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Primary fisheries management: a minimum requirement for provision of sustainable human benefits in small-scale fisheries

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Abstract

The social and economic importance of small-scale fisheries is frequently undervalued, and they are rarely effectively managed. There is now growing consensus on how these fisheries could be managed for sustainability and to minimize the risks of crossing undesirable thresholds. Using a concept developed in health care, these approaches have been referred to as primary fisheries management. By encouraging the use of best-available information in a precautionary way, the approaches will facilitate sustainable use and should therefore be encouraged, but they accept high scientific and implementation uncertainties as unavoidable because of limited management and enforcement resources and capacity. It is important to recognize that this limitation will result in social costs, because application of a precautionary approach in the face of high uncertainties will require forgoing potential sustainable benefits. Acceptance of primary fisheries management as a final and sufficient goal could therefore add a further constraint on the possibility of fishing communities escaping the poverty trap. Primary fisheries management should be seen as a first and minimum target for fisheries where there is currently no or inadequate management, but the longer-term goal should still be well informed and adaptive management that strives for optimal benefits, referred to here as tertiary management.

Keywords Fisheries management, health care, poverty reduction, precautionary approach, primary management, small-scale fisheries

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Introduction

Most fisheries operate from shore or from small boats in coastal and inland waters in what are loosely described as 'small-scale fisheries' (Allison and Ellis 2001; Kurien and Willmann 2009). Together, small-scale fisheries (SSF) account for more than half the world's catch and employ more than 90% of people engaged in fisheries, many of them in the world's poorest countries (Kurien and Willmann 2009; World Bank/FAO/WorldFish Center 2010, Mills *et al.* 2011). Slightly less than half the people working in SSF (including supply chains) are women (op. cit.). By any measure, these fisheries are important, not least to the food security of hundreds of millions of people, but their contribution is frequently under-valued (Béné 2006; Béné *et al.* 2006; Thorpe *et al.* 2007; Kurien and Willmann 2009).

The condition of being a small-scale fishery (SSF) is best understood in terms of meeting a number, but not necessarily all, of a wide set of attributes (Béné *et al.* 2004; Johnson 2006; Kurien and Willmann 2009). These can include, for example, that: fishers operate from dispersed and decentralized localities using small fishing vessels and simple gear; fishing activities are essentially household enterprises, often with a culturally conditioned way of life; and the participants are politically weak. These attributes present significant challenges for sustainability and effective governance.

Commonly adopted approaches to assessment and management of SSF especially in developing countries have proven less effective than they need to be to ensure sustainability and the supply of fish to societies (Pinkerton 1989a; McGoodwin 1990; Garcia and Grainger 1997; Mahon 1997; Cochrane 2000; Welcomme 2001; FAO 2003). Given their importance in the social and economic fabric of many least developed countries, it is essential that SSF are effectively managed to ensure sustainable delivery of benefits to the dependent communities.

There is good evidence of effective management of sustainable fisheries by small communities using traditional methods in the past, for example in pre-colonial Oceania, Guatemala and Peru (see McGoodwin 1990). By the beginning of the twentieth century, such traditional methods were being overwhelmed by a centralized management approach built around natural-science management advice. This approach has now been widely recognized to have been inadequate for effective management of fisheries in general and particularly for SSF in the developing world (e.g. Jentoft *et al.* 1998; Charles 2001; Garcia and Cochrane 2009). In general, fisheries research and management is shifting along the spectrum from having a narrow focus on fish and the process of catching them to placing fishing in a broader context that puts more emphasis on interactions among people, power, external disturbance and uncertainty, and wider governance dynamics (Andrew *et al.* 2007).

The problems facing SSF are complex and their solutions case-specific. No single class of response at any single scale of organization or time horizon will offer a panacea for the challenges facing the management and wider governance of SSF (Ostrom 2007; Ostrom *et al.* 2007). Effective management requires a range of perspectives and the inclusion of different actors in the management process, as well as better engagement in wider governance within society. The governance of fisheries, particularly within the development agendas of countries, is a critical issue and a topical issue for research (see for example Kooiman *et al.* 2005; Cash *et al.* 2006; Jentoft 2007; Mahon *et al.* 2008).

Jentoft *et al.* (1998) characterized the mainstream fisheries management approach prevailing at the end of the twentieth century as being 'top-down, bureaucratic and science-driven'. Each of these three elements, identified as having been at least as much a part of the problems in fisheries management as of the solutions, requires and is receiving due attention from human and natural scientists, and in implementation in many countries and fisheries. This paper is focussed on the third of these problem areas, the scientific advice and particularly scientific advice on use of the natural resources for the hundreds of millions of people who benefit from SSF.

