Alternatives to Conventional Management: Lessons from Small-Scale Fisheries

Fikret Berkes

Abstract

Based on long-term research on community-based resource management, and using small-scale fisheries as an example, alternatives to conventional management may be characterized by: a shift in philosophy to embrace uncertainty and complexity; an appreciation of fisheries as social-ecological systems and more broadly as complex adaptive systems; an expansion of scope of management information to include fishers' knowledge; formulation of management objectives that incorporate livelihood issues; and development of participatory management with community-based institutions and cross-scale governance. Such alternative management is adaptive as well as participatory in nature, as it engages the knowledge of resource users, their adaptive learning, and their institutions for self-governance. It is human-oriented but uses an ecosystem approach, effectively linking social systems with natural systems. Such management breaks out of the old tradition of management-as-control. It effectively redefines *resource* to mean, not commodity, but elements of an ecosystem that supports essential processes as well as human needs. It also redefines *management* to refer to governance, learning and adaptive management, oriented to maintaining the productive capacity and resilience of the linked social-ecological system.

En se basant sur des recherches à long terme sur la gestion communautaire des ressources et en servant de la pêche à petite échelle comme exemple, l'article présente les caractéristiques des solutions de rechange à la gestion conventionnelle : changement de philosophie, afin d'inclure l'incertitude et la complexité; compréhension de la pêche en tant que système socio-écologique et, plus largement, en tant que système complexe d'adaptation; élargissement de l'éventail des informations associées à la gestion afin d'inclure les connaissances des pêcheurs; élaboration d'objectifs de gestion qui intègrent les questions associées au vivant; et développement d'une gestion participative dans les institutions du milieu communautaire et la gouvernance à diverses échelles. Une telle gestion a une nature adaptative mais aussi participative car elle engage dans l'auto-gouvernance les connaissances des utilisateurs de la ressource, leurs apprentissages adaptatifs et leurs institutions. Elle s'intéresse aux humains mais utilise une approche écosystémique en créant avec efficacité des liens entre systèmes sociaux et systèmes naturels. Elle met fin à la gestion en tant que contrôle et redéfinit la *ressource*, qui n'est plus une commodité mais un élément d'un

écosystème qui répond à des processus essentiels autant qu'à des besoins humains. Elle propose aussi une nouvelle définition de la *gestion*, qui inclut la gouvernance, l'apprentissage et la gestion adaptative, afin de maintenir la capacité productive et la résilience du système socio-écologique.

Keywords
Fisheries; complex adaptive systems; traditional knowledge; livelihoods; ecosystem-based management

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Introduction

A comprehensive critique of conventional environment and resource management (managerial ecology) requires the exploration of alternatives to learn from lessons of the various experiments being carried out across Canada and the world. Established ideas need to be challenged with new ideas. Alternative approaches are appearing in a number of areas: fisheries, wildlife, forests, protected areas. Some of them are not 'management' at all in the conventional sense of centralized command-and-control, based on expert knowledge, aiming for the control of nature, and treating people as if they were separate from the environment

Of the various areas of resource and environmental management, fisheries provide one of the clearest examples of the *managerial approach*: the uncritical use of managerial tools and concepts; anthropocentric ethics; authoritarian political frameworks; and deterministic, control-oriented scientific worldviews (Bavington 2002). Worldwide, the management of fisheries has often failed in terms of both social and ecological criteria (Pitcher *et al*. 1998, Charles 2001). In particular, the governance of small-scale fisheries has been problematic (Mahon 1997, Berkes *et al*. 2001). Why conventional management has failed is discussed, in part, in the companion theme issue of *Environments* (Bavington and Slocombe 2002).

