fraction of the cost. Random sampling aims to avoid sampling bias (improve accuracy) by ensuring that all data units have an equal opportunity of being selected (see Section 5.2.3.4).

4.4.1 Stratification

Stratification is typically employed as part of sample based surveys to reduce the error in sample estimates (i.e. improve the precision of the estimate) by systematically removing data variability through the sampling design. This is achieved by dividing the sample population into groups or *strata* where as much as possible of the variability in the population is represented in differences between the groups. These strata may be based upon administrative or geographical criteria (major strata) often imposed for reporting purposes, as well as statistical criteria (minor strata) chosen to partition the population into homogenous sub-sets. Examples of minor strata include habitat, season, demographic variables (e.g. gender, age, income etc), boat and gear types. Guidelines for selecting strata are given in FAO (1999).

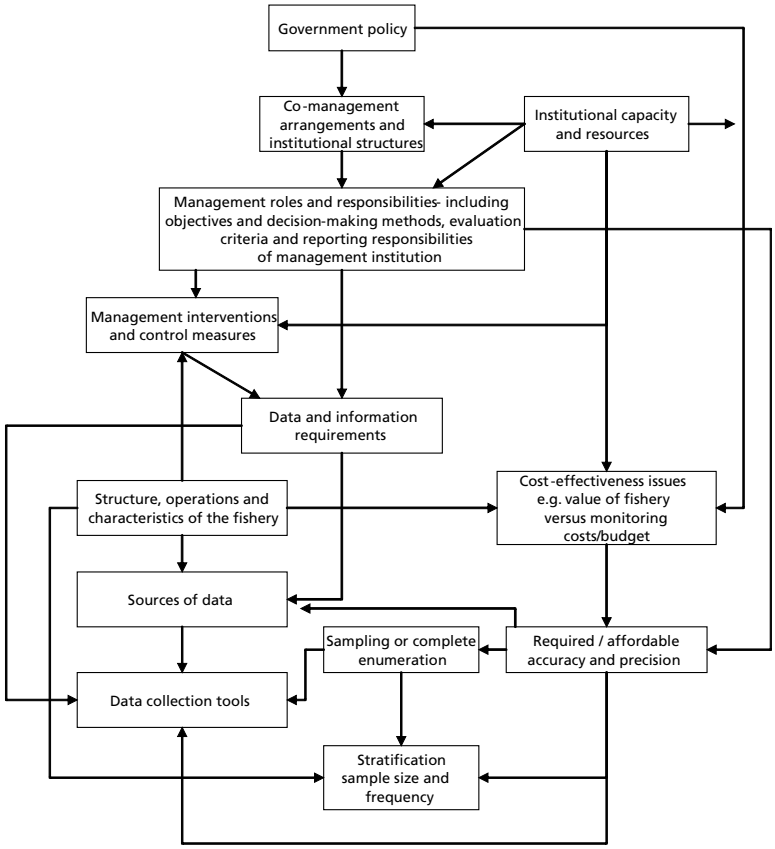
4.5 FACTORS INFLUENCING THE CHOICE OF SOURCES AND METHODS

The choice of appropriate data collection sources and methods to generate the data and information required by co-managers will depend upon a number of interacting factors (Figure 10). Careful consideration must be given to each of these factors when selecting sources and tools.

These interacting factors include:

- ***The type of variable or indicator to be collected***. For example, static variables such as those required for enforcement purposes (see Section 3.4.1) are often best collected through a registration system. Rapidly changing variables such as daily catch and effort are often best collected daily using interview or logbook approaches.
- ***The specification of the variable*** *(frequency of collection, accuracy, precision and required standards)* (see Section 3.1.2) can influence both the selection of sources and tools. For example, frequently collected data may need to rely on fishers to provide the data, whereas less frequently collected data such as household savings and investments or fish consumption could be collected by enumerators since

FIGURE 10
Factors influencing the choice of data sources and data collection methods



the data collection cost is lower, and possibly by other government agencies. Interview based methods may provide less precise estimates of total landings than catch assessment surveys based upon direct observations although the latter will require greater capacity and resources. Whilst accuracy should always be sought, *precise estimates are also not always necessary*, particularly for the type 1 category of data, compared to type 4 where the ability to detect small changes in outcomes may be important to refine a local management strategy or plan (Section 5.2.3.4).

- ***The operational characteristics of the fishery*** which determines the available sources of data and appropriate data collection method as well as opportunities and constraints for sample stratification. A fundamental first stage in the design of data collection systems is therefore to describe these operating characteristics by means of a *frame survey*.
- ***The choice between complete enumeration and sampling***. If sampling is employed then stratification may also have to be considered. Opportunities for stratification will be dictated by both the operational characteristics of the fishery as well as administrative constraints not under the control of designer. Some data collection methods such as interviews may not be suitable for complete enumeration approaches unless undertaken as part of a national census using structured interview or questionnaire techniques.
- ***Institutional, financial and human resources***. These will influence the type of variable or indicator that is collected, the specification of the variable, the data collection method and choice between complete enumeration and sampling.

4.6 SELECTING SOURCES AND TOOLS

Table 9 – Table 11 provides some guidance on sources and methods that may be appropriate in relation to the four categories of data identified in Chapter 3. Further guidance on selecting sources and tools is provided in Section 5.2.5. Note the importance of management plan information. All four categories include data and information contained in management plans. The use of a standard format for management plans among should be encouraged to allow among co-management fishery or unit comparisons (Section 3.5) and to ensure that all relevant data and information is included.

TABLE 9

Potential sources of commonly required data for co-managers

Data Categories: 1 – Data for policy and development planning and evaluation (Section 3.2); 2- Data to formulate local management plans (Section 3.2.3); 3- Data to enforce and coordinate local management plans (Section 3.3); 4- Data to evaluate local management plan performance (Section 3.5). *For example, fish consumption, poverty, equity data etc). **includes details of access rights and other local institutional arrangements. ●-strong linkage; ○-Secondary Linkage ; ♦- Possible source or secondary validation.

Data category	Data type	Harvest	Post harvest	Markets	Consumers	Support industry	Government agencies
1	Catch (3.2.1.1; 3.2.1.2; 3.2.2.1; 3.2.2.2; 3.2.2.4)	●	●	○			
	Effort (3.2.2.2; 3.2.4.4; 3.2.4.2)	●				♦	♦
	Market (3.2.1.1; 3.2.2.5; 3.2.5)	○	●	●	○	○	♦
	Trade (3.2.1.2; 3.2.1.4; 3.2.4.3; 3.2.5)		♦	♦			●
	Employment (3.2.1.3; 3.2.2.1; 3.2.5)	●	●			●	●
	Population/Demographic (3.2.1.2; 3.2.1.3; 3.2.1.5; 3.2.2.1; 3.2.2.4; 3.2.2.6; 3.2.2.7; 3.2.3; 3.2.5)	●	●		●	●	●
	Household data* (3.2.1.2; 3.2.1.3; 3.2.1.5; 3.2.2.4; 3.2.2.5; 3.2.2.6; 3.2.2.7; 3.2.3)	●	●		●		●
	Management Plan ** (3.2.2.11)	●	●	●		●	●
	Compliance (3.2.2.3)	●					●
	Costs and earnings (3.2.2.5; 3.2.2.6; 3.2.2.7; 3.2.2.10; 3.2.3)	●	●	○	♦	♦	♦
	Access to resources (3.2.2.8)						
	Conflict (3.2.2.9)	●	○			♦	●
	Management costs (3.2.2.10)	●					●
	MDG indicators (3.2.3.1)	●	●		●		●
	PRSP data (3.2.3.2)	●	●	○	●		●
	NSSD indicators (3.2.3.3)	●	●	○	●		●
	Vessel statistics (3.2.5)	●	♦			♦	●
2	Management plan (3.3)	●	●	●		●	●
3	Fisher/vessel/licence details (3.4.1)	●				♦	♦
	Management plan (3.3)	●	●	●	●	●	●
4	Catch (see above)	●	●				
	Effort (see above)	●				♦	
	Market (see above)	○	●	●	●	○	♦
	Costs and earnings (see above)	●	●	○	♦	♦	♦
	Conflict (see above)	●	○			♦	●
	Compliance (see above)	●					●
	Other (negotiated) indicators (5.2.3)	●	●	●		●	●
	Management plan (explanatory variables) (3.5.2)	●	●	●		●	●

TABLE 10

Guide to potentially appropriate methodologies for collecting data commonly required data by co-managers by *complete enumeration* modified and revised after FAO (1999)

Data Categories: 1 – Data for policy and development planning and evaluation; 2- Data to formulate local management plans; 3- Data to enforce and coordinate local management plans; 4- Data to evaluate local management plan performance. *For example, fish consumption, poverty, equity data etc). **includes details of access rights and other local institutional arrangements. ●-strong linkage; ○-Secondary Linkage ; ♦- Possible source or secondary validation

		Interview-based				Direct Observations by				Reporting sector			
Data category	**Data type**	**Registration**	**Questionnaires**	**Open-ended**	**Structured**	**PRA type**	**DoF**	**Intermediaries**	**LMI**	**Harvest**	**Post harvest**	**Sales**	**Trade**
1	Catch (3.2.1.1; 3.2.1.2; 3.2.2.1; 3.2.2.2; 3.2.2.4)		●				●	●	●	●	♦	●	
	Effort (3.2.2.2; 3.2.4.2; 3.2.4.4)		●				●	●	●	●			
	Market (3.2.1.1; 3.2.2.5; 3.2.5)		○				○		○		♦		
	Trade (3.2.1.2; 3.2.1.4; 3.2.4.3; 3.2.5)												●
	Employment (3.2.1.3; 3.2.2.1; 3.2.5)		●		●				●				
	Population/Demographic (3.2.1.2; 3.2.1.3; 3.2.1.5; 3.2.2.1; 3.2.2.4; 3.2.2.6; 3.2.2.7; 3.2.3; 3.2.5)		●		●								
	Household data* (3.2.1.2; 3.2.1.3; 3.2.1.5; 3.2.2.4; 3.2.2.5; 3.2.2.6; 3.2.2.7; 3.2.3)		●		●								
	Management Plan ** (3.2.2.11)		●	●	●	●	●	●	●	●	●	●	
	Compliance (3.2.2.3)	●	●		●				●	●			
	Costs and earnings (3.2.2.5; 3.2.2.6; 3.2.2.7; 3.2.2.10; 3.2.3)										○	●	
	Access to resources (3.2.2.8)		●		●								
	Conflict (3.2.2.9)									●			
	Management costs (3.2.2.10)		●		●								
	MDG indicators (3.2.3.1)		●		●								
	PRSP data (3.2.3.2)		●		●								
	NSSD indicators (3.2.3.3)		●		●								
	Vessel statistics (3.2.5)	●	●		●		●						
2	Management plan (3.3)		●	●	●	●	●	●	●	●	●	●	
3	Fisher/vessel/licence details (3.4.1)	●											
	Management plan (3.3)		●	●	●	●	●	●	●	●	●	●	
4	Catch (see above)		●			●	●	●	●	♦	○		
	Effort (see above)		●			●	●	●	●				
	Market (see above)		○			○		○		♦			
	Costs and earnings (see above)										○	●	
	Conflict (see above)									●			
	Compliance (see above)	●	●		●				●	●			
	Other (negotiated) indicators (5.2.3.3)		●		●			○	●	●	○		
	Management Plan (explanatory variables) (3.5.2)		●	●	●	●	●	●	●	●	●	●	

TABLE 11

A guide to potentially appropriate methodologies for collecting data commonly required data by co-managers by *sampling* modified and revised after FAO (1999)

Data Categories: 1 – Data for policy and development planning and evaluation; 2- Data to formulate local management plans; 3- Data to enforce and coordinate local management plans; 4- Data to evaluate local management plan performance. *For example, fish consumption, poverty, equity data etc). **includes details of access rights and other local institutional arrangements. ●-strong linkage; ○ -Secondary Linkage ; ♦- Possible source or secondary validation.

			Interview-based				Direct observations by			Reporting sector			
Data category	Data type	Registration	Questionnaires	Open-ended	Structured	PRA type	DoF	Intermediaries	LMI	Harvest	Post harvest	Sales	Trade
1	Catch (3.2.1.1; 3.2.1.2; 3.2.2.1; 3.2.2.2; 3.2.2.4)		●	○	●	○	●	♦	●	●	♦	○	
	Effort (3.2.2.2; 3.2.4.2; 3.2.4.4)		●	○	●	○	●	♦	●	●			
	Market (3.2.1.1; 3.2.2.5; 3.2.5)		●	●	●	●	○		○		○	♦	
	Trade (3.2.1.2; 3.2.1.4; 3.2.4.3; 3.2.5)												●
	Employment (3.2.1.3; 3.2.2.1; 3.2.5)		●	●	●	●		●	●				
	Population/Demographic (3.2.1.2; 3.2.1.3; 3.2.1.5; 3.2.2.1; 3.2.2.4; 3.2.2.6; 3.2.2.7; 3.2.3; 3.2.5)		●	●	●	●		●					
	Household data* (3.2.1.2; 3.2.1.3; 3.2.1.5; 3.2.2.4; 3.2.2.5; 3.2.2.6; 3.2.2.7; 3.2.3)		●	●	●	●		●	●				
	Management Plan ** (3.2.2.11)		●	●	●	●	●	●	●	●	●	●	
	Compliance (3.2.2.3)	●	●	●	●	●	●		●	♦			
	Costs and earnings (3.2.2.5; 3.2.2.6; 3.2.2.7; 3.2.2.10; 3.2.3)		●	●	●	●					○	♦	
	Access to resources (3.2.2.8)		●	●	●	●		○					
	Conflict (3.2.2.9)		●	●	●	●		○		●			
	Management costs (3.2.2.10)		●	●	●	●							
	MDG indicators (3.2.3.1)		●	●	●	●							
	PRSP data (3.2.3.2)		●	●	●	●							
	NSSD indicators (3.2.3.3)		●	●	●	●							
	Vessel statistics (3.2.5)	●	●		●	●	●	○					
2	Management plan (3.3)		●	●	●	●	●	●	●	●	●	●	
3	Fisher/vessel/licence details (3.4.1)	●											
	Management plan (3.3)		●	●	●	●	●	●	●	●	●	●	
4	Catch (see above)		●	○	●	○	●	♦	●	●	♦	○	
	Effort (see above)		●	○	●	○	●	♦	●	●			
	Market (see above)		●	●	●	●	○		●		○	♦	
	Costs and earnings (see above)		●	●	●	●					○	♦	
	Conflict (see above)		●	●	●	●		○		●			
	Compliance (see above)	●	●	●	●	●	●		●	♦			
	Other (negotiated) indicators (5.2.3.3)		●	●	●	●	●	♦	●	●	○	○	
	Management plan (explanatory variables) (3.5.2)		●	●	●	●	●	♦	●	●	●	●	

4.6.1 Recommendations from the Udon Thani Expert Consultation

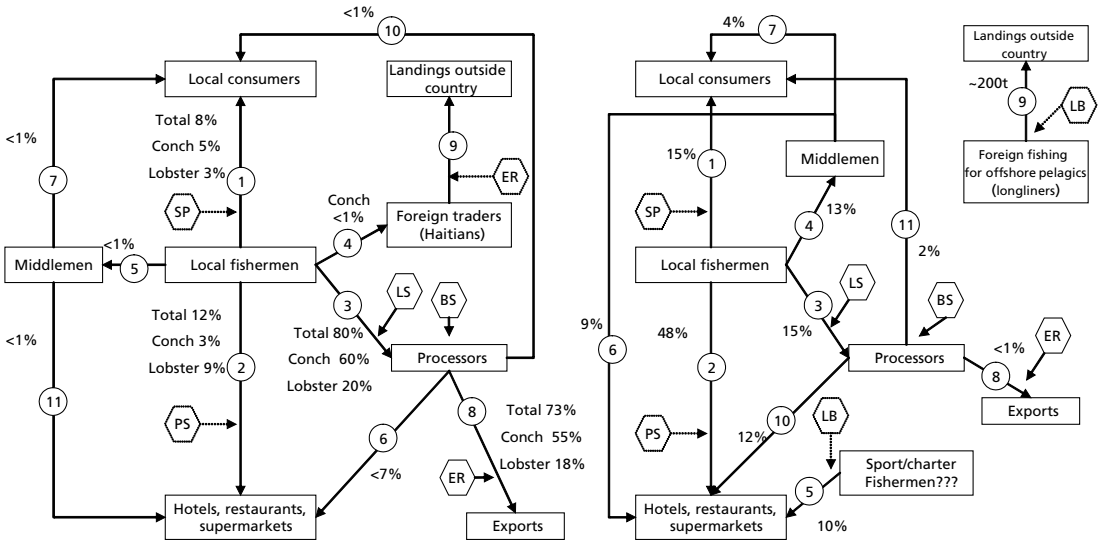
A recent FAO/MRC ad hoc expert consultation examined alternative approaches for collecting inland capture fishery statistics (FAO/MRC, 2003). The main conclusion drawn from the consultation was that *direct observation* methods particularly for collecting *Category 1* data types (e.g. Gross value of production, food security, community dependence…etc) are often both impractical because of the operational characteristics of the fishery (highly dispersed fishers and landing sites, strong seasonality etc) and often unnecessary because of the required precision and frequency at which it is necessary to collect them (typically low and infrequent). Instead *indirect* methods such as interview or questionnaire employed as part of national censuses or household (consumption) surveys, that are often conducted by *other* government departments or ministries, can provide estimates that are adequately accurate for policy and development planning and evaluation purposes. (Document available at http://www.fao.org/DOCREP/005/AD070E/ad070e00.htm.)