Current perspectives on management of small-scale fisheries

Fisheries management

All fisheries need to be managed in some way, if they are to achieve the objectives that society has for them. In a broad sense, fisheries management can be understood as (FAO 1997):

''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 to ensure the continued productivity of the resources and the accomplishment of other fisheries objectives.''

Notwithstanding that the majority of fisheries around the world are not being effectively managed, there have been many successful examples, particularly in industrial fisheries (e.g. Mace 2004; Hilborn *et al.* 2005; Hilborn 2007; Worm *et al.* 2009). Management methods tend to follow the process that is summarized in Fig. 1, or something similar, and to require, for example, high management capacity that is financially well supported; good scientific information; accurate monitoring and enforcement of catches and other management regulations; only one or a few target species, and a small number of well-organized, readily accessible stakeholders. Unfortunately, the very different attributes of SSF impose serious constraints on the practicality and effectiveness of such intensive methods in these cases.

The goals and objectives of fisheries management

In combination, the stakeholders in any fishery typically pursue multiple goals, and these will commonly reflect conflicting interests and values (Jentoft and McCay 1995; Berkes 2009a; Kurien and Willmann 2009). Within the context of an

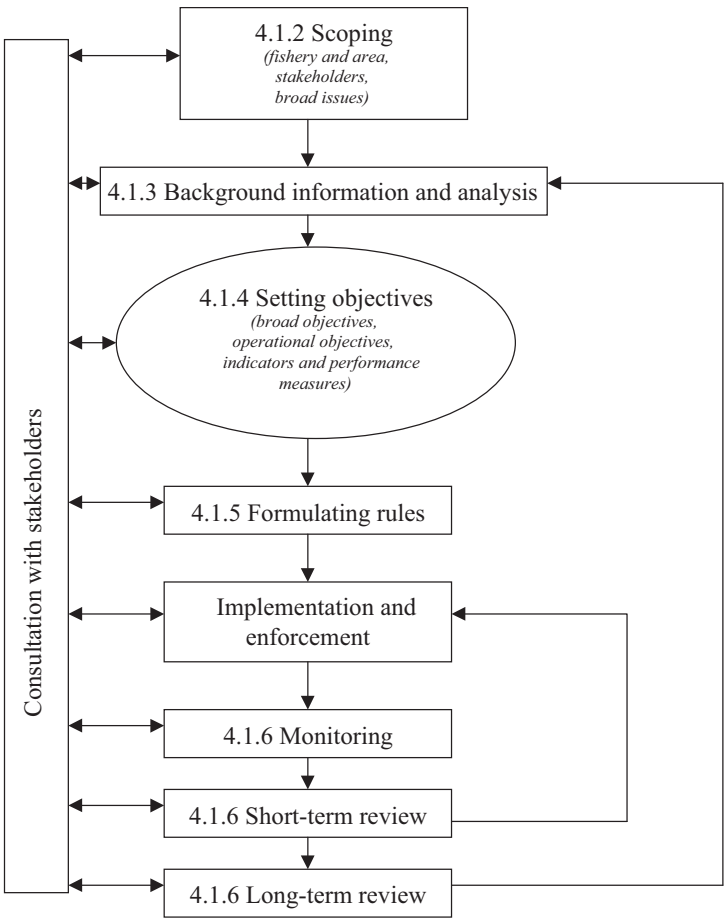

Figure 1 The fisheries management process (from FAO 2003).

ecosystem approach, the goal of fisheries management is accordingly described as being to address 'the multiplicity of societal needs and desires, without jeopardizing the options for future generations to benefit from the full range of goods and services provided by marine ecosystems' FAO (2003).

The goals can be categorized under three broad headings, all of which are inter-related: biological and ecological sustainability, social benefits and economic returns. The two latter categories encompass the primary purpose and reason for the existence of the fishery being managed. The specific and detailed objectives within these categories will vary in complexity and relative priority from fishery to fishery. There are no right or wrong answers in such cases and agreeing on priorities and reconciling conflicts in any specific fishery is a political issue to be resolved in consultation with the key stakeholders.

The category of ecological sustainability objectives (incorporating species-specific biological objectives) is similarly open to a range of potential solutions, which vary in the acceptable extent of perturbation of individual populations and the system as a whole from the 'pristine' condition, and the acceptable degree of risk of undesirable ecological outcomes. Recognizing that 'the manager has to keep in mind the overall health of this integrated social-ecological system' (Berkes 2009a, p.63), in an actively managed fishery, the acceptable degrees of perturbation and risks need to be decided in combination with setting social and economic objectives to ensure that the overall, agreed set of objectives is realistic, reconciled and therefore achievable. Clearly, the legitimacy and capacity of management institutions to set objectives, make rules, and sanction behaviour is critical.