A number of people have been thinking critically about conventional fisheries, including fisheries biologist Henry Regier: *"*I have a sense that the population dynamics approach [stock assessment methodology], as it has long been used generally for fisheries management (read mis-management!) has converged conceptually and practically to fit a vertically linear capitalistic approach to the business of fishing. The conventional population dynamics approach fits the 'rational actor model' (i.e., the stupid actor model!) of neo-conservative economics and Hardin's 'tragedy of the commons'… It does not serve well a communitarian, nested-interactive model of commons use…*"* (Regier, personal communication, 2002).

In this paper, I explore further why conventional managerial approaches to fisheries have not worked well, and I identify the elements of a different kind of fishery governance better suited especially for small-scale fisheries. In seeking an alternative, more holistic approach, I use two starting points. The first one is the necessity of combining natural and social systems. The evolving theory and practice of ecosystem-based management explicitly includes humans in the system, instead of trying to separate them out—as if that were possible. I use the term *social-ecological system* to emphasize that

social systems and ecological systems are linked, and that the delineation between the social and the ecological is artificial and arbitrary (Berkes and Folke 1998).

The second starting point concerns the need to manage environment and resource systems for resilience, rather than for products and commodities. The argument here is that maximization or optimization approaches tend to reduce natural variability, impairing renewal capacity of ecosystems and making social-ecological systems fragile and vulnerable (Holling and Meffe 1996). Since social-ecological systems are characterized by cycles of renewal, their integrity is closely related to their ability for self-organization, renewal, learning and adapting (Gunderson and Holling 2002). Systems need to be nurtured for diversity and flexibility. Such resilient systems contain the components needed for renewal and reorganization (Folke *et al*. 2002).

These two points provide the context for the critique of managerial approaches, and for the search for alternatives. If conventional managerial approaches do not work, what would the alternatives look like? What can we learn from the diversity of emergent ideas? In this regard, first I provide an introduction to small-scale fisheries. Then I discuss the relevant issues and explore new approaches through five themes:

- The need for a shift in our philosophy of resource management;
- The appreciation of fisheries as social-ecological systems, and more broadly as complex adaptive systems;
- The need to expand the scope of information and knowledge, including the use of fishers' knowledge;
- The need for broader objectives for management that can deal with social-ecological systems, and in particular with social objectives such as sustainable livelihoods and communities; and
- The significance of participatory management, with community-based institutions and cross-scale governance.

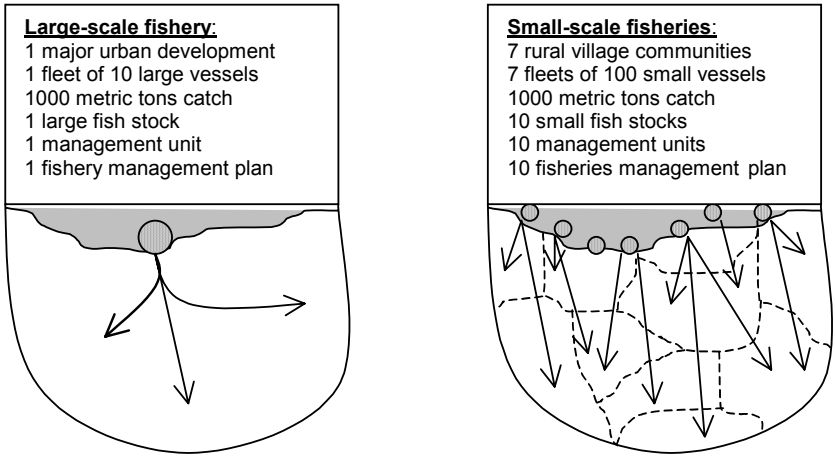
Small-Scale Fisheries

There are some 51 million fishers in the world, and all but 500,000 of them work in small-scale fisheries. According to FAO figures, some 95 percent of the world's fishers are in developing countries, producing 58 percent of the 98 million metric tons of the annual marine fish catch (Berkes *et al*. 2001). The small-scale fisheries sector produces the bulk of the food fish catch for direct human consumption, income and livelihoods. Yet small-scale fisheries have been marginalized throughout the world through government policies that tend to favour large-scale, commodity-oriented fisheries.