4.6.2 Fish disposition pathway diagrams

A useful way of helping identify appropriate data sources and collection methods particularly in relation to collecting catch data is by means of fish disposition pathway diagrams (Mahon and Rosenberg, 1988) constructed on the basis of frame survey or PRA results (Figure 11). These diagrams summaries the disposition paths of fish or fishery products from fisherman through all participants or major stakeholders in the industry, to the end user. Each complete path from fisherman to end user may consist of several segments. The diagram helps identify appropriate points at which data collection may occur. Different data collection tools will be appropriate at different path segments. The diagram also helps decide where resources are best focused to achieve maximum coverage. Low priority segments may be covered with less rigorous methods than those known to account for significant amounts of catch. Such path diagrams also provide a framework for regular review of data collection systems, for adapting to change and for planned improvement of the system as capacity changes (Mahon and Stamatopolous, 1988).

FIGURE 11

Examples of fish disposition pathway diagrams for (a) conch and lobster and (b) finfish in the Turks and Caicos Islands



Percentages indicate tentative estimates moving along each path. Existing (solid lines) and proposed (hatched lines) data collection tools are shown in hexagons (PS - purchase slip, LS - landing sheet, ER -export records, SP - sampling programme, LB - logbook, BS - biological and price sampling).
Source Halls *et al.* (2000).

5. Co-designing the data collection and sharing system

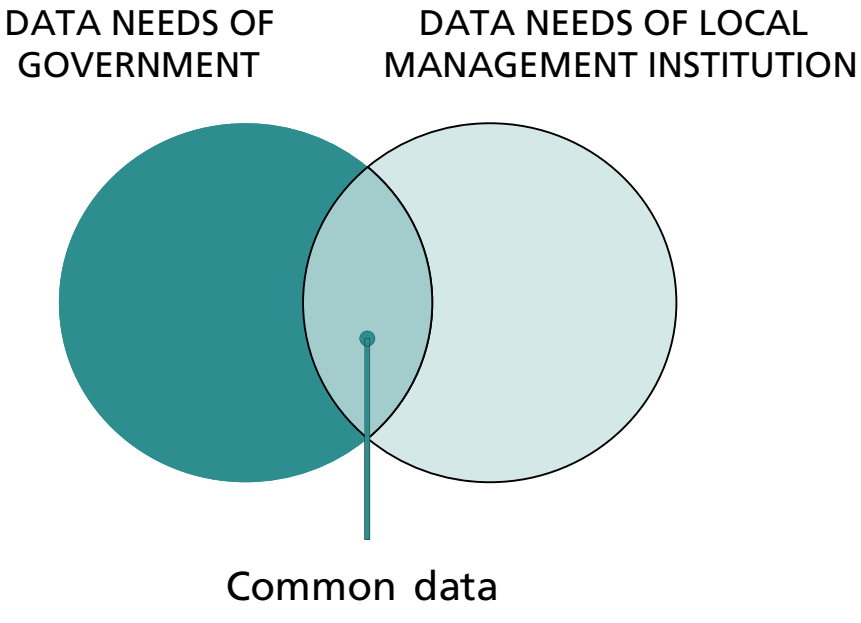
5.1 MEETING INFORMATION NEEDS

Co-managers will have overlapping data needs to support their roles (Figure 12). For example, many of the data types required for policy and development planning and evaluation may be similar to those required by local managers to evaluate the performance of their local management plans. The greater the overlap the more opportunities will exist to share data and information and the responsibility for collecting it.

Key stages in designing an effective and efficient data collection and sharing system are therefore identifying and maximizing this overlap, and reaching agreement on who should collect and share data to generate this information based upon their *capacity* and *motivation*. Responsibility for collecting the *remaining* data will also have to be reached. In some cases, the Government and LMI may be happy to collect these data independently of one another (often informally in the case of the LMI) but then later share them with one another. In other cases they may agree to collect data on behalf of one another provided they are sufficiently motivated to do so.

This chapter describes a participatory process for undertaking these key and other important stages when designing a data collection and sharing system for co-managed fisheries. The key elements of this chapter also form the basis of the accompanying Part 1 of this paper: *Practical guide.*

FIGURE 12
Common data needs of co-managers



This design process should be integral to the formulation or revision of the management plan. It is at this stage when the overlapping data needs of important stakeholders' will become evident having established or clarified their roles and responsibilities, objectives, planned activities or strategies, rules and regulations, and performance evaluation criteria.

Participatory (and supporting conventional) monitoring programmes can subsequently be designed to meet these needs following an examination of the incentives and capacity of each stakeholder to collect and share the data, alongside information relating to the operational characteristics of the fishery. Integrating the design of the system with the management plan formulation, formalisation or revision process also provides opportunities to revise or re-negotiated *iteratively* elements of the management plan *and/or* the data collection and sharing strategy as the potential scope of any monitoring and evaluation activities becomes evident. Relevant activities required for formulating or reviewing management plans are therefore included in the eight-stage design process we propose in below.

5.2 AN EIGHT-STAGE PARTICIPATORY DESIGN PROCESS

The eight-stage process we propose below is based around a general strategy of identifying stakeholders and their information requirements, identifying overlap in these requirements, and then designing a strategy for data collection and sharing based upon stakeholder incentives and capacity (Figure 13).

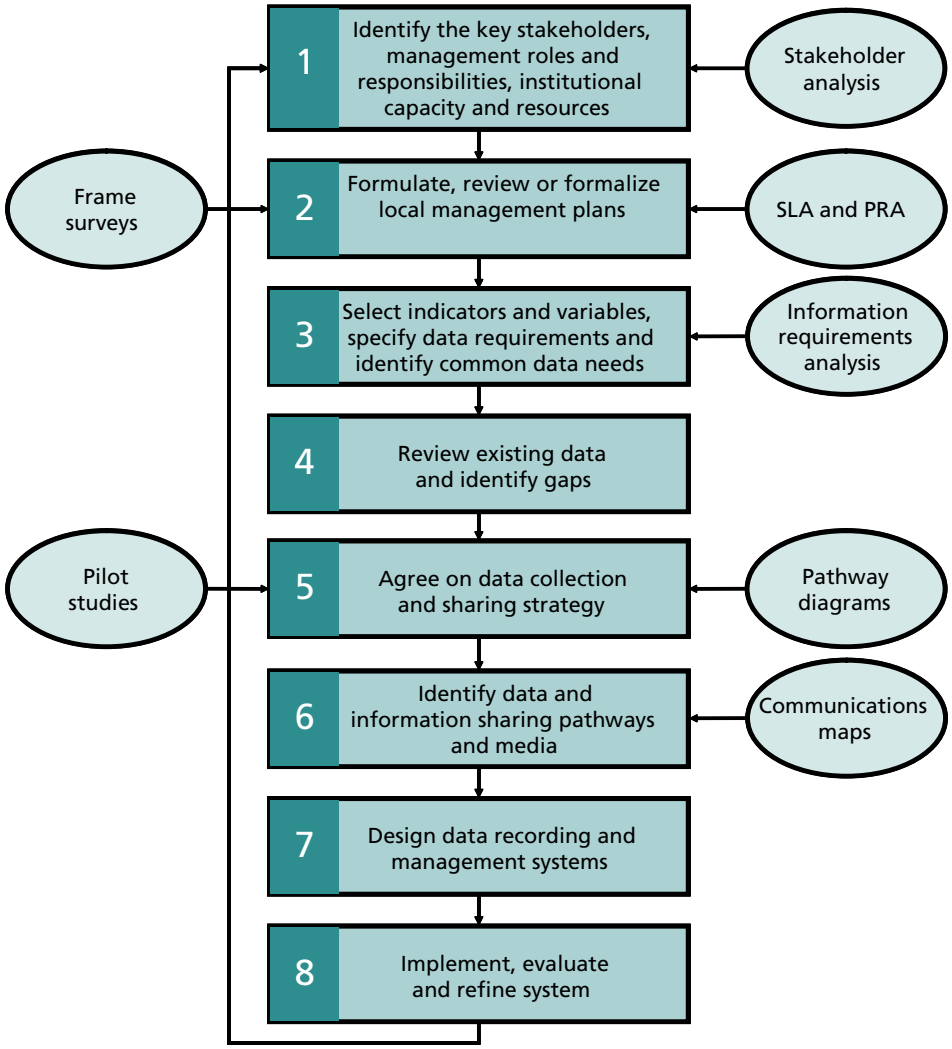
The first step is to identify the main stakeholders involved in management of the resource, and their responsibilities and capacities (Stage 1) which will help define their potential roles in the system. Management planning (Stage 2) is key to designing successful data collection and sharing systems because the management objectives and strategies will be defined in the plan. Based on the objectives in the plan, the data that will need to be collected can be identified (Stage 3). Existing data that are already collected by different institutions are then reviewed (Stage 4) and gaps are identified, so that for the remaining data that are required by the stakeholders, a strategy can be identified to collect those data (Stage 5). Pathways and methods to share those data between stakeholders are agreed in Stage 6, and ways of recording, storing and managing the data are identified in Stage 7. Finally in Stage 8, the system is implemented, evaluated and refined. A scaled-down pilot system could be implemented at first, involving a reduced number of data variables and stakeholders, so that all involved can get a feel for the system and which ideas will work well or not in practice.

The process is likely to require the participation of the main stakeholders in a series of focus group discussions and planning workshops, possibly at different spatial or administrative levels, for example, district, regional, national, depending upon the administrative structures of the co-management institutions. The location and timing of meetings, the facilities where the meetings are held, and facilitation should be arranged to make sure that all stakeholders are able to participate in the process in ways that are important to them. Berkes *et al.* (2001) provide useful guidance in respect to planning field working activities of this nature.

Facilitators can help facilitate the design process. They can help organize meetings or workshops, bring stakeholders together and help lead the discussions and drive the process forward. Facilitators may be external – either independent facilitators or from an outside organization not otherwise involved in the data collection and sharing system, or they may be from an organization involved in the process, for example, from the lead organization, such as the Fisheries Department, local government office or an NGO or project.

Each of stage in the process is described below, with tools and ideas for how to facilitate each part.

FIGURE 13
A proposed eight-stage process for designing data collection and sharing systems for co-managed fisheries. The light green ovals in the diagram represent possible tools that can help carry out the stages.



5.2.1 Stage 1 – Identify the main stakeholders, their interest and capacity

The main purposes of this exercise are to:

- Ensure the participation of key stakeholders in the management planning process and/or design of the data collection and sharing systems. This has several benefits. Participating stakeholders will understand why information is being collected promoting effective participation. Participation in the design process will also ensure data collection systems are both practical and understandable and will increase a sense of ownership in the data generated and the management process. Both of these aspects will improve the quality of the data collected and the interest in it (Garaway and Arthur, 2002).
- Determine the nature of their interest in the resource, and capacity to monitor, evaluate and manage in preparation to formulating or formalizing the management plan and co-designing the data collection and sharing strategy (see below). Here stakeholder capacity includes resources (people and money), knowledge and skills, legal rights and motivation.

Stakeholder analysis provides a systematic means of identifying these key stakeholders and is the starting point of most participatory work and/or social assessments. As well as providing an understanding of power relationships, influence and interests of stakeholders, it can provide essential information about who will be affected (positively and negatively) by selected management strategies or interventions (see below), which individuals, groups, or agencies need to be involved in the management, and how; and whose capacity needs to be built to enable them to participate. Stakeholder analysis might also be used to identify current systems of information flow, where constraints lie and where new linkages can be made (see later).

Even if the co-management arrangements are already well established and management plans already formulated, this exercise may still be useful to clarify these issues or update knowledge and understanding in preparation for designing the data collection and sharing system.

Practical guidance for conducting a stakeholder analysis is provided in Part I of these Guidelines. Further guidance can be found at http://www.iied.org/forestry/tools/four.html or Annex D of IFAD (2002) http://www.ifad.org/evaluation/guide/index.htm. Using these techniques it should be possible to identify the main stakeholders belonging to the three main categories described in 2.3.1 as well as specific information on these groups, their interests and relationships. Depending upon the local context, stakeholders belonging to other categories or administrative levels of government may also be identified and described.

5.2.2 Stage 2 – Formulate, formalize or review local management plans

Properly formulated and clearly recorded management plans will greatly aid the identification appropriate indicators and data variables for inclusion in monitoring programmes as well as appropriate sources and methods.

The information contained within the plan will also be required to help coordinate management plans and activities and thereby minimize conflict among local managers (Section 3.3.10) and may also provide a rich source of variables for *explaining the performance* of *both* local management activities (Section 3.5.2) and co-management policy (Section 3.5.8).

In spite of the importance of the management plan not only in terms of designing monitoring programmes but also for coordinating and evaluating management activities, few examples of local management plans were identified during the preparation of this document. It is therefore highly likely that it will be necessary to formulate or at least formalize the management plan.

Broadly speaking, the formulation of the plan (excluding the design and development of monitoring and data sharing activities or programmes) is likely to involve the following steps:

- **Describe the resource, environment, fishery, fishers and other stakeholders** (see Section 3.3) drawing upon the results of stakeholder analysis described above and any baseline data collection activities such as Sustainable Livelihoods Analysis (SLA), Participatory Rural Appraisal (PRA) and frame surveys described below.
- **Select or identify local management objectives** consistent with national policy. If these are not explicitly stated then it will be impossible to identify appropriate indicators to monitor management performance in relation to them. Co-managers should be clear what they mean by objectives. For example, banning destructive fishing practices might be seen by some as an objective, but actually this is a management measure often selected to pursue objectives such as improving yield or equity. Effectively establishing and enforcing such management measures could however be regarded as an intermediate objective (see Berkes *et al.*, 2001).
- **Select management strategies**, rules and interventions to achieve the objectives that comply with national legislation. The results of the stakeholder analysis (see

above) can also be used to predict the effects of management strategies on key stakeholders.

- **Collectively agree the roles and responsibilities** of each stakeholder to (help) implement and evaluate the management plan. This should take account of stakeholder capacity identified during the stakeholder analysis described above. Table 1 may provide a useful checklist for this purpose. When identifying roles it is important to precisely establish the area of competence, geographical area, fish resources and fisheries for which a given stakeholder is responsible (Cochrane, 2002). Remember, if policy and legislation permits or are still evolving, or if changes in stakeholder capacity have occurred, it may be possible to revise these respective roles, or share responsibility for them, in order to create or strengthen incentives that encourage participation in monitoring programmes and data sharing activities by important stakeholders (Section 5.2.5.5). Note that sufficient time and resources should be devoted to this exercise since, according to the results of research activities described in *Preparation of this document* in Part I, identifying stakeholders and clarifying their roles and responsibilities is a critical but often challenging activity (see Box 14).
- **Collectively agree on surveillance and enforcement activities** including who is responsible for doing what.
- **Develop legal and policy framework** for management if not already in place.

Guidance on how to undertake each step is given by Hoggarth *et al.* (1999; in press). Intermediaries may be able to help facilitate the formulation of the plan between the relevant administrative levels of government and the LMI. Visualization techniques including "cognitive mapping" may facilitate these processes (Berkes *et al.,* 2001; Guijt *et al.,* 1998). In Cambodia, the MRRF project uses SWOT (Strength, Weaknesses, Opportunities and Threats) analysis to review and adapt the management plan for the following year (MRC, 2004).

Much of the baseline data and information can be readily compiled using Rapid Rural Appraisal (RRA) (Pido *et al.* 1996) and PRA approaches (see http://www.iied.org/sarl/pla_notes/ or Annex D of IFAD (2002), http://www.ifad.org/evaluation/guide/index.htm and Maine *et al.* (1996)) involving the LMI and resource users, as they will often know what actions or management control measures would sustain local catches (e.g. establishing fish sanctuaries in particularly locations). Intermediaries such as NGOs, research institutions or donor projects may be an important source for the socio-economic and institutional baseline data and information. In addition, formal stock assessments or the application of analytical frameworks (Section 3.5) may be employed where feasible and appropriate to investigate the biological, social

BOX 14

The challenge of identifying stakeholder roles and responsibilities

"Decentralisation of management responsibility for fisheries management to the municipalities has resulted in a situation where there are more than 800 autonomous entities in charge of managing the fishery" (Felsing, 2004b)

"In Vietnam the Ministry of Fisheries has a very complex institutional structure and the sharing of management responsibilities with local management bodies is vague" (MRC2004).

"The difficulties in classifying the roles and responsibilities of various stakeholders in a collaborative management system (as a basis for identifying information needs) should not be underestimated" "Many of the roles and responsibilities in the systems are still evolving" (Purvis, 2004).

BOX 15
The application of logical frameworks

Significant scope exists for employing logical frameworks (logframes) to formulate management plans. The logframe is a powerful participatory tool that can be used to help define the roles of different stakeholders, and provide an explicit and objectively verifiable schedule of the actions that will need to be undertaken. It can also be used as the focus for discussions about amendments and alterations to an activity in the light of experience, while the activity is under way. Guidelines for developing logframes are available at http://62.189.42.51/DFIDstage/FOI/tools/chapter_05.htm. Berkes *et al.* (2001) describes the application of logframes for developing management plans for small-scale fisheries in Barbados (see http://web.idrc.ca/en/ev-28061-201-1-DO_TOPIC.html). The Mekong River and Reservoir Fisheries (MRRF) programme has used a logframe type approach in the context of planning management activities in reservoirs in Cambodia and Laos, and for planning and implementing participatory impact monitoring surveys in Thailand (see MRC, 2004 for further details).

and economic implications of different harvesting strategies and control measures (and their combinations) designed to control fishing mortality, and interventions such as stocking or habitat rehabilitation programmes.

5.2.2.1 A sustainable livelihoods approach to management planning

Poverty alleviation or reduction is often the central theme of national policy and development plans, as well as local management plans. The Sustainable Livelihood Approach (SLA) offers an effective means of identifying interventions or strategies in support of these policies and plans. The Department for International Development (DFID) formally adopted the approach in 1997 and defines the concept of sustainable livelihoods as:

"…the capabilities, assets (including both material and social resources), and activities required for a means of living. A livelihood is sustainable when it can cope and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base".