Notwithstanding potential differences from fishery to fishery in the details of the objectives and approaches adopted, the goal of ensuring ecological sustainability is entrenched in modern global and national policies and usually endorsed also by the fishers themselves. The world's governments have committed their countries to the principles of sustainable use of natural resources in a range of international instruments, both binding and non-binding. These include, for example, the United Nations Convention on the Law of the Sea of 10 December 1982, the Convention on Biological Diversity, the FAO Code of Conduct for Responsible Fisheries, and the World Summit on Sustainable Development Plan of Implementation of 2002 (WSSD 2002). In addition, the reality that 'healthy fish stocks are a collective good' (Jentoft *et al.* 1998) is recognized by fishers, and sustainable use of the natural resources they depend on for their livelihoods is a fundamental goal for them too, if their food and physical security and the state of governance of the fishery allow for it (Bruce Rettig *et al.* 1989; McGoodwin 1990; Jentoft *et al.* 1998; Cochrane 2008).

A basic premise in this paper is therefore that ensuring sustainable use of biological resources and ecosystems for human benefit is a fundamental goal for fisheries management; however, the human benefits are defined in any particular case. We recognize that in some extreme instances, for example where fisheries have become a means of livelihood of last resort, managers may actively pursue or passively allow over-exploitation, because it would be politically impractical to attempt to do otherwise. Even in such cases, however, it is in the interests of all concerned to have reliable information on the future prospects for such unsustainable fisheries and the dwindling benefits they will provide so that governments and stakeholders are aware of the long-term consequences of their approach.

Precaution, information and knowledge

Information and knowledge about the system being managed are essential for making sound decisions, and the better (i.e. the more complete, accurate and precise) this information is, the greater the likelihood of making good decisions (Pinkerton 1989a; Ostrom 1990; Johannes 1998; Cochrane 2009a). This is captured in the precautionary approach that emerged from the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992 and is now entrenched as an essential component of sustainable use of natural resources (e.g. FAO 1995; Johannes 1998; Berkes *et al.* 2001).

It is a general principle that greater uncertainty is more likely to lead to sub-optimal decisions and higher risks of undesireable consequences as a result of management mistakes. Greater precaution is therefore required in management actions under high uncertainty to maintain the risk of unacceptable ecological perturbation or irreversible change below a level that is considered to be appropriate to the circumstances. As a hypothetical example, with poor information available on a fishery and the

resources it exploits, the probability that steps taken to reduce fishing effort will be either more severe than actually required or insufficient to allow for stock rebuilding is higher than it would be if based on more precise and reliable stock assessments. Achievement of goals for both conservation and human benefits is therefore potentially compromised by poor information.

Large amounts of money and expertise are invested in high-value commercial fisheries to reduce scientific and implementation uncertainties and thereby risks (e.g. Cochrane *et al.* 1998; Cochrane 1999; Punt and Smith 1999; Parma 2002; Kraak *et al.* 2008). In contrast, the vast majority of SSF occur in developing countries where the resources to invest in acquiring potentially important supplementary knowledge may not exist, or the economic value of the fisheries may be perceived to be too low to justify the investments. The irony is therefore that the poorer fishers and communities who are in most need of optimal, sustainable returns from their resources have the greatest need to invoke the precautionary approach, thereby losing potential returns that would be sustainable if the underlying uncertainties could be reduced.

Sources of knowledge and information

Knowledge for informing decisions on natural resource management in general and fisheries in particular comes in various forms that can be categorized in different ways including as indigenous knowledge, traditional knowledge, local knowledge, fisher knowledge, citizen science, and scientific knowledge (Agrawal 1995; Pinkerton 1989b; Leach and Fairhead 2002; Hara 2006; Berkes 2009a). These types of knowledge may show methodological and epistemological differences, and differences in their context, but it is dangerous and misleading to consider indigenous or traditional knowledge on the one hand and scientific knowledge on the other as being irreconcileably different (Agrawal 1995).

From the perspective of obtaining information on the status and dynamics of populations and ecosystems, it is not the source of the information but its relevance and validity that determines usefulness. Whatever the source, it is important to try to evaluate how well the available information meets these requirements prior to using it in decision-making (e.g. Cochrane 2009a). Ideally, local and traditional, other stakeholder and conventional scientific knowledge should be combined through co-production of knowledge (Jentoft *et al.* 1998; Berkes 2009a,b). However, in data-poor SSF, limited availability of scientific information will often mean that knowledge from the fishers and other stakeholders has to be heavily relied on to advise management decisions.