Small-scale fisheries include traditional, artisanal and subsistence fisheries. They may be mechanized but tend to use traditional fishing gears such as small nets, traps, lines and spears. Biodiversity of the catch tends to be high. Harvests include a greater variety of species than in large-scale fisheries, and a greater variety of small stocks distributed over numerous management units (Figure 1). Small-scale fisheries tend to predominate in the developing world, however, they are also common in coastal areas of developed countries such as along the Atlantic coast of the USA and Canada (Apostle *et al*. 1998).

Worldwide, science and management of fisheries has a strong Western and Northern bias. Most of the world's fishery science has been devoted to stock assessment, largely single species management. The geographic focus has been on countries of the industrially developed world (the North), and the disciplinary focus has been on biology and economics. Such fishery science has not served well the fishery management needs of the developing world (the South), including countries that primarily depend on small stocks (Mahon 1997). As well, conventional fishery science has not adequately addressed the socioeconomic needs of fisherfolk, livelihood issues, integrated management of coastal resources, and the potential of interdisciplinary, participatory approaches to meet these needs. This is true not only globally (McConney and Mahon 1998, Charles 2001), but it is also true with respect to small-scale fisheries in Canada as well (Matthews 1993, Neis and Felt 2000).

Figure 1. Relative complexity of large-scale and small-scale fisheries.



Source: Prepared by P. McConney (Berkes et al. 2001).

A number of alternative approaches and methods for small-scale fisheries have been developed over the last two decades or so, and are available for fishery managers. These include methodological approaches with broad emphasis on management objectives and processes, rather than merely on stock assessment. They also include participatory rapid survey methodologies; approaches to access fishers' knowledge to enrich the information available for management; methods to build capacity and institutions; and collaborative approaches to bring resource user participation into the management process and decision-making (Berkes *et al*. 2001). These alternative fisheries assessment and management approaches are consistent with the vision of an ecologically, socially and economically sustainable small-scale fishery.

Philosophies of Resource Management Science

The history of *"*resource management*"* is closely associated with the commodification of people and nature in the service of efficient and often rapacious exploitation for industrialization, capitalism and colonialism. Hence, some people reject the term *resource* because it carries implications of exploitation of ecosystems and people. They also reject the term *management* because it carries implications of domination of nature. We can abandon these terms, or (as I do here) we can update their meaning and use. We can expand the meaning of the term resource to include ecosystem products and services used by different groups of people (and different species). We can update the meaning of the term management to highlight governance, social relations, adaptation and the maintenance of system resilience, in place of domination and control of people and nature. After all, resource management, as with all other disciplines, has been evolving.

It is nevertheless true that the dominant philosophy of resource management has been, and to a large extent is still, based on a tradition of positivistic science which assumes that the world is predictable and controllable. However, our evolving thinking on ecosystem-based management indicates that these assumptions do not often hold. The ability to actually predict ecosystem behavior is limited. Ecosystems have thresholds which, when exceeded, can cause major system structuring, and such changes can be irreversible. Models based on equilibrium thinking often do not work, not only because we lack data, but also because ecosystems are intrinsically and fundamentally unpredictable (Holling 2001).

The science of ecology is abandoning the notion of equilibrium (*"*balance of nature*"*) and instead adopting the idea that ecosystems are actually or potentially multi-equilibrium systems in which alternate states may exist over time, and an ecosystem may *"*flip*"* from one state to another (Gunderson and Holling 2002). According to this thinking, we can never possess more than an approximate knowledge of an ecosystem, and our ability to predict the behavior of multi-equilibrium complex systems, such as marine ecosystems, is limited. This does not mean rejecting science but recognizing the limits of conventional scientific knowledge, and appreciating other kinds of information, including the time-tested knowledge held by fishers and other people who inhabit and use these ecosystems directly. The idea of embracing complexity and learning to live with uncertainty is slowly replacing the command-and-control approach to management in a number of fields of applied ecology (Holling and Meffe 1996).