Several international development agencies are now applying a "livelihoods approach", each applying a somewhat different version and for a range of different purposes (see Krantz [2001] for further details). Most approaches reject the usual sectoral entry point (fisheries, agriculture, water, etc.) and instead begin with an analysis

BOX 16
The sustainable livelihoods approach to local management planning

The formulation of these management plans, programmes and activities are likely to be "… enriched if they build upon information gathered in a livelihoods analysis…by improving understanding of the "…interactions between different sectors and the importance of developing inter-sectoral links to maximise impact" (DFID, 1999).

Policy and practice would be improved "…by recognising the seasonal and cyclical complexity of [fisheries-dependent] livelihood strategies, helping to remove access constraints to assets and activities, and identifying ways of making livelihoods, as a whole, more able to cope with adverse trends and shocks" (Allison and Ellis, 2001 p. 378).

of people's current livelihood systems to identify appropriate interventions. They also place their emphasis on involving people in the identification and implementation of activities (*ibid*).

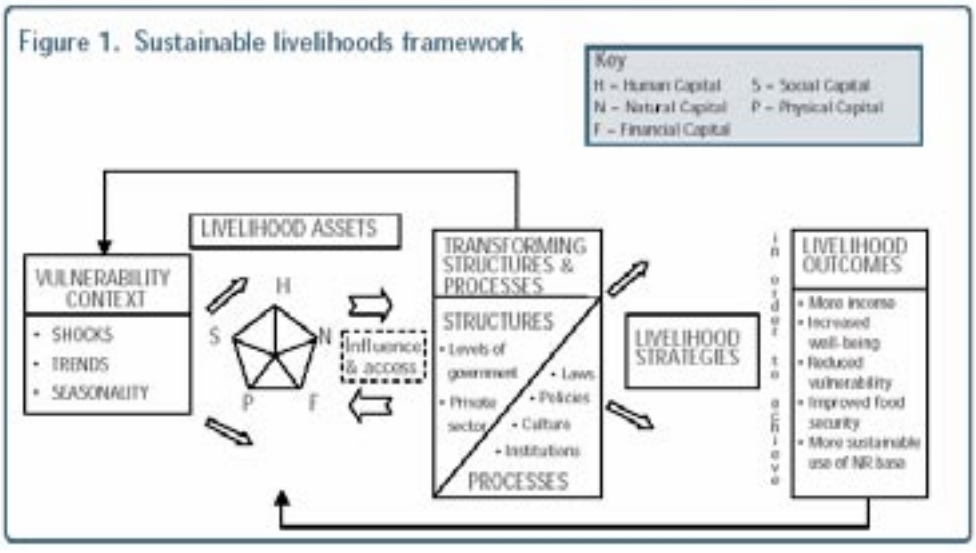
The micro or meso scale of most co-management initiatives lends itself well to the application of the SLA. Not only can more effective management plans be formulated using this approach taking account of the importance and impact of different sectors, but such initiatives also provide 'entry points' for other, (inter-) sectoral management and development interventions including poverty reduction strategies (PRS) (See Section 3.2.3.2).

As well as providing a means of identifying context appropriate strategies and interventions including both technical and institutional type, the application of the SLA may also help facilitate the design the data collection strategy by:

- Identifying important stakeholders.
- Identifying issues, constraints and opportunities.
- Identifying alternative livelihood opportunities.
- Helping appraise the fishery to determine appropriate data sources and collection methods.
- Generating information that should be included in the local management plan.

A central element of DFID's SL approach is the SL framework (Figure 14). The framework is not an exact model of reality, but an analytical structure or tool to improve understanding of livelihoods. It aims to provide a broad and systematic understanding of the various factors that constrain or enhance livelihood opportunities. It can be used in both planning new development or management activities and interventions, as well as assessing the contribution to livelihood sustainability made by existing activities. It is built around five principal categories of livelihood assets depicted as a pentagon. An important stage of the analysis is to identify people's access to different types of assets (physical, human, financial, natural and social) and their ability to put these to productive use. It also facilitates an understanding of how organizations, policies, institutions and cultural norms shape livelihoods by determining who gains access to different assets and defining the range of livelihood strategies available and adopted (*ibid*). It does not take a sectoral view but rather seeks to understand the contribution made by all sectors to the assets upon which people can draw from. In essence, it

FIGURE 14
The sustainable livelihoods framework



Source: http://www.livelihoods.org/info/info_guidancesheets.htm

aims to encourage users to take a broad and systematic view of the factors that cause poverty, whether these be shocks or adverse trends, poorly functioning institutions and policies, or a basic lack of assets, and to investigate the relations between them.

In doing so, appropriate interventions can be identified on the basis of threats or constraints to livelihoods such as providing people with better access to assets or supporting more effective functioning of structures and processes (e.g. management institutions, policies etc) that influence access to assets and available livelihood strategies. A full description of the SL concept, framework and application is available at http://www.livelihoods.org/info/info_guidancesheets.html. Hoon *et al.* (1997) examines appropriate indicators for SL analyses.

Poverty and Development Planning Applications

Norton and Foster (2001) conclude that the asset/vulnerability component of the framework has considerable potential to improve the PRSP, particularly in terms of the diagnosis, the design of the strategy, and the monitoring framework (see Box 17). DFID (2001) advocates that these benefits also extend to other country level development strategies including CDF and NSSD (See Section 3.2.3). Section 6 of DFID's Guidance Sheets available at http://www.livelihoods.org/info/info_guidancesheets.html describes a host of other opportunities where the application of SL approach, particularly its

BOX 17

What can an SL approach add to the PRS and other country-level development strategies?

Analytical or Diagnostic Work: Integrate household survey, environmental, social and political analysis to identify livelihood groups; identify trends, threats to existing livelihoods (supplementing expenditure/income analysis with information on trends in assets held by the poor, the returns obtained from them, the costs required to sustain them). Identify issues poor groups themselves prioritise.

Formulation of the Strategy: Integrate asset/vulnerability information with economic analysis, to identify which interventions have biggest sustainable impact on most poor people at affordable cost; and which interventions have most positive impact on identified poorest and most vulnerable groups. An SL approach could help to bring household expenditure/income data into a common frame with information on assets, including what is required to maintain and enhance them, and what returns might be. Participatory and historical analysis might be used to identify how different groups may react to new conditions, threats, opportunities. In moving the SL framework from local to national concerns, some sacrifice of the detailed, holistic approach will be required, but the analysis can inform decisions on where the main variations lie, and what features are important.

Approval: By identifying the importance of heterogeneity, an SL approach might help promote a more decentralised and locally responsive approach, in which the centre is approving a process by which resources are allocated but with greater discretion for adaptation through local level planning and budgeting processes.

Implementation: The SL approach can inform the development of frameworks for setting objectives and designing monitoring systems that capture early-warning indicators of poverty, including asset sales.

Impact Assessment: Recognition of need to assess longer-term trends in assets, especially environmental assets.

Norton and Foster (2001).

core principles can complement and support country-level policy and development planning.

5.2.2.2 Participatory Action Plan Development (PAPD) approach

Participatory Action Plan Development (PAPD) is an approach to management planning that was developed by the Center for Natural Resource Studies (CNRS), and a team from Newcastle and Durham Universities (Barr and Dixon, 2001). The method has been developed in Bangladesh but has been adapted and tested in Viet Nam (see Sultana and Thompson, 2003; 2004). The planning approach involves holding a series of linked local workshops where different stakeholders and users of a floodplain participate separately and in plenary to develop a management plan for the common resources they use.

The key features of PAPD

Each category of stakeholders works separately to identify and rank their problems regarding natural resource management (NRM). Later, all stakeholder groups come together to jointly agree on the priority problems. The stakeholder groups separately analyze possible solutions and their impacts, before meeting in plenary to share their analysis and form a consensus on win-win solutions and actions. The participants prepare in more detail an action plan for natural resource management. PAPD is designed to encourage participants to express their views, while avoiding a process that is dominated by locally-powerful and vocal people, and to develop a shared framework of understanding about resource management. It is based on certain principles such as the desirability of consensus, the need for all stakeholders to be involved in the process, neutrality and the sharing of information. However, it does not focus on negotiation or resolving existing direct conflicts between two parties over resources. PAPD focuses on problems, needs and potential solutions that are shared, and the differences and similarities in views of stakeholder groups over them. Many methods like Participatory Rural Appraisal (PRA) aim to raise individual awareness of resource management problems; PAPD as a process raises collective awareness of the problems and leads towards collective action that can tackle them effectively. PAPD is designed to enable the voices of the disadvantaged and less powerful to also be heard.

Methodology for PAPD

As originally conceived, PAPD was seen as a two-stage process comprising a problem census (listing of problems and ranking of their importance by different stakeholder groups) followed by stakeholder and plenary planning workshops. However, through the process of applying and testing the PAPD process, it has evolved into three phases that lead into continual or long-term participatory resource management (Sultana and Thompson, 2004). Each phase has a number of different stages and activities (Figure 15).

– *Scoping phase*
    1. Situational analysis (through summarizing local knowledge).
    2. Stakeholder analysis (with help of key informants).
    3. Household census and invitations to a random sample of households to PAPD (stratified by stakeholder categories).

– *Participatory planning phase*
    4. Problem census (with each individual stakeholder group).
    5. Compilation of problem rankings by facilitators (separating natural resource problems, combining stakeholder group rankings).
    6. Plenary with stakeholder representatives and local leaders (to review problems, vote on the top three or four for solution analysis).

7. Solution and impact analysis (with each individual stakeholder group).
8. Plenary with stakeholder representatives and secondary stakeholders (to present the whole process, identify feasible solutions, discuss institutional arrangements proposed by separate groups and next step).

– *Implementation phase*

9. Develop and adapt community organizations and institutions for fishery/common pool resource management.
10. Community organization develops detailed plan to implement solutions agreed in stage eight
11. Review of plans by wider community and adjustments to plan (to mitigate or avoid any adverse impacts, for example).
12. Implementation of action/management plan (for example, physical works, application of rules, monitoring).
13. Institutionalization of management arrangements including local policy support.

At the heart of the process are stages four to eight that involve participatory workshops with separate stakeholder groups and combined plenary sessions. These stages have been the main focus of the action-research, as it is here that the substantive consensus is built. However, this should be seen as one important phase in a larger process. In the more general sense, action research addressing problems of the community has its focus on steps 9 through 13 where both institutional arrangements and fishery management actions are tested and evolve through the efforts of the community with advice and facilitation from non-governmental organizations (NGOs), government agents and researchers.

Participation issues

There is an inverse relationship between people's willingness to express their views frankly, and the number and diversity of people participating. Individuals tend to discuss issues more freely on an individual basis than in public. Some reasons why people may not contribute ideas to a public discussion are: they do not consider their ideas valuable; they do not want to upset the status quo; they want to avoid offending others; and it is not traditionally or culturally acceptable for them to speak in a public meeting (e.g. women and young people) when it is for others (e.g. male elders).

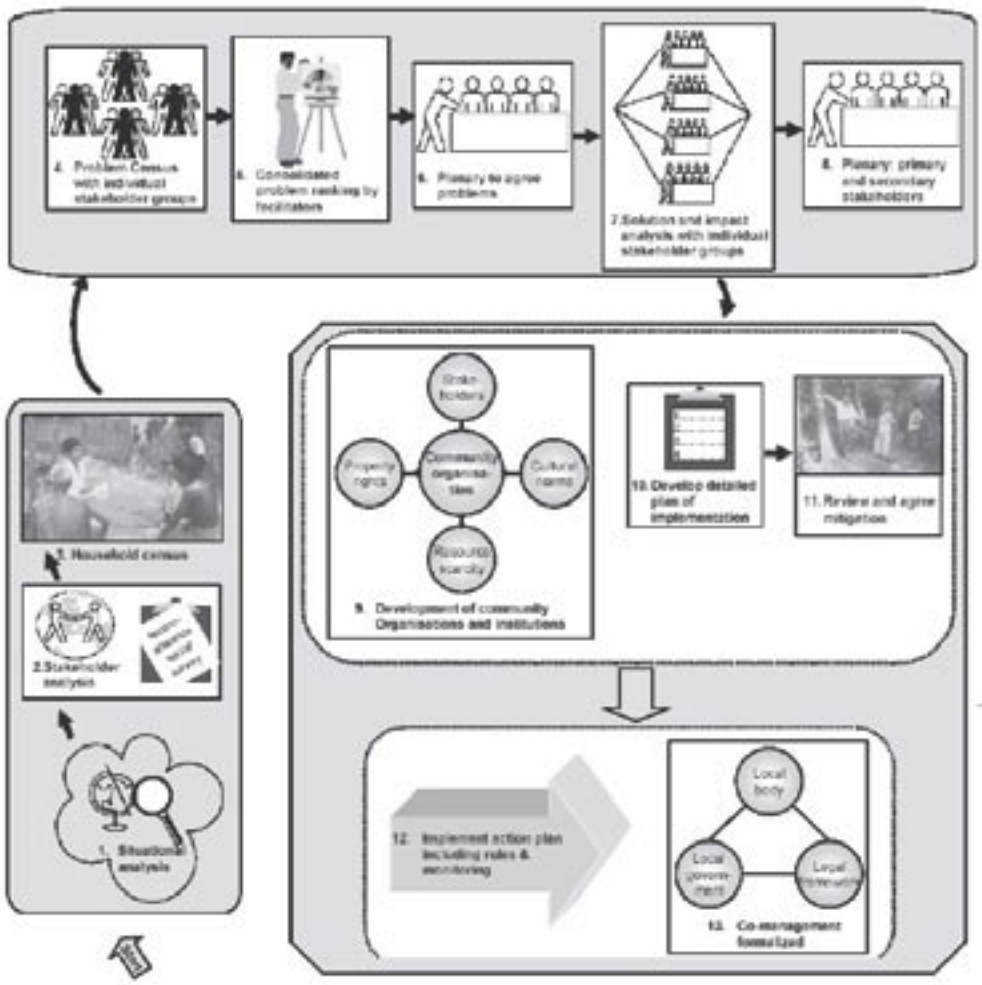
Building relations with a few key individuals can help obtain information of the real workings of society. This can be validated by triangulation with what other individuals say. However, it is a slow process and involves no explicit public consultation or planning objective.

An alternative is for people to express their ideas in a less judgmental forum where they feel comfortable, like with friends or with people of similar background. The drawback, however, is that these views are not aired in public and do not contribute to shared understanding and mutual learning, and so there is no change in the status quo.

The PAPD method takes into account these issues through a series of linked separation and aggregation steps that together can result in a balanced view. The separation steps are exercises undertaken by each stakeholder group. The aggregation steps are facilitated plenary sessions where all groups are represented.

These principles and the PAPD method can be adapted for participatory reviews and improvements in management as well as for initial planning. The process shown in the figure is consistent with the CBOs that result from PAPD designing management systems as part of the PAPD in sessions where government co-managers are actively involved with the primary stakeholders, these systems can include data sharing and reviewing.

FIGURE 15
Thirteen stages and three phases of the PAPD process



Source: Sultana and Thompson (2004).

5.2.2.1 Frame surveys

Frame surveys are used to generate important information required both for management planning purposes and for helping design data collection strategies or systems.

In particular, they are used to define the water bodies and areas that will be included in the plan or monitoring programmes and to describe the operating characteristics of a fishery or (co-)management unit including information relating to the environment, fishers, boats, gear, markets, fisher communities, and institutional arrangements etc (see Section 5.2.2). Because the types of data and information collected using frame survey approaches may be similar to those generated for SL analyses, opportunities may exist to integrate survey and appraisal activities where appropriate.

In the context of designing data collection strategies, the frame survey will provide important information relating to the infrastructure and characteristics of the fishery that can be used to guide the selection of data sources and tools, sampling strata, and information for raising sample estimates. At a minimum the frame survey should aim to include:

- The stocks or fishery being considered and the area under the jurisdiction of the LMI (Section 3.3.1).

- Information relating to the fishing units or FEUs including details of total numbers; gear types and technology employed, and distribution in relation to landing locations (Section 3.3.2).
- Diurnal fishing activity and landing patterns (quantities) by season and location (Section 3.3.2).
- Details of markets and their locations, (seasonal) prices; fish distribution routes, fish utilization, fish processing and marketing practices, fish trade, local consumption, number of processors or marketing units; supporting infrastructure (Section 3.3.8).

Additional information might include:

- Information on environments, habitats and potential catchment influences on the fishery or stock or locations critical to the life history of the stock or species (Section 3.3.1).
- Socio-economic categories of fishers (professional, subsistence etc), their sub-categories (e.g. women, children) and other stakeholders (fish traders, leaseholders etc) corresponding to or dependent upon different FEUs (Section 3.3.3)
- Management roles and responsibilities and institutional arrangements (Section 3.3.4).

Examples of typical data types collected for frame surveys are given in Section 6 of DFID Project Report ref. R7042 which can be downloaded at http://www.fmsp.org.uk/r7042.htm.

Frame surveys often draw upon information from numerous sources including directly from the LMI or resource users using Rapid Rural Appraisal (RRA) (Pido *et al.* 1996) and PRA techniques (Maine *et al.* (1996) and Annex D IFAD 2002, http://www.ifad.org/evaluation/guide/index.htm), and by direct observations, dedicated surveys or censuses, and other government departments or ministries.

Information is often usefully summarized in the form of thematic maps (Figure 16) or cognitive maps (see Berkes *et al.* 2001). Further guidance on frame surveys can be found in FAO (1997) Caddy and Bazigos (1985), Bazigos (1983) and Mahon and Rosenberg (1988). Meaden and Do Chi (1996) (see http://www.fao.org/DOCREP/003/W0615E/W0615E00.HTM) describe the application of GIS systems for creating thematic maps. De Graaf *et al.* (2003) illustrate the application of GIS for creating thematic maps for the fisheries of Lake Volta.