Management objectives when information is limited

As will be clear from the preceding discussion, we conclude that securing optimal human benefits from SSF is out of reach in most instances. A more realistic goal for SSF is to adopt a less ambitious approach intended simply to maintain the viability of the resources. This is well described by Johannes (1998):

''The aim of precautionary management is not to control the production of limiting resources, but simply to protect them, to maintain their viability…. Here, then, is a form of data-less management that helps protect fish stocks from severe depletion or extinction. Clearly it does not lead to optimal use (as conventionally defined) of the resource. But this is immaterial, as nothing else that is practical does either.''

Andrew *et al.* (2007) expressed a similar view, proposing that the goals of management should be to prevent SSF from falling into an undesirable states and to ensure they retain the capacity to recover from perturbations. This is generally consistent with the broader concept of resilience management of social-ecological systems (Walker *et al.* 2002; Berkes *et al.* 2003). Taken from this perspective, the objectives of management need to shift from yield optimization to a focus on nurturing the ecological and social processes that allow a fishery to absorb stress and reorganize itself following disturbance (Andrew and Evans, 2011). Pragmatically, this would involve setting precautionary limits to avoid crossing undesirable ecological thresholds and thereby reducing human benefits even further from the potential optimum. This shift in goals is also reflected in the strong emphasis on risk avoidance or minimization that is commonly found in modern practice (e.g. FAO 2003; Fletcher *et al.* 2005). Overall, at the time of writing, there appears to be no great optimism that we can get beyond a basic resilience and sustainability approach for the great majority of SSF in developing countries.

Methods for achieving the goals

While practical examples of successful implementation are still scarce, there is growing convergence on the tools that can be used to achieve these resilience and sustainability goals. Above all, it is generally recognized that management of fisheries has to involve full participation of the fishers and other stakeholders, and for reasons given in the introduction, this is even more of a pre-requisite for SSF. The necessity for involvement of stakeholders is motivated by the need to take advantage of their knowledge, commitment, legitimate self-interest and potential to contribute to planning, monitoring and enforcement, as well as by the more negative recognition that financial, technical and logistical support from national or local authorities will often be very limited, ineffective or both (e.g. Pinkerton 1989a; Ostrom 1990; Jentoft and McCay 1995; Parma *et al.* 2003; Prince 2003; Kurien and Willmann 2009).

Some general frameworks for management of SSF have been developed (e.g. Andrew *et al.* 2007; Garcia *et al.* 2008), and a range of overlapping approaches has been recommended. In terms of the nature and sources of reliable information for planning and adaptive decision-making, these include concepts such as data-less management (Johannes 1998), use of rapid rural appraisals, and the application of reference directions rather than points (Berkes *et al.* 2001). The general direction of current thinking is well captured in the characteristics and principles of rapid rural appraisals (Table 1) and the conceptual scheme for diagnosis and management of SSF (Fig. 2) proposed by Andrew *et al.* (2007). Taking into account that effective management is dependent on relevant and reliable information, these two views highlight key elements for moving forward in management of SSF. Following the terminology of Cochrane (2009b) which in turn draws from developments in the field of health care, we refer to this pragmatic approach to management of SSF in cases of limited data and capacity as being 'primary fisheries management'.

Implications of restricting the goal to avoiding undesirable outcomes

The authors of this paper agree with the prevailing view on the best approaches for managing small-scale and data-poor fisheries described in the previous section. However, we also stress the social and economic costs of managing with high uncertainty and, conversely, the potential benefits to the stakeholders of access to improved knowledge and the resulting opportunity to achieve more refined objectives. Management authorities, whatever their scale, need to consider the trade-offs between the costs and the benefits of acquiring improved information for their planning, monitoring and decision-making.

It is our view that the management goals and approaches currently being promoted for small-scale, data-poor fisheries, which emphasize avoiding disaster rather than striving for the best should be seen as being a necessary minimum, but not the desirable final state for fisheries management. This is especially important in cases where poverty is prevalent and the need for getting the most benefit from available resources is highest. In making this argument, we note the fortunate mitigating factor that, in general, initial increases in management expenditure, particularly in monitoring and research, can lead to rapid reductions in uncertainty and substantial increases in benefits (Fig. 3). Data-poor SSF will be found towards the left-hand side of the graph, where investment in management is low, uncertanty is very large, and benefits are much lower than they could be achieved under

Table 1 Elements of a Rapid Rural Appraisal (summarized from Pomeroy and Rivera-Guieb 2006).