In the area of fisheries, Charles (2001) refers to the *"*illusion of certainty*"* and the *"*fallacy of controllability.*"* Recent thinking in fisheries reflects the growing importance of recognizing complex adaptive systems thinking, and the necessity of moving away from single-species stock assessment models to protecting the productive potential of the ecosystem as a whole (Pitcher *et al*. 1998). Once we put aside the idea of controlling nature, then we can come to terms – as many generations of ecosystem-dwellers in ancient cultures have – with the idea that we can deal with resources through a learning-by-doing approach (Berkes *et al*. 2000). Adaptive management is the contemporary scientific version of such age-old, trial-and-error learning. Adaptive management starts with the assumption of incomplete information,

and relies on iterative feedback learning in which policies are treated as experiments from which to learn (Lee 1993; Gunderson and Holling 2002).

One approach to deal with uncertainty and complexity is to build working partnerships between the manager and the resource user, as envisioned in adaptive management (Lee 1993). The use of imperfect information for management necessitates a close cooperation and risk-sharing between the management agency and the fisherfolk. Such a process requires collaboration, transparency and accountability, so that a learning environment can be created and management practice can build on experience (Berkes *et al*. 2001). To take the argument one step further, we need to look at the further implication of dealing with people issues as part of complex systems.

Fisheries as Complex Adaptive Systems

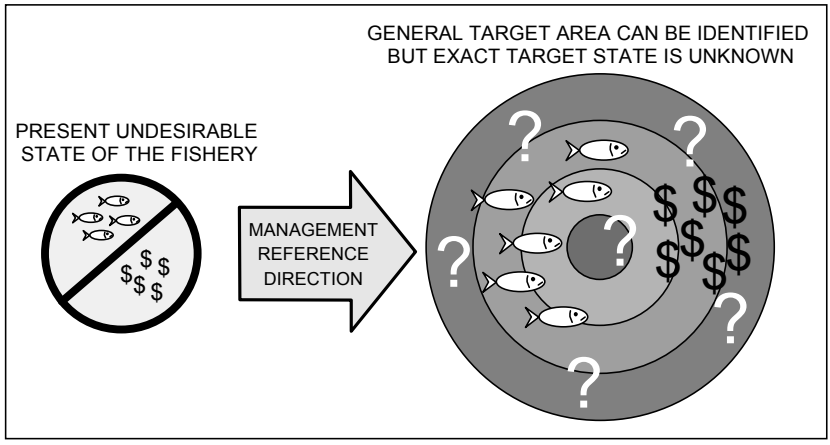
Globalization effects illustrate the futility of separating the social from the ecological. The vulnerability of local fisheries to international markets emphasizes the interconnected nature of the world. The manager of small-scale fisheries can no longer ignore such external drivers as environmental movements, biodiversity issues, eco-labeling and international codes of conduct. It is truly astounding that much of the technical literature of fisheries management has dealt with the subject simply as the biology of stock assessment. In reality, fishery management is an interdisciplinary subject, and fisheries are always complex systems of humans and nature.

A complex adaptive system often has a number of attributes not observed in simple systems, including nonlinearity, uncertainty, emergence, scale, and self-organization (Levin 1999, Gunderson and Holling 2002). These characteristics of complex systems have a number of important implications for resource and environmental management. For example, given ecosystem complexity and uncertainty, it has been generally known for some time that the maximum sustainable yield (MSY), as defined by stock assessment models, is in fact a meaningless target (Larkin 1977).

As an alternative approach, some fishery managers are experimenting with the use of reference *directions* (for example, to increase the proportion of valuable species in the catch, such as snappers and groupers) instead of the MSY or target reference points (e.g., a catch of 1,000 tons of a particular species). Using reference directions, rather than targets, still requires quantitative data, but the choice of the management direction itself is a qualitative decision. This approach shifts the focus of management action from the exacting and difficult question, *"*where exactly do we want to be?*"* to the simpler and more manageable, *"*how do we move from here in the desired direction?*"* (Figure 2).