5.2.2.2 Recording the management plan

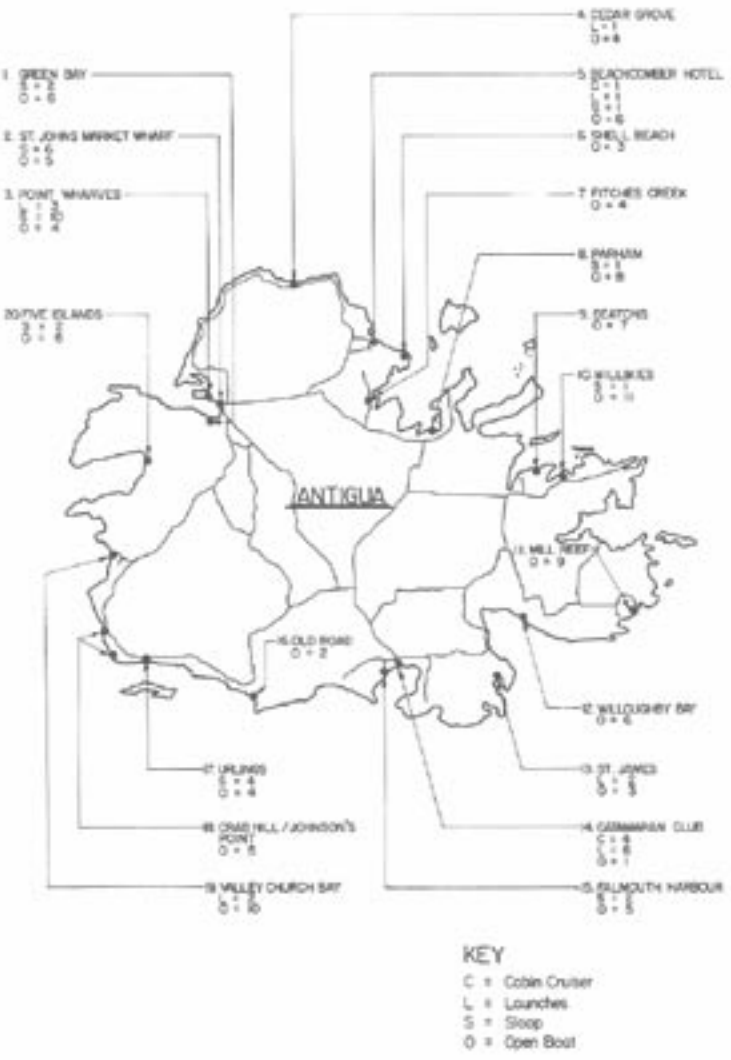
A checklist of the categories of information that might be included in each local management plan is provided in Section 3.3. Agreeing a common format will facilitate the coordination of individual management plans and activities (Section 3.3.10) and ensure that explanatory variables common among all LMIs or co-management units are available for comparative analysis purposes (Section 3.5.2). The plan will usually be presented in a report format, and should be made available to all stakeholders. Graphical or pictorial summaries of the plan, possibly based upon thematic frame survey maps (see above), may help to ensure understanding among stakeholders. Alternatively, it may be necessary to produce two versions of plan: a technical version that includes all the information in detail, and a less technical version that includes information in a form that all stakeholders can understand (see Berkes *et al.*, 2001 and Box 18).

5.2.3 Stage 3 – Identify common data needs including specification

At this stage, each stakeholder group will identify their own information needs which will later be compiled to identify common data needs in Stage 5.

Once the stakeholders have a formulated or revised management plan that describes the environment, resources and fisheries defines local management objectives, strategies and actions to take, and outlines roles and responsibilities for its implementation (i.e.

FIGURE 16
Example of a thematic map illustrating the location of important landing sites and numbers of fishing vessels by category in Antigua, Caribbean



Source: Mahon and Rosenberg (1988).

BOX 18
Management plans depicted by maps?

The experiences of the Aga Khan Rural Support Programme (see Guijt *et al.*, 1999) suggest that maps could be an effective means of preparing and recording local fisheries management plans, as well as evaluating their performance. The maps, prepared by local people, depict the available resources, how they are used, ownership, problems and constraint are used as the basis for local planning and decision-making. The maps are displayed in convenient locations that are accessible for all members of the community and used to monitor project activities and resolve problems.

Category 2 information), it should now be possible for each key stakeholder group to identify a provisional list of data needs or interests in relation to the remaining information Categories 1, 3 and 4.

Stakeholders do not need to think of all the information needs at this stage. As plans change and as stakeholders develop their ideas and their understanding of the plan, the data and information needs will change also and can be updated. This means that the data collection system and management plan should evolve and improve together through time as they are revised or reviewed.

5.2.3.1 Identify data for Category 1 and 4 information

Guided by explicitly defined objectives, both government and each LMI should be able select a list of performance indicators and corresponding data types and variables for monitoring and evaluating policy and development plans (Category 1), and local management plan performance (Category 4). Sections 3.2 and 3.5 provide typical examples of what might be selected for monitoring.

Identifying indicators for each information category can be done by fishers, LMI members, local government officers and national fisheries officers (for example) working in separate groups to identify their information needs, or they can work in mixed groups and identify the information needs for all groups. This may be done through a workshop and may need to cover basic concepts.

To maximize acceptable data variable overlap, the stakeholder groups should be encouraged to identify several *alternative* indicators. Stakeholders should then indicate how important each indicator is to them by *ranking or scoring the indicators* according to their overall importance. Scoring can be done using a scale of 1 to 5.

A provisional list of *explanatory* variables corresponding to each performance indicator should also be identified at this point for inclusion in either routine monitoring programmes or to be fully documented and described in the management plan. This list should include variables to explain both the performance of local management plans and policy and development activities. Intermediaries may be well placed to help the main stakeholders identify these variables. Discussions and presentations based around 'Bio-resource' flow-diagrams and other conceptual models of the fishery, and the construction of a hypothesis matrix may help facilitate this process (Section 3.5.2).

5.2.3.2 Develop alternative indicators if required

It is unlikely that the indicators described in Chapter 3 will meet the needs of all stakeholders in every context. In these cases, stakeholders will need to select or develop alternative indicators that meet their requirements. Differences in the perception of appropriate indicators even at the community level (according to gender, age, occupation, wealth status etc) may also exist and therefore negotiation even at this level may be required. Alternatively several different indicators may need to be monitored to reconcile differences in perceptions or understanding of individuals.

The UNDP identify a number of desirable characteristics that any indicator should:

- be developed within an agreed upon conceptual and operational framework;

BOX 19

The critical design stage

Identifying what to monitor is the most critical stage in the process of designing and implementing PM&E programmes or activities and often requires a lengthy process of negotiation and collaborative decision-making among various stakeholders, particularly if the data and information generated by the programmes are to be shared between stakeholders at different management levels.

- be sensitive insofar as that a small change to be measured should result in a measured change in the indicator;
- be clearly and consistently defined so as to be un-ambiguous or lend themselves to various interpretations, or to give inconsistent results in different situations;
- be specific and measurable in that they have an explicit scale ranging from undesirable states to desirable states (along with specific weightings) that enables them to be used for assessment purposes;
- be policy oriented so as to provide practical information by being able to record either changes in the means recommended by policy or changes in the development impact attributable to policy;
- have ownership by users;
- reflect input, output process, and outcomes or impact; and
- be readily collectable and, thereby, lowering the technical and collection costs. Preference should be given to indicators for which existing data-collection mechanisms exist or can be adapted to fulfil the purpose of collecting data.

Further details can be found at http://www.undp.org under "Sustainable Livelihoods: Concepts, Principles and Approaches to Indicator Development". Abbot and Guijt (1998, p. 41) suggest similar criteria.

The selection of relevant indicators for monitoring performance in relation to objectives can be guided by performance questions (IFAD, 2002, Section 5, downloadable at http://www.ifad.org/evaluation/guide/index.htm). Performance questions help focus the selection of appropriate indicators by addressing what is necessary to know if the management plan or policy is performing as planned. Once you have your performance questions, you can more easily decide what information you need to monitor. The following question can help find a good performance question: "What questions would you need to answer to know the extent to which you are achieving the objective?" After the performance questions are agreed, it is then much easier to decide what information you need to answer them.

Be sure to avoid duplication. Organizations such as national statistical bureaux, census bureaux, statistical offices or ministries of agriculture etc) may already be monitoring relevant indicators or data variables (see Section 5.2.4). Rai (1998) describes how indicators can be developed in a participatory manner on the basis of pictures depicting goals or management activities.

5.2.3.3 Identify the data needed

The next step is for the stakeholders to identify, for each ***quantitative*** (numerical) indicator, what data they would actually need to collect to be able to calculate the indicator. To do this, firstly identify the ***types of data*** required for each indicator. For example, to calculate indicators of fish abundance such as catch per unit effort (CPUE), the ***data types*** required will be catch and effort.

Next, groups should identify several possible ***data variables*** that could be collected for each data type. For example, catch data can be collected in several ways: as the weight of the catch, the number of fish caught, or the number of baskets or boxes of fish. Part I illustrates this process using a series of tables.

To maximize the opportunity for sharing data and the responsibility for collecting it, each group should attempt to identify several alternative acceptable data variables for each quantitative indicator. For qualitative (non-numerical) indicators and explanatory variables, stakeholders should discuss and negotiate as many common indicators and explanatory variables as possible. *Grass roots* indicators derived by individuals, households or communities (Abbot and Guijt, 1998) may not always be compatible with the needs of other stakeholders. Thus indicators will need to be selected or developed that integrate these different perspectives. This will involve discussing their significance and relevance with each stakeholder group. While a common set of

indicators is desirable, bear in mind that different *quantitative* indicators selected by stakeholders may rely on the *same data variables* for their calculation. In these cases the emphasis should be on negotiating indicators that share *common data variables*.

Also bear in mind that the process of negotiating indicators requires developing a common understanding of success that is likely to differ among stakeholders. Negotiations of this type are beneficial since they can reinforce a shared vision for management and development. Interestingly, Abbot and Guijt (1998) report that stakeholders are often keen to work toward standard national procedures for monitoring and data handling. Note that even if local managers are not involved in data collection activities, selected indicators must be relevant and palatable.

5.2.3.4 Agree data specification

Having identified acceptable indicators and data variables for their calculation, the specification of each indicator or explanatory variable should be agreed among each stakeholder group and stated explicitly. This information is required to help design the data collection strategy (see Stage 5) including the selection of appropriate data sources, data collection tools, sampling units and sampling strata; and the identification of the required sampling intensity (sample size and sampling frequency) and coverage (sample or complete enumeration).

These specifications should aim to include details of the required frequency, accuracy and precision of the indicator or explanatory variable as well as details of any required standards (Sections 3.1.2. and 4.5). Some basic concepts related to accuracy and precision are presented in Box 20.

The required minimum level of accuracy (1- β) is typically 80-90 percent, but precision requirements will depend largely upon the how the indicators and variables are analysed and used. For example, catch data might need to be monitored with high precision (e.g. δ=10 percent) and accuracy to adequately evaluate the performance of different management strategies or stocking programmes (see Section 3.5.1.1). For policy and development planning purposes however, less precise (e.g. δ=20 percent) and less frequent estimates may be acceptable thereby providing opportunities to collect the data using less costly indirect methods and sources such as infrequent national censuses (see Section 4.6.1). Further guidance on data specification is available in Sections 3.1.2 and 4.5.

Stakeholders should be encouraged to clearly justify the reason for the data specification. This exercise can be very enlightening and may encourage managers to review or re-consider their roles and responsibilities as the purpose of management data and information becomes clear.

FAO have produced a number of very useful manuals and handbooks on the subject of sampling design including Stamatopolous (2002; 2004) and Sparre (2000) that should be consulted at this stage of the design process. These include detailed guidelines on how to achieve required levels of accuracy and precision, and on the design of data collection strategies, methods and forms. The FAO's ARTFISH software (see Section 5.2.7.2) also contains routines to help managers plan and design sample-based surveys.

5.2.3.5 Identify data and information to implement the management plan

Data and information required to implement the plan, particularly with respect to the enforcement of local rules and regulations and resolving conflict i.e. Category 3 information (Section 3.4) might also be identified at this point, particularly if government is expected to take full or partial responsibility for these roles and responsibilities. Remember, most information required for helping to resolve conflict will already be contained in the management plan.

BOX 20

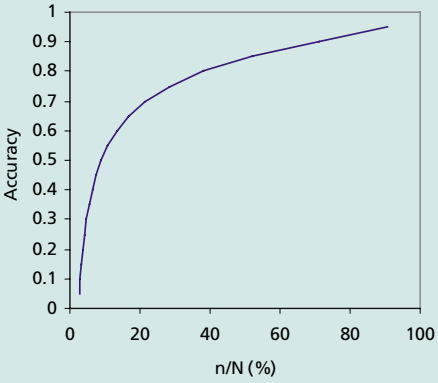
Accuracy and precision concepts

Accuracy (A) is a measure of how close the estimated value (m) is to the true value (μ) and can be expressed as:

$$A = 1 - \frac{m - \mu}{R}$$

where R denotes the population range (y_{max}-y_{min}).

Generally speaking, accuracy increases sharply with increasing sample size n expressed as a proportion of total population size N and then much slower beyond a certain *critical* sample size (equivalent to $\sqrt{N}$) up to a maximum of 1 (or 100 percent). The figure below illustrates the form of this relationship based upon an arbitrarily selected population variance.



For a given population variance estimate σ^2, the minimum sample size to achieve a maximum allowable difference d between the estimated mean and the true value is given by

$$n = \frac{1}{\frac{d^2}{z^2\sigma^2} + \frac{1}{N}}$$

where Z is the upper $\alpha/2$ point of the standard normal distribution (approx equal to 2). Stamaltopolous (2004) provide estimates of n when σ^2 is not known or cannot be estimated.

Precision

Precision refers to the closeness of a sample estimate to the expected value and, like accuracy, is a function of population variance, σ^2. Estimates can be precise but not accurate when samples are not representative (biased). Precision is often expressed in terms of confidence limits around the estimate. Precision increases (the confidence interval becomes narrower) with decreasing population variance and increasing sample size. Precision determines the minimum differences detectable between means sampled between sites or periods of time. This *Minimum detectable difference* (δ) is therefore an important concept when evaluating the performance of different management strategies. The minimum detectable difference between two samples is a function of both the pooled population variance estimated by the pooled sample variance (S^2_p) and the sample size, n (Zar, 1984) given by:

$$\delta = \sqrt{\frac{2s^2{}_p}{n}}(t_{\alpha(2),v} + t_{\beta(1),v})$$

where $t_{\alpha(2),v}$ is the critical value of the t-distribution for a two-tailed test corresponding to the probability (α) of committing a Type I error (typically 5% or 0.05) with v degrees of freedom (2(n-1)), and where $t_{\beta(1),v}$ is the critical value of the t-distribution for a one-tailed test corresponding to the probability (β) of committing a Type II error (typically 10 percent or 0.10) with v degrees of freedom.

Population variance will vary among different types of data variable. For example monthly CPUE estimated on the basis of catch per fisher will have a higher variance (be less precise) than catch per trap because individual fishers may own different numbers of traps and may not always fish the same numbers of days each month. A trade-off will therefore exist between the types of variables selected for monitoring and the required sample size. Larger samples sizes will be required for less precise data variables. Less precise variables may however be easier and less costly to collect. These trade-offs should be carefully weighed up when designing the data collection strategy (see below). Sampling the population prior to the design of the data collection strategy may provide useful estimates of the (pooled) population variance estimate σ^2, i.e. the (pooled) sample variance, s^2.

5.2.4 Stage 4 – Review existing data and identify shortfalls

Check that another institution or organization is not already collecting the data. Other government agencies, universities, research organizations, NGOs and other stakeholders will often have or be routinely collecting indicators or data variables of interest. It might be useful to start by asking whether reporting mechanisms at the village, district or national levels already exist for relevant information such as population, boat ownership, poverty indicators etc that may be generated by a range of methods such as national statistical or census or specific research methods. It is often helpful to compile an inventory, possible in tabular format, of existing information collection detailing what information is collected, who collects it, how, and for what purpose, and where the information is held (see Table 7 in Part 1 and Table 6-3 in IFAD, 2002).

Also determine how the information was collected, and whether it is reliable for the needs of each stakeholder. Remember, it may be possible to modify data gathering by other agencies to better support the needs of stakeholders (see Section 4.6.1).

5.2.5 Stage 5 – Agree data collection and sharing strategy

Co-managers should now be in a position to be able to begin designing the collection and sharing strategy to meet their data needs. This will involve identifying possible sources and methods for each data variable, identifying an appropriate sampling strategy and agreeing who will take responsibility for collecting the data and sharing it with whom.

5.2.5.1 Summaries needs and options

To facilitate this process, options to meet the requirements of each stakeholder identified above might to be considered in a tabular format similar to the type illustrated in below (Table 12). The table might initially include, for each stakeholder, details of:

- Required performance indicators or explanatory variables
- The required specification for each indicator or variable (frequency of estimate, acceptable accuracy and precision of estimate, any required standards, etc).
- The required data types and a list of acceptable data variables for collection. These will depend primarily upon the data type but also the operating characteristics of the fisheries determined by frame surveys or related methods and stakeholder capacity determined during the stakeholder analysis stage (Section 5.2.1).
- The population of interest (e.g. fishers in a village or management unit, households in a province or the entire fisheries sector.
- Survey coverage (sampling or complete enumeration) (Section 4.4)
- A list of potential sources (Section 4.1).
- A list of potential methods (Section 4.2). The selection of sources and methods should take account of available local capacity and resources, required accuracy and precision, but should also:
  - o Be perceived by local participants as a way to help them address questions and problems.
  - o Not impinge on participant's day-today activities and normal responsibilities.
  - o Provide timely and necessary information for decision-making.
  - o Produce reliable and, if not precise, credible results.
  - o Reinforce community solidarity, cooperation and involvement.
  - o Be gender sensitive.