1. Structured but flexible	Clear planning and objectives but flexible to respond to changed circumstances
2. Integrated and interdisciplinary	Requires a multidisciplinary team
3. Awareness of bias	Must consider bias of appraisers and of respondents
4. Accelerating the planning process	Tries to shorten the time to know an area and plan interventions
5. Interaction with and learning from people	Must involve local intended beneficiaries
6. Combination of different tools	Combination of communication and learning tools (including all available and relevant knowledge)
7. Iterative	Constant review of results

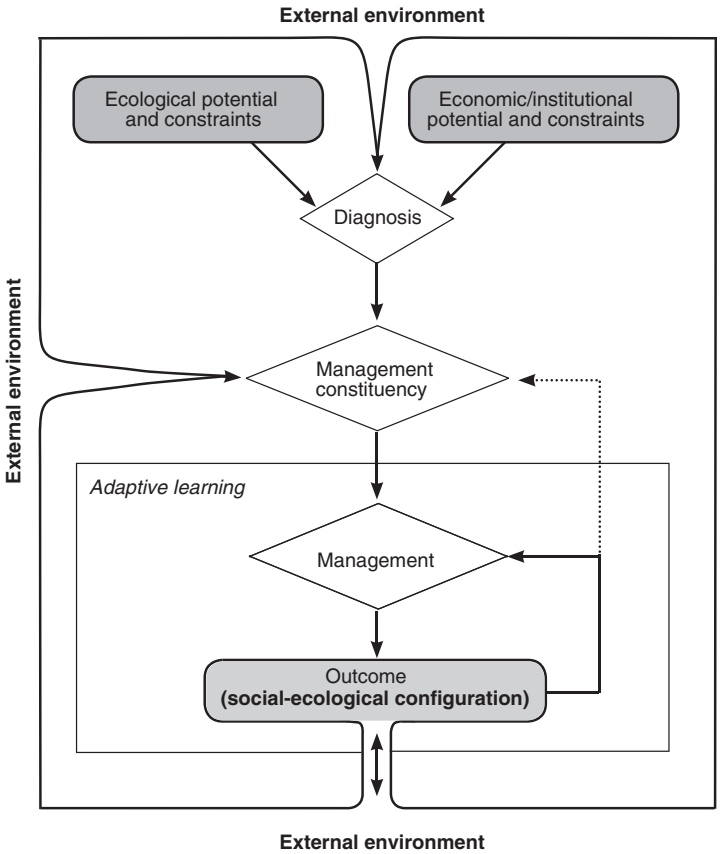

Figure 2 A conceptual framework for diagnosis and management of small-scale fisheries (from Andrew *et al.* 2007).

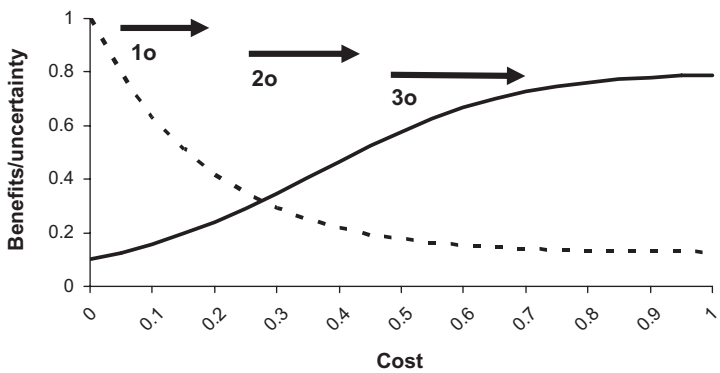

Figure 3 General form of the relationship between sustainable benefits to humans from a fishery (solid line) and uncertainty in information for management (broken line) as functions of the management costs. In all cases, the scales are relative to a theoretical maximum for each variable (after Bianchi and Cochrane in press). Arrows show an indicative position of primary (1o), secondary (2o) and tertiary (3o) management in relation to the three variables.

more informed management. Marginal gains tend to increase most rapidly at this end of the scale and to decrease the higher the investment in management.

A parallel with medicine: primary health care

While fisheries scientists and practitioners often tend to view fisheries as being something unique, in

almost all of its features, the sector is simply a particular manifestation of the age old human conflict for limited resources (McGoodwin 1990). As a result, many potential solutions to problems being experienced in fisheries have been developed and tested in very different contexts and sectors. Primary health care is one such example.

The origins of primary health care lay in the emergence of a large number of newly independent countries in the 1960s and 1970s, previously under the control of colonial rulers (Hall and Taylor 2003). These countries set out to establish health care services for their people that were comparable to the best available. The Governments set up an array of expensive tertiary medical services and training facilities, frequently with donor assistance. Most of these facilities, however, were concentrated in urban areas, creating problems of access to the rural populations that typically made up the majority of the population. The standards achieved in establishing this tertiary medical care varied, but by the 1970s, it was clear that the health services and peoples' health conditions in rural areas had not been improved and in some areas had even deteriorated. The parallels with SSF are obvious.