The consideration of nonlinearity raises other questions. Emphasis on centralized institutions and command-and-control resource management, based on linear thinking and mechanistic views of nature, often aims to reduce natural variation in an effort to make the ecosystem more productive, predictable, economically efficient and controllable. But the reduction of the range of natural variation is the very process that may lead to a loss of resilience in a system, leaving it more susceptible to crises and less able to renew and self-organize (Holling and Meffe 1996).

Figure 2. Reference directions can be the basis for initiating management action even when target reference points cannot be established with certainty.



Source: Prepared by P. McConney (Berkes et al. 2001).

The scale issue raises yet other questions. Can a fishery be managed by a centralized agency, or are there more appropriate structures of governance in which the scale of management institution is matched to the scale of the ecosystem? Often, a *"*one size fits all*"* kind of management ignores scale issues; such mismatches of scale may be one of the key reasons for the failure of environmental management regimes (Folke *et al*. 2002). Management occurs at multiple scales, but the local level is key. The relevant principle is sometimes called the *subsidiarity principle*: as much local management as possible, and only so much government management as necessary (Berkes *et al*. 2001).

One of the insights from complexity thinking is that multiplicity of scales means, there is no one *"*correct*"* perspective in a complex system. A fishing community may focus on livelihoods, regional managers on user-group conflicts, and the central government on export earnings from shrimp. The perspective depends on the interests of the observers and their reading of the history and context of the fishery. A complex social-ecological system cannot be captured using a single perspective. It can be best understood through a multiplicity of perspectives.

Local and Traditional Knowledge

Much progress has been made in the scientific study of fisheries, marine ecology and oceanography. Yet despite the accumulation of a great deal of scientific data, there is insufficient information to manage fish stocks, especially those in multispecies fisheries in tropical seas. We have long been taught to believe that fisheries management requires extensive research, sophisticated models, large amounts of data, and highly trained experts. We now know that these ingredients are not always sufficient, and we are coming

to realize that simpler approaches can be more practicable and cost-efficient (Pitcher *et al*. 1998). Especially in small-scale fisheries, management can work with lower inputs of data, including qualitative indicators, and local and traditional knowledge, as means of evaluating the resource and determining future directions (McConney and Mahon 1998, Neis and Felt 2000).

Traditional ecological knowledge may be defined as a cumulative body of knowledge, practice and belief, evolving by adaptive processes and handed down through generations by cultural transmission (Berkes *et al*. 2000). Traditional ecological knowledge is both cumulative and dynamic, building on experience and adapting to change. It is an attribute of societies with historical continuity in resource use in a particular area. Practical knowledge that does not have such historical and multigenerational character can simply be called local knowledge. Both local and traditional knowledge are relevant to management, and have been used in many contexts from Oceania (Johannes 1998) to Newfoundland (Neis *et al*. 1999).

How can fishery management be improved by supplementing scientific data with local and traditional knowledge? How can information from resource users themselves broaden the base of knowledge necessary for sustainable resource use? There are two considerations regarding the use of fishers' knowledge: its use in place of expensive scientific data, and its use to achieve consensus regarding management action.

Regarding the first, Johannes (1998) provides several examples in which the use of local knowledge and commonsense has led to improved management systems. He takes care to point out that such *"*dataless management*"* does not mean management without information. Johannes (1998) emphasizes the importance of supplementing traditional knowledge with the use of studies on similar fisheries in other locations, including the use of marine protected areas as sources of baseline data.

Regarding the second, the ability to take the steps needed to improve a fishery will be considerably strengthened when the stakeholders can agree on some measures to effect change. The key element is agreement or consensus. Thus, achieving consensus will be an important part of participatory management that is based on local and traditional knowledge. Given the various uncertainties, it is acceptable, and even desirable, to approach management through simple rational schemes that can be understood by all of the participants.