5.2.5.2 Identify common data needs and agree responsibilities

Next, identify and highlight common data types or variables in the "Acceptable data variables" column of the table. In the example table below this has been done by highlighting common data variables with circles of the same colour.

For these common data needs, stakeholders should then discuss and agree who will collect that data, how and from where by selecting from the available options. Also agree with whom the data can be shared with. Consideration should be given to stakeholder capacity and their incentives to collect and share information (Section 5.2.5.5). In the table, open circles have been used to indicate who will collect the data, how and from where. The arrows connecting the coloured circles show how the data will be shared.

Having agreed a provisional data collection and sharing strategy, estimate the sample size and sampling frequency needed to meet the specified levels of accuracy and precision corresponding to each data variable. Another column should be added to the table to record this information. This may require pilot sampling programmes to find out the sample variance and if there is any sampling bias.

If stakeholders are unable to sample the population at the required intensity (sample size and frequency) to meet the common needs of the stakeholders then alternative sources and data collection methods may need to be selected. Sampling strata (Section 4.4.1) may be used to improve the precision of estimates, and may also be required for reporting or administrative purposes. Appropriate sampling strata to might be identified on the basis of the frame survey results. A further column may be added to the table to record any strata selected or required.

If proposing to use data that other institutions are already collecting, it will be necessary to negotiate the use of their data with them and agree how the stakeholders involved will access it. This will be particularly important if the data will be needed either more frequently or in a different format from that usually made available to the public.

Stakeholders will need to agree on the form in which the data or information will be shared. How will the collected data be compiled or analysed, and who will do what? This will depend on the level of detail required by each stakeholder and the capacity of each stakeholder to analyse and compile the data. Stakeholders should refer to the data specification for details of what is required by each group.

If necessary, in order to come to agreement on the data collection and sharing strategy, re-negotiate indicators, identify alternative data variables and adjust sample sizes until all stakeholder needs are met. Improvements to precision and accuracy may be achieved by selecting alternative data variables, and sources and methods. Where stakeholder needs in terms of accuracy and frequency do not coincide, each group will have to carry out their own data collection to satisfy their requirements.

A minimum 'need-to-know' approach may help make sure that the most important information is collected with enough accuracy and at the lowest possible cost. Once it is set up, the system can be expanded to include more detail on species, value, products and other factors (MRC, 2004).

If a mutually agreeable strategy cannot be identified, it may be necessary to create further incentives or re-negotiate the respective roles and responsibilities of each stakeholder. When considering alternative strategies, always bear in mind operational constraints such as the cost of salaries, training, capital costs (e.g. transport, computers, office equipment) establishing and maintaining information sharing networks (see Section 5.2.6) and any recurrent costs. Further advice on preparing budgets can be found in FAO (1999 p70); Sparre (2000, p159) and IFAD (2002 p7-36) that lists more that 40 potential cost items. Particularly for catch data, the selection of tools and sources may be guided by the use of fish disposition pathway diagrams that draw upon information gathered during the frame survey or PRA activities (see Section 4.6.2).

5.2.5.3 Uncommon (unique) data needs

Once stakeholders have agreed how to collect and share their common data needs, they should consider who might collect the remaining data needs. It may be that the

TABLE 12

Example of a tabular format to help identify common needs among key stakeholders and possible data collection and sharing strategies

Arrows indicate how variables might be shared to meet the requirements of other stakeholders. S- Sampling; CE- Complete enumeration.

Stake-holder	Indicator	Indicator Frequency	Prec-ision	Data types	Acceptable data variables	Population	Cover-age	Data sources	Methods/ Tools	Sample size	Strata
LMI and local resource users	Catch per unit effort by species	Monthly	10%	Catch (by species)	- Weight - Number - Number of baskets	Fishers belonging to management unit	S	- Harvest - Post harvest	- Questionnaire - Interview - Direct Obs (DoF) - Direct Obs (LMI) -Reporting (LMI)	500/ month	Gear type
				Effort	- Hours fishing - No. of traps set			- Harvest			
					-Nos. active full/part time fishers	Villages belonging to management unit	CE	- Harvest	- Questionnaire - Interview - Direct Obs (DoF) - Direct Obs (LMI) -Reporting (LMI)	1/ month	
	Income (profit)	Monthly	10%	Costs & Earnings	- Fixed & variable costs & earnings	HH belonging to management unit	S	- Harvest - Post harvest	- Questionnaire - Interview	100/ month	Demographic sub-groups
PFMI	Poverty	Annually	10%	Costs & Earnings	- Fixed & variable costs & earnings	HH in Province	S	- Harvest - Post harvest	- Questionnaire - Interview	1000/ month	District Demographic sub-groups
				Living costs	- Basic daily living costs			- Harvest - Markets -Gov.Depts	- Questionnaire - Interview	1000/ year	District
	Employ-ment	Annually	20%	Employment in fisheries sector	- No. active fishers by category e.g. full / part time	Fishers in Province	CE	- Harvest - Post harvest -Gov.Depts	- Questionnaire - Interview - Direct Obs (LMI)	NA	Management sector (co- and non-co-managed)
DoF	Gross Value of Production	Annually	20%	Production (Catch)	- Landed weight of species	Fisheries Sector	S	- Harvest -Gov.Depts	- Questionnaire - Interview - Direct Obs (DoF) - Direct Obs (LMI)		
				Price	- Unit price of species		S	- Harvest - Post harvest -Gov.Depts			

government and LMI are happy to collect their own remaining data needs and can select appropriate sources and tools accordingly using the approaches described above. Alternatively, incentives may be offered to stakeholders, particularly the LMI or resource users, in exchange for the task of collecting data. Examples of incentives that governments are likely to be able to offer LMIs in return for collecting and sharing data and guidance on encouraging participation and data sharing are described below.

5.2.5.4 An example

In the simple example illustrated in Table 12 below, an LMI has identified an interest in monitoring both CPUE and profit and has identified, with the help of other stakeholders, corresponding levels of precision for each indicator expressed in terms of minimum detectable difference (MDD) (see Box 20). It has also identified data variables that would be acceptable or collectable given its capacity and requirements, possible data collection sources and methods and corresponding sample sizes to meet its data specifications. The Provisional Fisheries Management Institution (PFMI) and the DoF identify poverty, employment and GVP as important indicators for policy and development planning and evaluation purposes. They also specify their own required levels of precision for these indicators, shortlist possible data variables, identified possible data sources and methods and estimated required sample sizes.

During a process of consultation and negotiation, the LMI agree to monitor catch weights and numbers of active fishermen in each month by direct observation and agree to share these data with both the PFMI and the DoF who can use these data variables to help determine levels of employment and calculate GVP. Sample sizes that can be collected by LMI were found to be adequate the meet the needs of both stakeholders. If this was found not to be the case, then it may have been necessary to negotiate larger sample sizes with the LMI or encourage the LMI to collect more precise measures of effort such as total fishing hours. In return, the PFMI agrees to share income data with the LMI that they plan to collect by means of interview methods on a monthly basis from households including those belonging to members of the LMI. The DoF offer incentives of the type described in Section 5.2.5.5. The outstanding data needs to construct the poverty and GVP indicators required by the PFMI and the DoF (i.e. living costs and price data respectively) have been identified as being available from other government agencies (Section 5.2.4).

5.2.5.5 Stakeholder capacity and incentives to collect and share

Local managers have an incentive to collect data to evaluate the performance of *their own* management plans allowing them to see for themselves the benefits or impacts of their management activities. Having been involved in data collection activities, fishers and other local stakeholders are more likely to believe the results of any evaluation. Indeed, the research activities described in *Preparation of this document* in Part 1revealed that local managers have an interest in monitoring their management plans in a more objective and systematic manner. Local managers should not, however, be expected to *collect* data, such as that required for policy and development planning purposes (Category 1 information), simply to relieve the workload of the fisheries department. Likewise, it would be unrealistic to expect the administrative levels of government to collect data on behalf of local managers solely for the purposes of local management plan evaluation.

In addition to providing any necessary training and capacity building programmes, a number of further *incentives* exist that could be offered or made explicit to the LMI by the administrative levels of government, in exchange for agreeing to participate in local monitoring programmes, maximizing data overlap and sharing data and information. These incentives may be financial but providing local managers with

support to formulate, implement and evaluate their other local management plans may be more attractive, sustainable, as well as *mutually beneficial*:

- **Helping local managers formulate their management plans**. This might include:
  - o undertaking baseline studies, frame surveys and livelihood appraisals to help local managers identify appropriate management strategies or pursue alternative livelihoods (e.g. tourism), and design effective data collection strategies.
  - o Provision of technical advice or information including for example, best practice for stocking programmes, management strategies, fish diseases, fisheries law (including citizen's rights), credit policies and alternative markets for fish or sources of raw materials.

As well as encouraging local participation in monitoring programmes, involvement in local management planning also provides opportunities for government departments to ensure that *local* management *objectives are consistent with policy goals or objectives*, and that the content of the plan is compliant or *consistent with national legislation* (Section 2.3.1).

- **Helping local managers implement their management plans.** This might include:
  - o Helping local mangers enforce local rules and regulations.
  - o Providing conflict resolution mechanisms.
  - o Coordinating local management plans to minimize conflicts and promote integrated approaches to management (Section 3.3.9).
- **Helping local managers evaluate and refine their management plans.** This might include:
  - o Facilitating communication and learning among LMIs in support of adaptive approaches to management plan performance evaluation (see Section 3.5.4).
  - o Training and capacity building to help local managers evaluate for themselves the impact or performance of their management activities.

As well as encouraging local participation in monitoring programmes, these activities may also help government evaluate their co-management policy (see Sections 3.2.2.11 and 3.5.8).

- **Communicating the importance of local monitoring in shaping policy.**
  - o Emphasizing that policy and development planning decisions will ultimately shape their livelihoods may provide local managers with a strong incentive to participate in local monitoring programmes, thereby ensuring that policy decisions take full account of the value of their fisheries resources. Communicating these benefits will be key during the management planning phase (Section 5.2.2). Local management institutions in Tanga participate in local monitoring programmes largely for the purposes of lobbying local government and policy makers (Purvis, 2004).
- **Feedback** The strongest incentive to participate from the perspective of local stakeholders may be the ability to see that their action, input or voices have impacted on policy and higher level institutions. This reinforces the importance of regularly *feedback* of the impacts of monitoring programmes (Box 21).
- **Other incentives**. Participation in local monitoring programmes could be made a condition of access to the fishery or licence agreements as part of the local management plan. Alternatively, payments for access or licences may be used to fund monitoring programmes either undertaken by appropriate administrative levels of government or the LMI. Catch records may even be used as collateral for credit!

5.2.5.6 Disincentives to participation

As well as promoting the incentives described above, government should also recognize and attempt to minimize any disincentives faced by local fishers and other stakeholders

BOX 21
The importance of feedback

Where data collection is carried out locally but the data are analysed elsewhere, it is important to give regular feedback about the results of the monitoring. Data collectors need to see the results of their hard work to understand how the data they collect contributes to the larger scheme of things. Providing regular feedback helps maintain motivation and ensure the data continue to be collected well.

BOX 22
Lessons from Cambodia

"[In Cambodia] the CFDO uses a great deal of participatory methods, including PRAs and focus group discussions. However … villagers sometimes find it difficult to spend time participating in these processes if they are not compensated, which can be done through the payment of transportation costs and the provision of snacks" (Felsing, 2004a).

BOX 23
Benefits must exceed costs

To be effective and sustainable, participatory monitoring programmes must ensure that the incentives or perceived benefits of participation *exceed* the cost of participation.

to participate in local monitoring programmes. Typically, these disincentives will centre on the *opportunity costs* associated with their participation, often, though not exclusively in the form of lost earnings. For example, earnings may be lost by fishers because part of their day must now be spent monitoring and recording leaving less time for fishing and related activities such as maintaining their gear. Earnings may also be lost if the value of their catch is diminished as a result of participation. Delaying the transportation to markets or sale to fish traders may result in the deterioration of their catch and subsequent loss of value, or the attainment of less favourable prices. These types of opportunity costs are often overlooked by designers of participatory monitoring programmes.

For example, on Lake George in Uganda, the opportunity costs of participation compared to the perceived benefits may be threatening the sustainability of the Catch Assessment Survey (CAS) (Lamberts, 2004). With poor preservation facilities, fisherman experience a decline in the value of their catch as they queue at "weighing check-points" to have their catches sampled. In addition, the time forgone waiting could have been used for other income generating activities. Opportunity costs should also be considered when co-designing data and information sharing systems and other co-management activities.

5.2.5.7 Other conditions that affect participation

In addition to perceived benefits and costs, a number of other factors described by Garaway and Arthur (2002) and Guijt *et al.* (1998) are likely to affect stakeholder participation in monitoring and evaluation which should be borne in mind when designing systems:

- Relevance of the PME to the priorities of participating stakeholders. Local participation will only be sustainable if it contributes to local understanding and empowerment.
- Timeliness and relevance of feedback of findings.
- Flexibility of the PME process to deal with diverse and changing information needs.
- Meeting expectations that arise from PME, for example acting on recommendations that are made.
- Degree of trust between stakeholders.

5.2.5.8 Check the agreed data collection and sharing strategy

A checklist of the type below may help to confirm or otherwise that you have the right strategy.

- *Feasibility*. Do you have the capacity, motivation, skills and equipment? Can you cover the geographic area adequately? Can sufficient technical support and training be provided?
- *Appropriateness*. Do stakeholders agree that the strategy is appropriate and do they understand it? Can it be supported by existing institutions?
- *Validity*. Do stakeholders who are to use the information believe that the methods are valid and generate sufficiently accurate information?
- *Relevance*. Does the strategy generate the required information? Are all the data relevant/required? Is there a pilot phase to test and refine the system (see below).
- *Sensitivity*. Are minimum detectable differences in indicator or variable estimates adequate for management purposes? Can it be adapted to changing conditions without excessive loss of reliability?
- *Cost-effectiveness*. Do sufficient resources exist to support the strategy? Will it produce the required information at relatively low cost or do cheaper alternatives exist that would be adequate?
- *Timeliness*. Does the strategy generate data in time for its intended purpose or use?
- *Sustainability*. Will it be sustainable without continuous project support? Is the system documented (see below) so that everyone knows what it generates and what information is disseminated?

5.2.6 Stage 6 – Identify or develop data and information sharing system

Once stakeholders have identified their common and unique data needs to evaluate the performance of their policies and local management plans and agreed who will collect these data, how, from where, and share with whom, they will now need to design communication systems pathways or networks for sharing these common data needs. However, depending upon the agreed roles and responsibilities of the stakeholders, these information sharing pathways or networks might also be required to:

- share information contained within local management plans (Category 2 information) with relevant administrative levels of government to help them coordinate local management plans and resolve conflicts with local managers (see Section 3.3.10 and 5.2.3.5);
- share Category 3 information with relevant administrative levels of government if they are expected to take full or partial responsibility for enforcing local rules and regulations described in the management plan (see Sections 3.4.1 and 5.2.3.5);
- share Category 4 information with relevant administrative levels of government, intermediaries and research institutions if they are expected to help local managers evaluate the performance of their management plans (see Sections 2.3.1 and 3.5.4);

BOX 24
Lessons from the Lao People's Democratic Republic

In the Lao People's Democratic Republic, it was found that providing access to information regarding others' experiences was a key role of information networks. Likewise, providing district level staff with the opportunity to discuss ideas and experience with each other and with state level staff and external researchers provided more opportunities for learning and information sharing at that level (MRAG, 2004).

- facilitate communication and learning among LMIs (or management units) to help local managers evaluate and refine their management strategies and institutional arrangements described in their management plans (see Box 24 and Section 3.5.4);
- feedback the following information to relevant administrative levels of government and LMIs:
  - o details of policy and development plans and the results of policy and development plan performance evaluations;
  - o information about the actions needed to coordinate and enforce local management plans;
  - o technical and socio-economic advice about effective management strategies, interventions and institutional arrangements generated by research including comparisons of management performance indicators and explanatory variables among LMIs or management units (Section 3.5.4).

Remember, many of these information sharing and feedback requirements of the system may be incentives offered in return for participation in data collection (and other co-management) activities (see Section 5.2.5.5). An effective data sharing system may therefore be key to sustaining the data collection system.

Advice on designing information sharing systems in the context of fisheries management is sparse. This probably reflects the fact that there are no blueprint solutions or generically applicable networks. The design of the information sharing system will be dependent upon the institutional arrangements and administrative structures defining the co-management arrangements, and the roles, responsibilities and capacity of each key stakeholder. Garaway and Arthur (2004) suggest that stakeholders should start be examining existing communication networks; their opportunities and constraints. A diagram illustrating potential information flows is shown in Figure 17.

5.2.6.1 Communications mapping

One way of identifying possible information sharing networks is to draw a communications map showing existing and required information flows among stakeholder. Start by writing each stakeholder group on a piece of paper or card and positioning them on a larger sheet of paper. Then draw arrows that link different stakeholders to represent current and required information flows (see Figure 18).