During the same period, some countries including China, Tanzania and Venezuela started to implement programmes to ensure delivery of less ambitious, but still comprehensive, basic health care services to their rural populations, referred to as 'primary health care' (Table 2). Underlying the development of primary health care was a questioning of the prevailing top-down approach and of the dominant role of the medical profession in providing health care. From these examples, a new emphasis emerged on the need for equity and affordable access to medical care, focusing on prevention of disease but still striving to provide appropriate curative services as well. This was reflected in the Declaration of Alma-Ata, adopted by all WHO Members in Alma Ata 1978, that accepted primary health care as the correct means to deliver comprehensive, equitable and affordable health care service around the world (Hall and Taylor 2003). The Declaration states (paragraph VI, Alma Ata 1978):

''Primary health care is essential health care based on practical, scientifically sound and socially acceptable methods and technology made universally accessible to individuals and families in the community through their full participation and at a cost that the community and country can afford to maintain at every stage of their development in the spirit of self-reliance and self-determination. It forms an integral part both of the country's health system, of which it is the central function and main focus, and of the overall social and economic development of the community. It is the first level of contact of individuals, the family and community with the national health system bringing health care as close as possible to where people live and work, and constitutes the first element of a continuing health care process.''

Table 2 Some characteristics of primary health care (based on Alma Ata 1978; Hall and Taylor 2003).

Basic but comprehensive
Focusing on rural poor
Community-based preventative and curative services
Affordable to community and country
Questioning of top-down approaches and the role of the medical profession
Substantial community involvement
Based on practical, scientifically sound and socially acceptable methods and technology
Where professional doctors and nurses not available, Village Health Workers to be trained and used
Forms the first element of a continuing health care system
Includes education on preventing and controlling problems
Emphasis shifted from larger hospitals to community-based delivery of services
Inter-sectoral in nature

Some characteristics of primary health care are shown in Table 2. Parallels with current thinking on management of SSF include the urgent need for more comprehensive spatial coverage in fisheries management beyond the existing pre-occupation with the large-scale, economically valuable fisheries so as to include socially important SSF. The need to ensure both scientific validity and social acceptability is also essential in fisheries. A key issue in both sectors is, of course, affordability with the consequence that professional scientists and managers, dedicated enforcement officers and other fisheries specialists will frequently be too expensive and too rare to be available for each community or local fishery. The dependence on local health workers instead of professional medical staff for primary medicine is thus also an important model for widespread adoption of primary management in fisheries.

Prince (2003) coined the term 'barefoot ecologist' to refer to such an on-site fishery worker, paraphrasing the 'barefoot doctors' trained in China to

bring basic health care to rural villages during the 1950–1970s. Prince placed greatest emphasis on the role of the barefoot ecologist in monitoring and management of the 'localized natural resources'. In response to the need for good information, these change agents would be trained and have a key role in helping to catalyse and facilitate collection and analysis of reliable and precise information on status and trends of natural resources, as argued by Prince. However, he also saw them as having a wider role in building social capital and strengthening community structures (Prince 2003, 2010). This broad view is supported in this paper, and we envisage a role for the on-site fishery worker that encompasses both assistant and sometime facilitator, for which incumbents will need to have the practical skills and background knowledge in all aspects of fisheries management to help in routine implementation of primary management in the absence of on-site professional support.

Governments need to extend their support to SSF by giving much greater emphasis to training and use of such facilitators. They will need to be equipped with social skills to facilitate interactions and building social capital within communities, and to deal with conflict resolution. It would also be of value, if they had the training and ability to recognize feasible and cost-effective opportunities to improve knowledge and to reduce uncertainties allowing evolution into secondary and even tertiary management, where such opportunities exist. The wide geographic range and social contexts of SSF suggest that there will be many opportunities for local innovation in the role and functions of the on-site fishery workers.

Primary, secondary and tertiary management for fisheries

In this paper, we have focused on the need for and features of primary management and compared those features with the current more sophisticated forms of management that we have referred to as tertiary management. Tertiary management as described here should not be confused with conventional, single-species management as widely practiced in much of the twentieth century. The concept of tertiary management in this paper is consistent with modern-day best practices that emphasize power sharing and ecosystem approaches within an adaptive management framework.

By inference, secondary management (not developed here) will build on the social capital developed in the process of securing the viability of the fishery, but will do so in more measured steps that, by reducing some of the major uncertainties still encountered in primary management, will make some progress towards improving the sustainable benefits from the system. Monitoring and evaluation programmes to guide decision-making will likely be more important in these SSF than research that is disconnected from the management process. Pure primary and tertiary management are extremes in a continuum and may even exist side-by-side with, for example, a small-scale inshore fishery being managed with a primary approach, while an adjacent large-scale fishery exploiting some of the same populations may be being managed by secondary or tertiary methods, with connections between the two fisheries.