The use of local and traditional knowledge is closely related to civic society and democratic objectives. As part of the trend towards stronger civil society institutions, information produced by specialists is no longer confined to specific groups but becomes widely available. Citizen action and civic science use locally produced information, as well as science. As the barriers between the scientist/manager and the resource user/citizen break down, local and traditional knowledge also start to play a role in resource management. Using fishers' knowledge helps widen the range of information available for decision-making, particularly important for complex, multi-scale systems (Berkes and Folke 1998). Such a wider range of information is not only important, but in many cases necessary for decision-making.

Sustainable Livelihoods and Management Objectives

There is agreement on the larger goals of management: preventing biological and commercial extinction and promoting sustainable use. But the specific goals are more controversial and elusive. They have changed over time, from the maximum sustainable yield (MSY) approach, to maximum economic yield (MEY), to optimum sustainable yield (OSY) (Larkin 1977, Charles 2001). Benefits from a fishery can be measured in different ways, as the quantity of fish harvested (biological), or as revenue from the fishery (economic), or as a composite benefit to society, including sustainable livelihoods and sustainable communities.

The idea of optimal yields emerged as it became evident that the benefits from a fishery could be measured in many other ways than simply the weight or the landed value of the catch. The problem, however, is that multiple objectives are messy. Maximization of a single objective is much easier than optimisation that must address trade-offs and compromises. Nevertheless, the OSY approach is useful because it necessitates a process of reaching consensus on the most appropriate objectives, hence bringing people into the decision-making model more explicitly than is the case with MSY and MEY.

Most of the objectives commonly stated for fisheries management fall into three categories (Clark 1985). One set relates to resource sustainability, ensuring that the biological productive capacity of the resource is maintained. The other two sets are social and economic, and relate either to the optimization of returns from the fishery (efficiency), or to the distribution of those returns among stakeholders (equity). Some 22 fishery objectives may be recognized, six of them related to sustainability, 12 related to efficiency, and eight related to equity (Table 1). Any of these objectives may be a valid goal for a fishery, but it is not possible to achieve them all for a single fishery. Some of the objectives are incompatible with one another. For example, management can aim to maximize the biological yield or the economic yield but not both.

One of the characteristics of small-scale fisheries is the importance of the social context of the fishery, such as kinship and other social relations. In fishing communities, norms, networks and trust relationships (so-called social capital) tend to be important, as are reciprocal relations, values and local institutions. Fishing is not merely a job but a way of life (Pollnac and Poggie 1988), not merely a source of employment but also a livelihood that produces food for the household. In developing countries as well as in the small-scale fisheries of countries like USA and Canada, fishing is often part of a complex of livelihood activities, which may include agriculture and other part-time occupations in which, for example, women may play a major role (Apostle *et al*. 1998, Jentoft 2000).

Fishing may be a seasonal activity that is part of livelihoods of households and communities. Many small-scale fishers are dependent on a diversity of species and habitats for their livelihoods (Allison and Ellis 2001). The ability to follow a seasonal round of activities and the ability to switch species (fishing more when the resource is abundant; moving on when it is not) allows them the flexibility to change and adapt as conditions dictate. Such a pattern of fishing makes for resilient livelihoods; it also has the

potential of maintaining biodiversity by limiting heavy exploitation on any one species.

Table 1. Some objectives of fishery management.

Objective	Main purpose		
	Sustain-ability	Economic	
		Efficiency	Equity
1. Maximise catches		√	
2. Maximise profit		√	
3. Conserve fish stocks	√		
4. Stabilise stock levels	√		
5. Stabilise catch rates		√	
6. Maintain healthy ecosystems	√		
7. Provide employment			√
8. Increase fisher's incomes			√
9. Reduce conflicts among fisher groups or with non-fishery stakeholders			√
10. Protect sports fisheries		√	√
11. Improve quality of fish			
12. Prevent waste of fish	√	√	
13. Maintain low consumer prices			√
14. Increase cost-effectiveness		√	
15. Increase women's participation			√
16. Reserve resource for local fishers			√
17. Reduce overcapacity	√	√	
18. Exploit under-utilised stocks	√	√	
19. Increase fish exports		√	
20. Improve foreign relations		√	√
21. Increase foreign exchange		√	
22. Provide government revenue		√	

Source: adapted from Clark (1985).