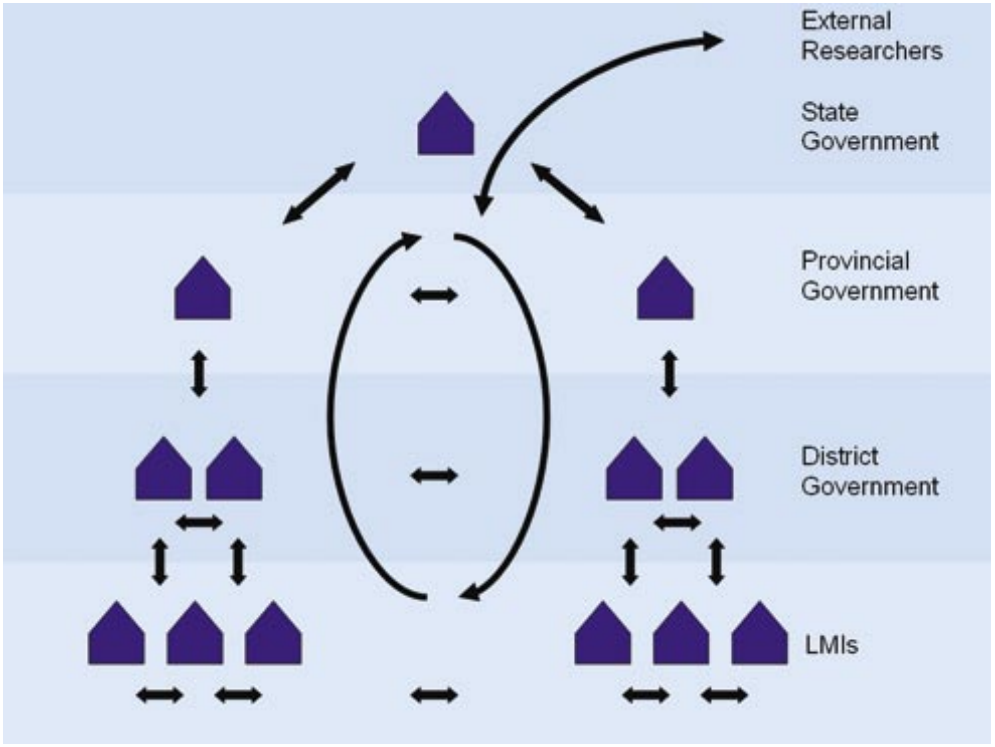
These diagrams can be drawn by stakeholders and used as the basis for discussions to identify their opportunities and constraints, and develop networks for the data collection and sharing system. Trust among stakeholders is the most important thing to be able to develop effective systems (Box 25).

5.2.6.2 Develop information sharing systems

To design and agree on a data and information sharing system, stakeholders will need to discuss and agree on the following points:

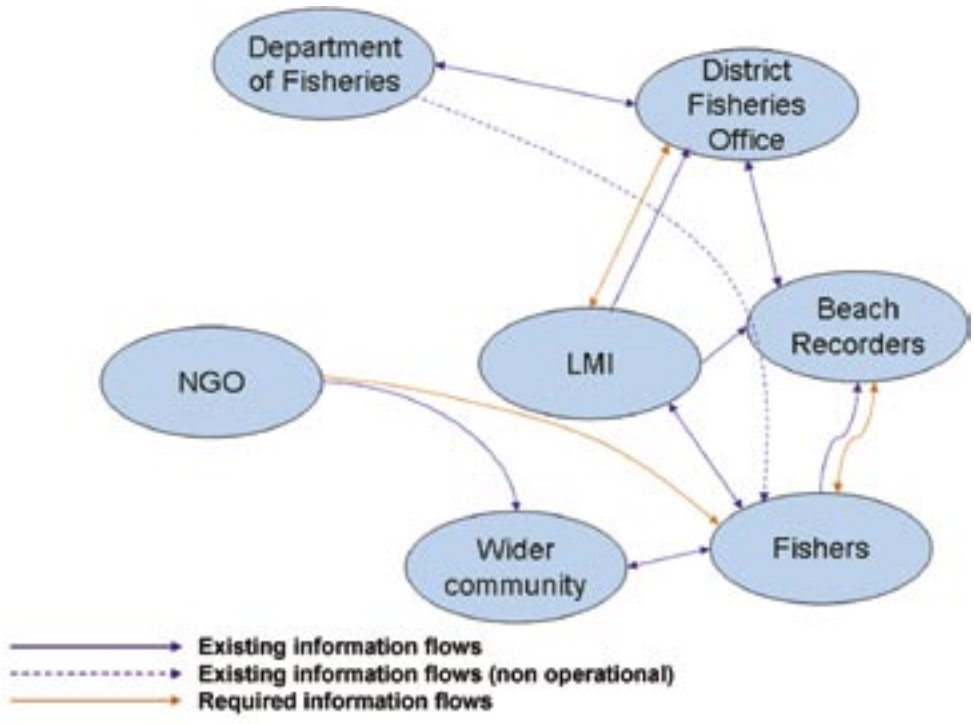
- who will share what data and information (and in what format) with whom;

FIGURE 17
Illustration of the potential information flows that might be created



Modified from Garaway and Arthur (2004)

FIGURE 18
Example of a communications map



BOX 25
Lessons from Cambodia

"[In Cambodia] District Fisheries Officers sometimes are not trusted in rural communities because of the policing role and 'rent-seeking' behaviour undertaken by some officers. The value of trust in information sharing is underscored by the reported importance of word-of-mouth information in rural communities, and [it is] recommended that information be brought to communities by trusted, regular and recognisable sources, and be delivered in an interactive manner. [The] use of mass media such as TV, which is becoming increasingly common in rural areas [also has potential]. The provision of information to communities through regular and lengthy field visits is expensive, and a better way to reach communities may be through the establishing of a network for sharing information where communities and other stakeholders interact directly with each other through a series of scheduled meetings" (Felsing, 2004a).

- how it will be shared, distributed or delivered to the relevant people and organizations (e.g. on what media – printed matter, on CD, by radio, by post, delivered by bicycle, called through on mobile phone etc.);
- how frequently it will be shared, e.g. daily, weekly, monthly, annually. For example, if you are holding meetings, choose a time and frequency when people will be able to come.

It is important that these systems are realistic and sustainable. For example, if information is to be passed on through a phone call, there must be resources available to pay for the cost of the calls; if the postal system is unreliable, other methods will have to be found to deliver data on printed material, diskette or CD.

Some examples of existing data and information sharing networks are described in Annex 2.

5.2.6.3 Media for information distribution

A variety of media and methods might be used to deliver, disseminate and facilitate information sharing each having associated advantages and disadvantages. Literature, for example, can reach the largest number of people, but does not provide the opportunity for feedback. Radio provides for speedy communication to a wide audience and often encourages feedback, but is not appropriate for communicating detailed or complex information (Muthiah, 1991). Face to face contact can lead to greater understanding and more frank discussion and feedback. A matrix based approach involving discussions with the key stakeholders may provide a useful means of agreeing which approach might be most appropriate (see for example Table 13 below). Further practical guidelines are given in Maine *et al.* (1996).

The utility of existing information sharing networks might also be explored. The STREAM initiative, for example, facilitates information and knowledge sharing on a regional scale concerning a wide range of issues related to aquatic resource management and poverty alleviation. Stakeholders in ten Asia Pacific countries currently share information about technologies, practices, ways of working, research, development, legislation and policy via the STREAM journal and Web site (http://www.streaminitiative.org/). OneFish (http://www.onefish.org/), an Internet portal ,also provides an enabling environment for sharing research-based knowledge among diverse stakeholder groups.

BOX 26
Participatory monitoring in Guinea – disseminating lessons using video

A SFLP community project has assisted small-scale fishermen in Koukoudé, Bongolon and Matakang (Guinea) in the participatory monitoring, control and surveillance (MCS) of industrial trawlers. These vessels break zoning regulations and the participatory surveillance carried out by the communities in collaboration with the Centre for National fisheries Surveillance (CNSP) has had a positive impact on reducing incursions and improving the livelihoods of the fisheries communities in the zone. The SFLP assisted in the production of a video documentary to describe these experiences. The video will subsequently be translated into English and Portuguese in order to spread the lessons learnt to other SFLP countries where similar problems exist. The script has been drafted with input from all stakeholders and the video documentary was shown at the national forum on participatory MCS held in Conakry in April 2003.

BOX 27
The importance of coordination

"[In the United Republic of Tanzania] the creation of a Central Co-ordinating Committee (CCC) for each of the Management Areas under the Program is seen as a critical mechanism for information sharing and exchange. The CCC brings together representatives from the different villages (and in some cases districts) and provides a valuable point for intervention or inputting new information into the local systems. The CCC is not just a "talking shop" but has a number of heavy responsibilities especially in terms of the consolidation of the management plans from the various villages" (Purvis, 2004).

5.2.6.4 Practical considerations when disseminating information

The following recommendations have been identified from IFAD (2002) and from the studies described in *Preparation of this document* in Part 1:

- Ensure messages are clear, understandable and relevant to the target stakeholder. The interests and concerns of different stakeholders vary and will require appropriate media, language and content. The format should be simple and easy to understand. The format required locally may differ from that of the government.
- Agree on the frequency for communication information. For example, if meetings are employed, choose a time and frequency when people will be able to come.
- Ensure timeliness. Ensure information is presented in time for its intended purpose.
- Make effective use of graphic information to facilitate analysis (Maine *et al.*, 1996). Visually presented information is often easier to understand. Photography or videos may be effective (Box 26) but can be more costly. When disseminating the outcome of evaluations (see above), it may be useful to provide target stakeholders with prepared data sets which they can analyse themselves and present findings to each other, instead of simply presenting results. Remember, involving the collectors directly in the analysis of data, and presenting information back to collectors as soon as possible as helps to create a sense of ownership in the data, builds capacity and gives people a stake in the process (Garaway and Arthur, 2002).
- Standardization is only required when information has to be compared over time or between cases.
- Costs should be low, and never exceed the benefit gained from utilizing this information.

TABLE 13
An example of a matrix approach to help identify appropriate communication media and methods with stakeholders (modified from MRAG, 2004)

Communication media or method	Communication activity				
	Delivery of data and information from LMI to other stakeholders.	Dissemination of development plans and results of policy evaluations	Dissemination of information for coordinating and enforcing management plans	Dissemination of technical and socio-economic advice/findings	Sharing information, lessons and experiences among LMIs and other stakeholders
One-to-one meetings			Y		Y
Group/ village meetings	Y	Y	Y	Y	Y
Workshops/conferences	Y	Y	Y	Y	Y
Web site		Y	Y	Y	
Electronic files / database			Y		
Video conference					
Data recording forms	Y				
Management Plan Document	Y		Y	Y	
E-mail / Fax			Y	Y	
Telephone			Y		
Radio Broadcasts		Y		Y	
Posters		Y	Y	Y	
Conference proceedings		Y	Y	Y	
Mail	Y			Y	
Journal article				Y	
Newspaper article / Newsletter		Y		Y	Y
Technical report			Y	Y	

TABLE 14
Example of a monitoring and evaluation matrix

Information needs and indicators	Baseline information existing information and required action	Data gathering: data collection sources and methods, frequency and responsibilities	Planning and resources: required forms, planning, training, data management, expertise, resources and responsibilities	Information use: analysis, reporting, feedback and responsibilities
Indicator 1				
Indicator 2				

Source: IFAD, 2002.

5.2.6.5 Record the plan

The operational details of the data collection and sharing strategy should be summarized and supported by a workplan or schedule for data collection, possibly in a similar format to the Monitoring and Evaluation Matrix below (Table 14), with maps or diagrams showing the position of data collection locations. Providing a list of data collectors and a roster may also be needed. Annex C of IFAD (2002) provides a worked example in the context of project monitoring and evaluation.

5.2.7 Stage 7 – Design data recording and management systems

5.2.7.1 Data recording systems

Data can be recorded in many ways, depending in large part on the data collection method (Section 4.2). Some methods, particularly the interview and direct observation methods may require filling in of logbooks, ledgers, forms or tables, whilst others might

TABLE 15
Examples of basic fields of information typically included in data collection forms

Basic information fields	Examples	Units
Form number	Form number Serial number	Alpha-numeric or number
Enumerator ID	Name of recorder/observer Team number Recorder team ID Observers ID	Text Number Alpha-numeric Alpha-numeric
Major stratum	Region Strata I-XII Stratum ID	Text Roman numerals Alpha-numeric
Minor stratum	Area Stratum Province Island name Location/locality Island ID	Alpha-numeric or text
Minor stratum descriptors	Latitude Length of shoreline % of shoreline District	Degs. Mins. Secs km % Text
Survey date/Period/Time Date	Month Time Date	Text Time
PSU ID	Landing site Fishing camp Village name/code Code of fishing site Fishing site ID/serial number Name of fishing Site Beach name	Alpha-numeric or text
PSU descriptors	Geographical location Left bank, right bank Distance from 'X' Fishery habitat Type of fishing site Environment Accessibility Description of boundaries Permanent landing /fishing site	Text Text km Text Text Text Text Text (Y/N)

utilize a video camera or taking detailed notes. For each data variable selected above, it will be necessary to agree upon how it will be recorded. Consistent methodology will help to ensure that data are comparable. For routinely collected data, recording forms should include basic information that facilitates data checking and ensures that data can be referenced, sorted, collated and manipulated (Table 15).

While it is impossible to develop generic data collection forms, Halls *et al.* (2000) (see report Ref R7042 at http://www.fmsp.org.uk/r7042.htm) identified fields of information that are typically included in recording forms that are employed for frame surveys, catch assessment surveys (CAS), biological and socio-economic monitoring programmes, and for vessel monitoring and licensing purposes. While these fields are not exhaustive or definitive, workers have reported that they provide a useful starting point for designing data collection forms (Jim Anderson *pers. comms.*). Users of data recording systems should ideally be involved in their design to ensure that they are both understandable and appropriate. Further guidance on the design of data collection forms including numerous examples can be found in Sparre (2000); FAO (1999); Caddy and Bazigos (1985) and Bazigos (1983).

5.2.7.2 Data management system

When considering how to store data and information IFAD (2002) recommend that stakeholders bear in mind:

- *The data and information to be stored*. In principle, everything that co-managers decide to monitor and evaluate will need to be stored in some way either as

BOX 28
End-user requirements and capacity

"[In Cambodia] the community fisheries pilot database was originally developed using Microsoft Access, but was later changed to Microsoft Excel to ease operation by CFDO staff. The potential for executing queries and generating reports using Microsoft Excel is limited, but naturally the database is of no use if it cannot be operated at the local level. This stresses the need for the development of information management systems with the end-users" (Felsing, 2004a).

reference, for tracking change through time or for making comparisons among different locations or sites. Only store data and information if it will be used. Some raw material generated by PRAs may not need to be stored if the information generated from it has been processed and stored elsewhere. Diagrams for example, may not need to be copied, distributed and stored at all levels. Originals can be left with the stakeholders who produced them.

- *The needs of different stakeholders*. How the data is stored will depend largely upon who needs to have access to it and how frequently. Consider their capacity and the types of communication methods which they are comfortable with (see Section 5.2.6).
- *The format for storage* – hard copies or electronic data. Generally speaking, electronic files allows access to the data by more people. However, not all data or information gathered at the local level can be readily formatted electronically. Furthermore, local level stakeholders might not have the capacity to access computers or electronic networks. Information presented diagrammatically or generated through discussion may be distilled into short reports for storage and dissemination.
- *The need to regularly review the content of the system*. The content of the data storage system should be reviewed regularly to avoid it becoming congested and unwieldy. Computerized data should be regularly archived yet remain accessible. Documents may need to be stored for legal reasons or for accounting purposes. Copies or material required for making comparisons through space or time must also be retained including baseline data, copies of management plans, and summaries of progress, etc.

5.2.7.3 Electronic databases

Electronic databases provide a means of storing raw data in a secure and standard format and help facilitate its rapid processing (filtering, aggregating, transforming) for decision-making. Databases also help to ensure data validity, integrity and consistency, and may allow different datasets to be integrated thereby increasing their overall utility. FAO (1999) offer guidelines on database design including advice on software development, interfaces, documentation, as well as data processing, reporting, access and dissemination. A more thorough treatment of the design of database tables, forms and queries can be found in Sparre (2000) which includes a detailed description of an example database.

FAO have also produced software called ARTFISH (Approaches, Rules and Techniques for Fisheries Statistical Monitoring) to help design shore-based surveys for generating fishery production and value information, and supporting database (Box 29). The software can be downloaded at http://www.fao.org/fi/artfish.htm which also contains links to other relevant documents.

BOX 29
The ARTFISH software

The ARTFISH software is a family of standardized statistical approaches and computer software aimed at facilitating the design and implementation of shore-based fishery surveys on fish production and values. The software comprises three components:

ARTPLAN is intended for planning frame surveys and evaluating alternative sampling scenarios for cost-effectiveness, including required sample sizes, drawing upon existing knowledge regarding fishing operations and patterns.

ARTBASIC is the central module used for the storage and processing data concerning catch, effort and prices. It operates on standard classifications, frame survey data and samples on catches, fishing effort, prices and values and generates output stratified by month and boat or gear type.

ARTSER generates formatted reports and allows for flexible and user-friendly data screening and extraction, data grouping, reporting and plotting.

All ARTFISH procedures contain built-in operational guidelines. The installation kit also includes a quick-start user manual. About 12-15 days training is typically required for learning the functions of these ARTFISH components.

ARTFISH does not require additional programming, changing of software or any specific computer expertise thereby minimising development and training costs. It has been designed to adapt to any situation and its use can thus be as sophisticated as the country needs dictate. Users need only construct the required survey structures and feed the system with parameters and sample data. Since 1994, the software has been implemented in 15 countries in Africa, Asia, Latin America and the Caribbean.