The differences between primary and tertiary fisheries management (Table 3) mainly reflect the greater economic value of the fisheries that are likely to receive tertiary management as well as some of the other ecological, geographical and social differences between small-scale and large-scale fisheries discussed in the introduction. The elements of Table 3 reflect that social integration must be a key feature of any successful form of management. It is also important to note that central governments will be required to provide considerable support for implementation of primary management but that the nature of that support is very different to that typically provided for tertiary management. Training and support to enable and facilitate local management, including through the provision of an on-site fishery worker where appropriate, should be an integral part of central government's responsibilities.

The Declaration of Alma-Ata quoted previously affirms the critical role of primary health care but still refers to it as the 'first level of contact' and the 'first element of a continuing health care process'. It is our view that the same developmental approach must prevail in fisheries, particularly where individuals and societies are critically dependent on fisheries and fish resources for their livelihoods. 'Primary fisheries management' should be seen as a minimum goal for fisheries or ecosystems where no or inadequate management exists but, wherever the need and the capacity exist or can be created in a cost-effective way, also as an interim step towards the final goal of

Table 3 Some characteristics of primary and tertiary fisheries management.

Primary management	Tertiary management
Objectives	
Social and ecological resilience	Productive and healthy ecosystems
Food security and poverty reduction for communities	Optimal social and economic benefits for stakeholders and society
Management approach	
Based on practical, scientifically sound and socially acceptable methods and technology	Based on practical, scientifically sound and socially acceptable methods and technology
Should be applicable and relevant to all fisheries, but with particular attention on small-scale, low-value fisheries where practical difficulties are likely to be strongest	Principles should be applicable and relevant to all fisheries but professional capacity requirements and costs are often likely to restrict application to high-value fisheries
Co-management with substantial local community involvement	Co-management with substantial industry/community involvement, coordinated at regional scale and integrated within ecosystem/coastal/watershed management
Existing traditional tenure systems validated and promoted by government	Legal regulation of access through individual or community-based formal dedicated access privileges (ITQ, IVQ, IEQ, TURF)
Affordable to community and country	Economic benefits from tertiary management should justify management costs
Some costs supported by government, but supplemented by community input (mainly through in-kind contributions)	Costs supported largely through cost-recovery systems
Role of central government	
Create awareness of the need for fisheries management and the benefits from pro-active approaches; devolve some management authority to local communities	Exercise authority over management regulations at a hierarchy of spatial scales
Provide training and capacity-building for community ownership	Central support in provision of scientific advice, monitoring and management
Periodic reviews and guidance from professional managers, scientists, etc.	Coordinate annual cycle of assessment, management decisions and implementation, as well as periodic in-depth reviews
Rely on community for vigilance. Resort to use of criminal legal system where necessary	Support implementation of sophisticated MCS systems and legal framework
Coordination in scaling-up e.g. in relation to stocks and ecosystems intra-nationally shared between communities	Idem (when local management in place) plus international coordination and cooperation for shared stocks
Inter-Departmental/Sectoral coordination in accordance with ecosystem approach	Inter-Departmental/Sectoral coordination in accordance with ecosystem approach
Scientific advice and input	
Monitoring and analysis based on indicators within capability of community (e.g. logbook records, cognitive mapping). Results feed back into a system of adaptive management	Monitoring and analysis based on best-available science, involving systematic ongoing collection of fishery dependent and independent data, often using sophisticated technology (e.g. satellite vessel monitoring, tagging, trawl/acoustic/video surveys). Results feed back into a system of adaptive management
Appraisal based on local knowledge, and qualitative analysis of indicators, reference directions and qualitative risk assessment	Formal modelling and stock/ecosystem assessments including quantitative risk analysis
Management plans developed and implemented locally with guidance and coordination from extension officer or on-site fishery worker	Management plans developed through cooperation between government managers and scientists and stakeholders
Greater uncertainty requires reliance on limit reference points and reference directions, with required precaution	Strives for achievement of target objectives. Harvest targets determined by quantitative control rules developed through formal management strategy evaluation protocols that have been shown to perform well in simulation testing
Encompasses needs for an ecosystem approach	Encompasses needs for an ecosystem approach
Harvest control methods	
Data-less methods: size limits, closed areas and seasons, gear restrictions	Idem plus catch and/or effort quotas determined by harvest control rules, often allocated to individual vessels, permit holders or cooperatives
Traditional rotation of fishing grounds	Formal spatial management

fisheries development and tertiary management that can be summarized as:

''…use of aquatic resources that will eventually approximate an optimal position on economic and social accounts'' (Kurien and Willmann 2009).

Although tertiary management is highly aspirational for most SSF, implementing primary fisheries management will be a challenging but necessary step – it will require an organized constituency, adequate fora and opportunity for participatory management, appropriate incentives for people to participate and a network of on-site fishery workers assisting and facilitating change at the local level. Without such social institutions, though, nothing will work in the long run.

The decision as to whether to settle for primary management, accepting sub-optimal benefits because of high uncertainties, or to strive to develop secondary or tertiary systems that invest money and resources into reducing those uncertainties will be case-specific. The needs of the fishers and other stakeholders should be a primary factor in this decision, and where there is significant poverty, food insecurity and high dependence on fisheries, the need for optimizing benefits is greatest. However, as argued earlier, there will have to be sufficient scientific and management capacity within the system and the economic and social resources to sustain it in order to shift management to these more intensive levels. Only where there is no realistic hope of acquiring the required additional capacity should primary management be seen as the only option, and in such cases, attention should be focused on trying to ensure that primary management works as effectively as possible.

Conclusions

The purpose of this paper is twofold. The first goal is to draw attention to and support the growing consensus on how to manage small-scale, data-poor fisheries to achieve sustainability and minimize the risks of fishery systems crossing undesirable thresholds. We refer to these approaches as primary fisheries management. The second goal is to caution that this approach has costs in terms of loss of potential benefits to people who are often critically dependent on fisheries for their livelihoods. Primary fisheries management should therefore be seen as a first and minimum benchmark for fisheries management. Achieving that benchmark is likely to lead to setting of higher goals, and building capital for tertiary management that seeks to optimize benefits should remain the long-term goal for fisheries where the human needs are high and the capacity can be developed to produce the higher, sustainable benefits that should result.

In our view, adopting this multi-level approach is important to avoid SSF becoming traps, where poverty and the absence of development opportunities are accepted and taken for granted. Policy-makers and development agencies must have a further-sighted and more ambitious view of the potential of SSF, if they are to give these fisheries the priority and support they will need to emerge from marginalization.

At the same time, we recognize that even achieving effective primary fisheries management is a serious challenge that will require much higher priority and support being afforded to SSF than has been the case up until now. In this regard, the track record of primary health care is not encouraging. Hall and Taylor (2003) report that despite good evidence that primary health care, where it had been well implemented, had resulted in substantial improvements in health, it had largely been dropped in the world's health agenda. Some of the reasons for this demise are summarized in Table 4 and, once again, echo similar problems in fisheries.

Table 4 Reasons why primary health care (PHC) was not sustained (from Hall and Taylor 2003).

1 Many people felt PHC was a cheap form of health care and preferred access to higher levels
2 Civil war, natural disasters, HIV affected ability to deliver
3 After Alma-Ata, political commitment was not sustained
4 Agencies were content if countries adopted PHC as a policy and did not assess effectiveness of implementation
5 Politicians saw PHC as a way to reduce expenditure in health and often most health care resources still directed to higher levels
6 Governance and corruption problems in use of resources made donors wary of funding comprehensive, broad-based programs
7 Inadequate funding and insufficient training and equipment for health care workers
8 Inadequate data, analysis and evaluation systems meant that the actual record of PHC in achieving its health objectives could not be established

While there are many parallels in the challenges and solutions in provision of health care and fisheries management to all those who need it, there are also some fundamental differences that should not be ignored. One such difference is that fisheries exploit a common-pool resource, and most approaches to deal with the problems of excess effort and capacity create winners and losers. Solving this problem requires multi-sectoral approaches to accommodate all. Further, the spatial scale of shared fish resources will often be much wider than the spatial scale of the basic primary management unit that may be restricted to one or more communities. In fisheries, this requires integration across widely separated management units, often including primary and tertiary systems. This in turn will require the creation of and support to additional institutions to undertake the integration. Such differences will add to the challenges of implementing primary management, but they must be confronted as a part of the difficult but achievable road towards ensuring that the SSF realize their potential as contributors to food security and poverty reduction in developing countries.

The challenges to be faced in achieving the minimum goal of successful primary management for all fisheries are therefore substantial, and those of scaling-up to achieve greater benefits from secondary and tertiary management where the need exists are even greater. However, in a world faced with the dual challenge of nearly 1 billion people suffering from malnutrition and widespread erosion of aquatic resources and ecosystems, it is imperative that these challenges are met. Governments need to be made more aware of the vital importance of fisheries to the livelihoods of hundreds of millions of people and the need to secure these livelihoods. They need to provide the policy, financial and technical support to achieve this. Working together, governments, fishers and other stakeholders can then aim for realistic goals that recognize both the needs and the current capacity within the fishery, while also looking further forward to strengthening that capacity where necessary and possible to ensure optimal and sustainable benefits.

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