For further information see http://www.fao.org/fi/artfish.htm

5.2.8 Stage 8 – Implement, evaluate and refine

The final stage in the design process is the implementation and revision or refinement of the system during which consideration should be given to the following:

- *Training and capacity building.* It is likely that considerable attention and resources will need to be directed towards training and capacity building for staff and other stakeholders to ensure successful implementation. For example, if local stakeholders are to be involved in selecting or negotiating indicators, then training on their meaning, selection and use may be required. Similarly, training on species identification may also be required. Training and capacity building needs should be assessed against each indicator and corresponding set of sources and methods (effectively each row in Table 12). The gaps identified should form the basis of a training plan. Guidance on the scope and delivery of appropriate training programmes including advice on "training of trainers" are available in FAO (1999) and Sparre (2000). As well as providing training, it will also be necessary to ensure that everyone involved in the system has sufficient financial resources and equipment to support their activities.
- *Incentives.* In addition to the incentives used to encourage participation by local stakeholders described in Section 5.2.5.5, attention should also be given to ensuring that all staff involved in the data collection and sharing system are motivated to participate effectively. Incentives to encourage participation and motivation include:
  - o Ensuring that all stakeholders understand their respective roles and responsibilities, supported where appropriate, by memoranda of understanding or contracts.

- o Regularly demonstrating the function and value of the data generated including the results of evaluations, and explanations as to how the data are analysed and for what purpose (feedback). Local stakeholders are often reluctant to disclose information concerning their fishing activities and earnings because of fear that statistics will be used for taxation purposes.
- o Financial and other rewards such as housing and vehicle use.
- o Activity support: provision of adequate finances and logistics to conduct data collection and sharing activities such as transport, accommodation, species identification manuals, raincoats, weighing scales, maps and rosters.
- o Recognition: listening to staff and participants and acting upon their recommendations, possibly on the basis of staff appraisals.

- *Technical Committees and Legal Frameworks.* Prior to implementation, FAO (1999) also recommend that technical committees be established to guide the development and refinement of the system. Furthermore, if the provision of data is to be made a condition of access or licensing agreements (see Section 5.2.5.5) then legal or policy instruments need to be in place before the data collection system can be implemented.
- *Data Verification.* Fisheries data are prone to error and therefore data verification is necessary to ensure that data generated by the system are both accurate and complete. FAO (1999) describe methods for verification according to data type and the scale over which estimates are made. "Triangulation" where at least three sources or techniques must be consulted or used to investigate the same topics is a common approach employed to verify the accuracy of data or information generated by RRAs and PRAs methods (Pido *et al.,* 1996). IFAD (2002, Section 6.3) provide useful guidance on how to improve the reliability of data and information including tips to avoid non-sampling errors and methods to verify data.
- *Feedback.* The data sharing component of the system should have already addressed the feedback requirements of the different stakeholders (Section 5.2.6). However, feedback should also be encouraged to help identify inadequacies or weaknesses in the data collection and sharing system which can then be addressed immediately and monitored. The MRC (2004) suggest that the results of information gathering programmes should always be fed back to those involved in the data collection activities providing opportunities to discuss and revise any shortcomings, inaccuracies and inconsistencies of information and data, which otherwise would become untrustworthy.
  - *Pilot data collection programmes.* Where possible the data collection and sharing strategy should be pre-tested on a pilot scale. Sparre (2000) describes a 42-step process for piloting a data collection programme which includes consultation, training, resource need identification, design, data verification and feedback activities.
  - *System Appraisal.* The system should be reviewed continuously in a participatory manner to ensure that it meets the needs of all the stakeholders involved in the co-management process. Reviews should include a continuous process of data verification (see above). Sparre (2000) describes a detailed iterative process to system design appraisal and refinement that FAO (1999) suggest should "…give a higher probability of system adequacy and stability".
  - *System Documentation.* Documenting the system is important to keep existing and future stakeholders informed of the activities and status of the data collection and sharing system, to justify further investment in the system, and help to make comparisons with other systems. Sparre (2000) lists 13 documents that might be relevant including guidance on their format and publication. Reyntjens-Mesquita and Pittaluga (2004) recommend that documentation

should at least include the following headings: Objectives; Indicators; Sources of information; Baseline data needed; Who is involved?; Tools and methods; How often need [Data collection frequency]; How often will the data be used, analysed, and by whom; Who receives the information.

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Glossary

Throughout the manual we have used, wherever possible, FAO's glossary of terms available at http://www.fao.org/fi/glossary/

Abundance	Degree of plentifulness. The total number of fish in a population or on a fishing ground. Can be measured in absolute or relative terms.
Access right	In fisheries, an authorization (access right) , given to a user (e.g. a vessel owner) by a competent fishery management authority or by legislation, to exploit a resource, a particular species, or a share of a total allowable catch. Access rights can be granted against payment or free of charge. They are usually conditional and used under constraints specified in the management plan.
Accuracy	Of an estimate: an indicator of the closeness of an estimated value (e.g. population parameter) to the actual value. It should not be confused with precision which relates to the confidence limits (variability) of the estimate and can always be computed from the samples.
Adaptive management	A management process involving step-wise evolution of a flexible management system in response to feedback information actively collected to check or test its performance (in biological, social and economic terms). It may involve deliberate intervention to test the fishery system's response.
Assemblage	In a particular site and time, a collection of co-existing organisms, not strictly inter-dependent but with unspecified relationships (e.g. trophic) between them.
Assessment	A judgement made by a scientist or scientific body on the state of a resource, such as a fish stock (e.g., size of the stock, potential yield, whether it is over- or underexploited), usually for the purpose of passing advice to a management (qv) authority.
Baseline	A set of reference data sets or analyses used for comparative purposes; it can be based on a reference year or a reference set of (standard) conditions.
Bayesian	A formal statistical approach in which expert knowledge or beliefs are analyzed together with data. Bayesian methods make explicit use of probability for quantifying uncertainty. Bayesian methods are particularly useful for making decision analyses.
Bias	A systematic difference between the expected value of a statistical estimate, and the quantity it estimates.
Capacity building	A process of strengthening or developing human resources, institutions, or organizations.
Catch	The total number (or weight) of fish caught by fishing operations. Catch should include all fish killed by the act of fishing, not just those landed.
Catchability	The extent to which a stock is susceptible to fishing.
Co-management	A process of management in which government shares power with resource users, with each given specific rights and responsibilities relating to information and decision-making.
Community	An organized body of individuals in a specific location.

Coordination	The process of bringing together concerned government agencies, research institutions, municipalities, NGOs and resource users to agree on objectives, formulate strategies and subsequently implement them.
Data	Facts that result from measurements or observations.
Database	A logically structured and consistent set of data that can be used for analysis. Commonly used to indicate such data set and the computer software in which it has been organized and stored.
Data set	A collection of data and accompanying documentation which relate to a specific theme.
Decision-maker	An executive person or group responsible for land-use policy, action and allocation of resources.
Dynamic pool model	The term is used to describe analytical yield-per-recruit types of fisheries models describing how growth, recruitment and mortality interact, resulting in biomass and yields.
Equity	In a broad sense, the just distribution of resources, rights, duties, opportunities, and obligations in society at large, i.e. social justice. In an applied sense at micro level, as for example in the sharing of fisheries resources, an allocation rule based on the concepts of parity, proportionality and priority.
Fishery management	The integrated process of information gathering, analysis, planning, decision-making, allocation of resources and formulation and enforcement of fishery regulations by which the fishery management authority controls the present and future behaviour of interested parties in the fisheries, in order to ensure the continued productivity of the living resources.
Fishery management plan	An explicit arrangement (contract) between the interested parties as defined above, and the fisheries management authority which makes explicit the objectives and means of management, the nature of the management authority, its powers and responsibilities, its working and consultation procedures, as well as the rights and responsibilities of the interested parties in the fishery.
Fishery management unit	A fishery or a portion of a fishery identified in a Fishery Management Plan (FMP) relevant to the FMP's management objectives. The choice of an FMU depends on the focus of the FMP's objectives, and may be organized around biological, geographic, economic, technical, social, or ecological perspectives.
Fishery policy	Measures by which a national and/or a provincial government attempts to influence or control the behaviour of individuals, companies and communities in the fisheries sector to achieve certain objectives. The measures can be of varied kinds including fiscal measures, (e.g. taxes, subsidies, public investments, etc.; trade measures (e.g. import and export duties; quotas); social measures (health and education services); regulations (i.e. on food quality; means and types of fish harvesting; ITQs;) and others.
Frame survey	A complete description of the structure of any system to be sampled for collection of statistics. In fisheries, it may include the inventory of ports, landing places, number and type of fishing units (boats and gears), and a description of fishing and landing activity patterns, fish distribution routes, processing and marketing patterns, supply centres for goods and services, etc.

Gear restriction A type of input control used as a management tool whereby the amount and/or type of fishing gear used by fishers in a particular fishery is restricted by law.

Geographic information system (GIS) A computer system for storage, analysis and retrieval of information, in which all data are spatially referenced by their geographic coordinates (north, east). In addition to primary data, such as climatic and soil characteristics, a GIS can be used to calculate derived values, such as erosion hazard, forest yield class, or land suitability for specified land-use types. Data are usually derived from maps and derived values can be printed out as maps.

GLM A statistical procedure similar to an Analysis of Variance or a Multiple Regression that is used to estimate the magnitude of the effects of different factors on a variable of interest.

Government The political direction and control exercised over actions of the members, citizens, or inhabitants of communities, societies, and states.

Household All the persons, kin and non-kin, who live in the same dwelling and share income, expenses and daily subsistence tasks. A basic unit for socio-cultural and economic analysis, a household may consist of persons (sometimes one but generally two or more) living together and jointly making provision for food or other essentials elements of the livelihood.

Indicator A variable, pointer, or index. Its fluctuation reveals the variations in key elements of a system. The position and trend of the indicator in relation to reference points or values indicate the present state and dynamics of the system. Indicators provide a bridge between objectives and action.

Information Knowledge of a specific event or situation generated from data.

Input controls Management instruments used to controls the time and place as well as type and/or amount of fishing with the view to limit yields and fishing mortality; e.g. restrictions on type and quantity of gear, effort, and capacity; closed seasons.

Institution An organization founded for social purpose.

Landing site Location at which boats land their catch.

Landings Weight of the what is landed at a landing site. May be different from the catch (which includes the discards).

Legitimacy Perception of conforming to established social rules or standards

Licensing Restriction of the right to fish to those persons or vessels issued with licenses for the purpose.

Limited access As used in fisheries, usually the same as harvester rights (see above) but sometimes used to include all controlled access to use of a natural resource, including full ownership. Also, limited entry.

Limit reference point LRP indicates the limit beyond which the state of a fishery and/or a resource is not considered desirable.

Local management institution A local organization founded for management purposes.

Logbook A detailed, usually official record of a vessel's fishing activity registered systematically on board the fishing vessel, usually including information on catch and its species composition, the corresponding fishing effort and location. Completion of logbooks may be a compulsory requirement for a fishing licence.

Management objective	A formally established, more or less quantitative target that is actively sought and provides a direction for management action.
Management organization	An institution or arrangement established (usually between two or more States) to be responsible for activities related to fisheries management.
Management strategy	The strategy adopted by the management authority to reach established management goals. In addition to the objectives, it includes choices regarding all or some of the following: access rights and allocation of resources to stakeholders, controls on inputs (e.g. fishing capacity, gear regulations), outputs (e.g. quotas, minimum size at landing), and fishing operations (e.g. calendar, closed areas and seasons).
Markets	A collection of buyers and sellers who interact, resulting in the exchange of goods and services.
Maximum sustainable yield	The highest theoretical equilibrium yield that can be continuously taken (on average) from a stock under existing (average) environmental conditions without affecting significantly the reproduction process. Also referred to sometimes as Potential yield .
Member States	States that are members of an international organization or arrangement.
Model	A simplified representation of a limited part of reality with related elements.
Modelling	The construction of physical, conceptual or mathematical simulations of the real world.
Monitoring	The collection of information for the purpose of assessment of the progress and success of a land-use plan. Monitoring is used for the purpose of assessing performance of a management plan or compliance scheme and revising them or to gather experience for future plans.
Natural resources	Any portion of the natural environment, such as air, water, soil, botanical and zoological resources, and minerals.
Nominal catch	The sum of the catches that are landed (expressed as live weight equivalent). Nominal catches do not include unreported discards
Objective	Expresses the object of an action or what is intended to be achieved
Open access	A condition of a fishery in which anyone who wishes to fish may do so.
Opportunity cost	Defined as the benefit foregone by using a scarce resource for one purpose instead of its next best alternative.
Parameter	A "constant" or numerical description of some property of a population (which may be real or imaginary).
Performance	Accomplishment; fulfilment; functioning, usually with regard to effectiveness. Indicators of performance will be interpreted in relation to reference points and objectives.
Population	A group of interbreeding organisms that represents the level of organization at which speciation begins.
Precautionary approach	Set of measures taken to implement the Precautionary principle. A set of agreed cost-effective measures and actions, including future courses of action, which ensures prudent foresight, reduces or avoids risk to the resource, the environment, and the people, to the extent possible, taking explicitly into account existing uncertainties and the potential consequences of being wrong".

Primary production The rate at which energy is stored (i.e. the amount of energy fixed in a given time) by photosynthetic and chemosynthetic activity of producer organisms (chiefly green plants) in the form of organisms substances which can be used as food materials). Values are expressed in grams of dry organic matter (or carbon) produces per square meter per day.

Production The total output especially of a commodity or an industry.

Recruitment The number of fish added to the exploitable stock, in the fishing area, each year, through a process of growth (i.e. the fish grows to a size where it becomes catchable) or migration (i.e. the fish moves into the fishing area).

Reference point A reference point indicates a particular state of a fishery indicator corresponding to a situation considered as desirable (Target reference point, TRP) or undesirable and requiring immediate action (Limit reference point, LRP, and Threshold reference point, ThRP).

Risk In general, the possibility of something undesirable happening, of harm or loss. A danger or a hazard. A factor, thing, element, or course involving some uncertain danger.

Rent In a fishery, difference between the total revenues obtained from the fishery resource and the total costs of production , i.e. capital and labour valued at their opportunity costs (see Opportunity costs).

Sampling design The sampling design of a scientific survey refers to the statistical techniques and methods adopted for selecting a sample and obtaining estimates of the survey variables from the selected sample.

Selectivity Ability to target and capture fish by size and species during harvesting operations, allowing by-catch of juvenile fish and non-target species to escape unharmed. In stock assessment, conventionally expressed as a relationship between retention and size (or age) with no reference to survival after escapement.

Single-species model A model describing the dynamics of a species which does not explicitly incorporate the effects of interactions with other species.

Size limit A minimum or maximum limit on the size of fish that may be legally be caught.

Socio-economic Pertaining to the combination or interaction of social and economic factors and involves topics such as distributional issues, labor market structure, social and opportunity costs, community dynamics, and decision-making processes.

Spawning stock Mature part of a stock responsible for the reproduction.

Species Group of animals or plants having common characteristics, able to breed together to produce fertile (capable of reproducing) offspring, and maintaining their "separateness" from other groups.

Species diversity The variety of species in a community, which can be expressed quantitatively in ways which reflect both the total number of species present and the extent to which the system is dominated by a small number of species.

Species richness Species richness/abundance is the distribution of the number of species and the number of individuals of each species in a community.

Stakeholder	A large group of individuals and groups of individuals (including governmental and non-governmental institutions, traditional communities, universities, research institutions, development agencies and banks, donors, etc.) with an interest or claim (whether stated or implied) which has the potential of being impacted by or having an impact on a given project and its objectives. Stakeholder groups that have a direct or indirect "stake" can be at the household, community, local, regional, national, or international level.
Statistic	The estimate of a parameter which is obtained by observation, and which in general is subject to sampling error.
Straddling stock	Stock which occurs both within the EEZ and in an area beyond and adjacent to EEZ.
Surplus production model	Mathematical representation of the way a stock of fish responds to the removal of its individuals (for example by fishing). In fisheries, usually represented by a relationship between yield and/or cpue, and fishing effort or mortality.
Survey design	The overall survey design of a probability survey refers to the definitions and the established methods and procedures concerning all phases needed for conducting the survey: the sample design, the selection and training of personnel, the logistics involved in the management of the field force and the distribution and receipt of survey questionnaires and forms, and the procedures for data collection, processing and analysis.
Top-down management	A process of management in which management information and decisions are centralized and resource users are kept outside the decision-making process.
Traditional rights	Rights of indigenous or traditional people which (to present) have not been considered in a national and international context or have not (yet) been recorded, and which are based on the legal system of the individual cultures.
Uncertainty	The estimated amount (or percentage) by which an observed or calculated value may differ from the true value.
Utility	The level of satisfaction that a person gets from consuming a good or undertaking an activity.
User	The term includes a commercial, recreational and indigenous fisher; fish watcher (scuba diver) and a member of the community.
Variable	Anything changeable. A quantity that varies or may vary. Part of a mathematical expression that may assume any value.
Variable costs	Costs that vary with the rate of output.
Yield-per-recruit	The expected lifetime yield per fish recruited in the stock at a specific age. Depends on the exploitation pattern (fishing mortality at age) or fishing regime (effort, size at first capture) and natural mortality.

ANNEX 1

Standard fishing effort measures

(Source: FAO, 1999b). http://www.fao.org/documents/show_cdr.asp?url_file=/DOCREP/003/X2465E/X2465E00.HTM

NB The size of gear should also be recorded if variation in gear size is significant. For example Liftnet effort may need to recorded in terms of liftnet m^2 hours calculated as (number of hours fished) x (area of net).

FISHING GEAR	EFFORT MEASURE DESCRIPTORS	DEFINITION
FIRST PRIORITY		
Surrounding nets (e.g. purse seines)	Number of sets	Number of times the gear has been set or shot, whether or not a catch was made. This measure is appropriate when school size and packing density is related to stock abundance or sets are made in a random manner.
Surrounding nets (e.g. purse seines)	Searching time	This represents time on the grounds less time spent shooting net and retrieving the catch as well as time hove to. This measure is complicated by the use of aircraft spotting as well as by the dissemination of information from vessel to vessel. The measure is appropriate when school size and packing density are unrelated to stock abundance and a set is only made when a school has been located.
Surrounding nets (e.g. purse seines) if fishing with Fish Attracting Device (FAD)	Number of hours since last fishing this FAD	Time in which FAD (Fishing Attracting Device) is left in the water since it was last fished.
Boat seines (Danish seine, etc.)	Number of hours fished	Number of hours during which the seine was on the bottom and fishing.
Beach seines	Number of sets	Number of times the gear has been set or shot, whether or not a catch was made.
Castnet	Number of casts	Number of times the gear has been cast, whether or not a catch was made.
Trawls	Number of hours fished	Number of hours during which the trawl was in the water (midwater trawl), or on the bottom (bottom trawl), and fishing.
Boat dredges	Number of hours fished	Number of hours during which the dredge was on the bottom and fishing.
Gillnets (set or drift)	Number of effort units	Length of nets expressed in 100-metre units multiplied by the number of sets made (= accumulated total length in metres of nets used in a given time period divided by 100).
Gillnets (fixed)	Number of effort units	Length of net expressed in 100-metre units multiplied by the number of times the net was cleared.
Lift net	Number of hours fished	Number of hours during which the net was in the water, whether or not a catch was made.
Traps (uncovered pound nets)	Number of effort units	Number of days fished times the number of units hauled.
Covered pots and fyke nets	Number of effort units	Number of lifts times the number of units (= total number of units fished in a given time period).
Longlines (set or drift)	Numbers of hooks	Number of hooks fished in a given time period.
Pole-and-line	Number of days fished	The number of days (24-hour periods, reckoned from midnight to midnight), on which any fishing took place, including days during which searching took place without fishing.
Rod-and-reel (recreational)	Number of line-hours	Number of hours during which the lines were in the water times number of lines used.
Troll	Number of line-days	Total number of line days in the given time period.
Jigs (hand and mechanical)	Number of line-days	Total number of line days in the given time period.
Other small-scale net gears	Number of operations	Those small scale gears including push net, scoop net, drive-in net etc. Number of fishing operation, whether or not a catch was made.

Other small scale stationary gears	Number of hours fished	Those gears include guiding barriers, bag net, stow net, portable net, etc. Number of hours during which the gears were in the water for fishing, whether or not a catch was made.
Harpoons, spears etc.	Number of days fished	The number of days (24-hour periods, reckoned from midnight to midnight), on which any fishing took place, including days during which searching took place without fishing.
SECOND PRIORITY		
Boat seines (Danish seine, etc.)	Number of sets made	Number of times the gear has been set or shot, whether or not a catch was made.
Trawls	Number of sets made	Number of times the gear has been set or shot (either in mid-water or to the bottom), whether or not a catch was made.
Lift net	Number of hours fished	Number of times the net was set or shot in the water, whether or not a catch was made.
All gears	Number of days fished	The number of days (24-hour period, reckoned from midnight to midnight) on which any fishing took place. For those fisheries in which searching is a substantial part of the fishing operation, days in which searching but no fishing took place should be included in "days fished" data.
THIRD PRIORITY		
All gears	Number of days on ground	The number of days (24-hour periods, reckoned from midnight to midnight), in which the vessel was on the fishing ground, and includes in addition to the days fishing and searching also all the other days while the vessel was on the ground.
FOURTH PRIORITY		
All gears	Number of days absent from port	The number of days absent from port on any one trip should include the day the fishing craft sailed but not the day of landing. Where it is known that fishing took place on each day of the trip the number of "days absent from port" should include not only the day of departure but also the day of arrival back in port. Where on any trip a fishing craft visits more than one "fishing area" (as defined for statistical purposes) an appropriate fraction of the total number of days absent from port should be allocated to each "fishing area" in proportion to the number of days spent in each, so that the total number of days absent on the trip will be the sum of the number of days allocated to all of the different "fishing areas" visited.
FIFTH PRIORITY		
All gears	Number of trips made	Any voyage during which fishing took place in only one "fishing area" is to be counted as one trip. When in a single trip a craft visits more than one "fishing area" an appropriate fraction of the trips should be apportioned to each "fishing area" in proportion to the number of days spent fishing in each, so that the total number of trips for the Statistical Area as a whole will be the same as the sum of trips to each "fishing area".

ANNEX 2

Examples of existing and planned data and information sharing networks

Lake George Uganda

Lamberts (2004) describes how, for co-managed fisheries on Lake George, Uganda, catch data are compiled and shared through a network of stakeholders to provide an overall indication of the scale and significance of fisheries to the country. This information, when combined with others, is used to guide broad national planning and policy decisions. National catch data are transferred internationally to FAO where global catch data compilation is undertaken.

The catch, effort and price data are collected using Catch Assessment Survey (CAS) forms and initially processed at Beach Management Unit (BMU) level. This information is then forwarded from the Parish to the district level. At each level, the estimates are raised with an appropriate raising factor for each level or strata using the appropriate data collection form (Figure 19).

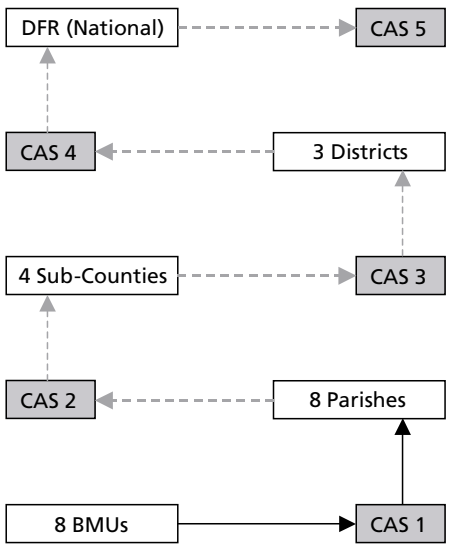
The sub-county fisheries officer serves as a transfer and collection point for information. The officer collects copies of CAS 1 (BMU-level) and CAS 2 (parish-level) forms by 15th of each month and completes a CAS 3 form to the district FO before the end of the same month. The district Fisheries Officer (DFO) then completes a CAS 4 form and submits that to district authorities and to DFR, Entebbe, by end of the same month. The Department for Fisheries Resources (DFR) produces synthesized information for the entire lake (CAS 5).

At each level, the data are used in the local government planning process, i.e., for the development of Parish Development Plans, Sub-county Development Plans and District Development Plans respectively.

The District Fisheries Officer (DFO) coordinates the distribution of this information throughout his district and sends it to LAGBIMO – the Lake George Basin Integrated Management Organisation (LAGBIMO). The LAGBIMO Executive Secretary is responsible for compiling information at lake-wide level for planning purposes and sends it to the Fisheries Management Committee (FMC) members (Figure 20). The FMC could also acquire this information from its BMU representative members. The outcome of the FMC meeting is distributed to the other committees in LAGBIMO.

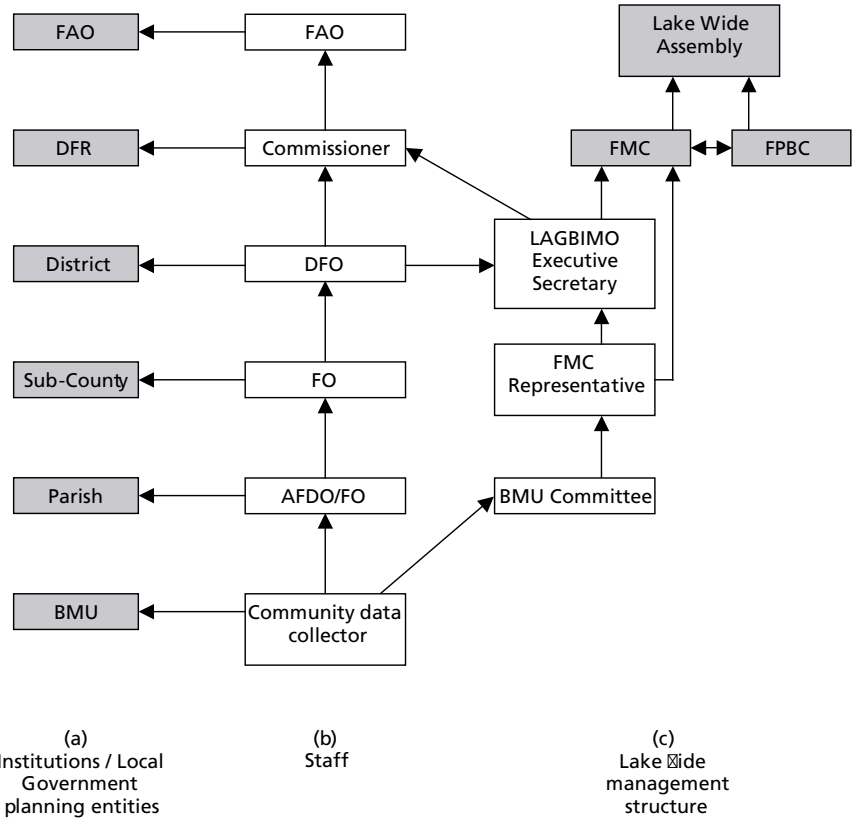
The DFO also sends the information to the Department for fisheries Resources (DFR) as a contribution to the compilation of the state of fisheries in Uganda. DFR is then responsible for making policies, laws and plans based on the information collected. DFR then sends this information on to FAO, which uses the information

FIGURE 19
Data collection activities and actors on Lake George, Uganda



Solid arrows indicate original data, dashed arrows indicate flow of synthesized information.
Source: Lamberts (2004).

FIGURE 20
Fisheries information flow and use in planning for Lake George, Uganda



The greyed boxes indicate instances where data analysis and use in planning occur. The hashed box (DFO) indicates the level where data are stored and processed on computers. FPBC-Finance, Planning and Budgeting Committee. DFR-Department for Fisheries Resources.
Source: Lamberts, 2004.

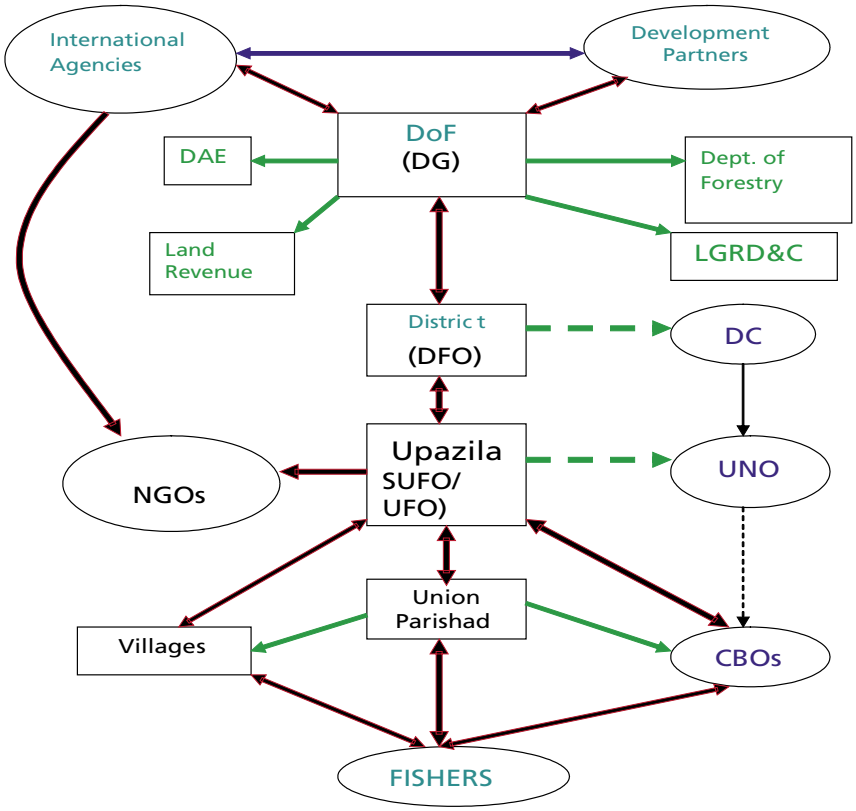
for normative activities. The DFOs also send the information regarding their district to the Executive Secretary of LAGBIMO. There is, however, capacity to absorb and use data from other sectors that are currently underutilized. In part, this integrated management planning happens through the interaction with local government planning and monitoring, but this is still at an early stage, and the efficacy of the existing approach is yet to be assessed (Lamberts, 2004).

Bangladesh

In Bangladesh initiatives to network local community based organizations (CBOs) for inland capture fishery management established under various projects have shown that community organizations are interested to share and disseminate their knowledge and experiences through meetings, exchange visits and newsletters. After the first network meetings most of the involved CBOs contributed articles describing their management experiences for the CBO newsletter (Sultana, 2003).

For example, the RMC at Kali Nadi recognize the potential of newsletters for disseminating their ideas, knowledge and experiences. They also believe that the newsletter could be used to raise awareness among government institutions of their needs to improve the management of the river fisheries and lobby government institutions over management issues such as the creating of enabling legislation to support their management plans. What is apparent is that individual CBOs cannot easily network among themselves since they lack resources and contacts with similar

FIGURE 21
The information sharing network developed by stakeholders at Sunamganj, Bangladesh using a draft version of these guidelines



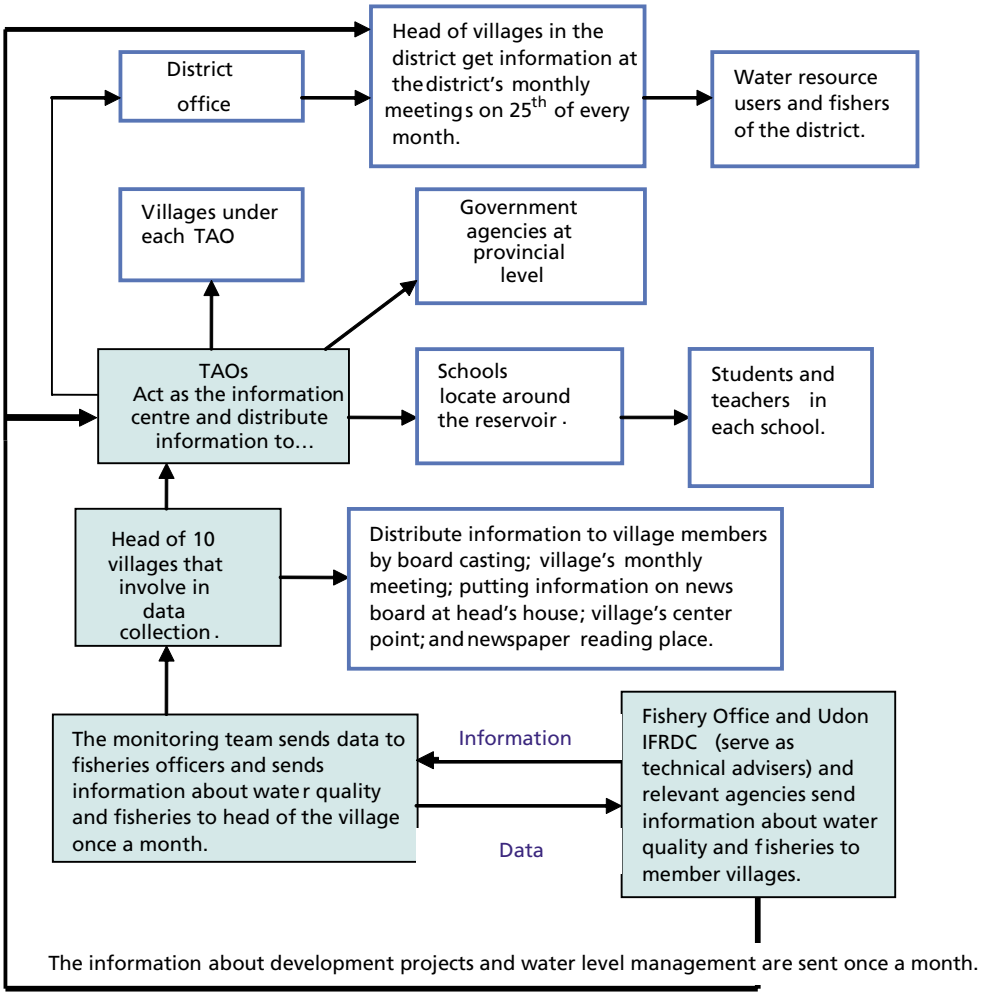
initiatives. Some facilitation and funding support is needed to support this process. Networking has attracted interest in Bangladesh and has the potential to improve local management and national understanding of co-management activities and effectiveness when separate co-management units share their experiences and adjust decisions based on experiences in their own **and** similar communities and fisheries, and have a forum to interact with Department of Fisheries.

During the field testing of an earlier draft of these guidelines at eight sites in Bangladesh, stakeholders representing the Departments of Fisheries and Agriculture, partner NGOs (PNGOs), Community Based Organizations (CBOs), and other government bodies were able to use the eight-stage design process to design a preliminary data collection strategy to meet their information needs, and identify potential networks for sharing the information (Figure 21). It is hoped that these preliminary designs will be further developed and implemented to ensure that the information needs of local communities and government stakeholders can be sustained beyond the life of the CBFM and FFP projects.

Thailand

In Thailand, Or-Bor-Tor (OBT) or TAO – the local management institution, has a responsibility to facilitate information sharing between government officers and villagers. Village leaders share information with their people through loud-speaker and monthly meetings at the village level. Information sharing between fishermen is usually informal, or through the OBT (Hartman *et al.*, 2004). In September 2005, a draft version of these guidelines were used to develop the data and information

FIGURE 22
The information sharing system developed by co-managers of the Huay Luang reservoir using a draft version of these guidelines



sharing system illustrated in Figure 22 to support the management of the Huay Luang Reservoir in Udon Thani, Thailand which is co-managed by the DoF and resource users from ten villages.