Flexibility in fishing requires access to a range of resources. Hence, equity-related objectives of small-scale fisheries are important; they need to be balanced against efficiency objectives such as maximizing yield or revenue. All equity and efficiency objectives, in turn, need to be underpinned by resource sustainability objectives. The conventional objective of maximizing biological yields or economic returns often ignores the larger question of the ecological and social costs of maximization. A broader view of fishery objectives recognizes that a sustainable fishery exists only within the context of a fishing community and an ecosystem that supports it.

Community-Based Management and Participatory Governance

The participatory style of management requires partnerships between the manager and the resource user. However, building such partnerships has never been easy; it requires fishers who are sufficiently well organized to carry out such a partnership; it requires appropriate community-based institutions. Further, it requires an appropriate policy environment and government willingness to engage in participatory management. It also requires appropriate government institutions to interact with fisher organizations – because it *"*takes two to tango*"* (Pomeroy and Berkes 1997).

Until the 1980s, the question of fisheries co-management through the collaboration of government agencies and community-based institutions would not even have come up for discussion. The prevailing management thinking was that fishers could not self-regulate; in fact, fisheries were used as the classical example of the *"*tragedy of the commons.*"* Hence, it was widely believed that government management agencies had to enforce various regulations on fishers as the only way to avoid a *"*tragedy*"* (Pinkerton 1989, Matthews 1993).

There is a large literature showing that fishing communities, under certain circumstances, are capable of using their resources sustainably (Berkes *et al*. 2001). The literature on common property resources has established that communities of users do not require central government regulations to make and enforce simple and practical systems of resource use. Some of the main conditions for community-based management are fairly well known (Ostrom *et al*. 1999). Key findings of commons research indicate that resource managers can deal with users as part of the solution, rather than as part of the problem. This does not mean that the role of the manager has ended; it means that the role of the manager has changed in nature.

The fishery manager needs to know something about participatory processes and local institutions. Institution-building, as part of the larger issue of capacity-building, is central to fishery management. The logic of capacity-building is simple. Involving fishers and fishing communities in the management process depends on the existence of self-organizational capacity to make and enforce local rules. Not all fishing communities have the capability to regulate themselves. Some have traditions of social organization and autonomous decision-making for resource management. They may have their own resource use areas and a system for making rules of conduct (Wilson *et al*. 1994). However, in other cases, community self-organization does not come easily, and it may take effort to organize and build institutions (Pomeroy *et al*. 1997).

In the new science of small-scale fisheries, community-based institutional capacity-building is widely recognized as one of the vital components of coastal resources management (Pomeroy *et al*. 1997, Berkes *et al*. 2001). This is consistent with the interest in a civil society in which the citizens are no longer treated as subjects. It is part of a trend emphasizing horizontal processes such as collaboration, partnership and community empowerment in all areas of resource management and applied ecology, from fisheries to forests and protected areas.

Conclusions

Stock assessment-based fishery management has been too expensive, too incomplete, too uncertain and too impractical to address the needs of small-scale fisheries. There is a general consensus in many circles that "reinventing fisheries management" (Pitcher *et al*. 1998) and searching for new directions have become necessary. Conventional fishery science has many strengths, but it originally developed in the service of single-stock fisheries in the North temperate regions of the world, for the management of large-scale fisheries. It still largely operates in a positivistic mindset, and adheres to an "illusion of certainty"; it has limited ability to deal with environmental variation and uncertainty (Charles 2001).

The conventional approach is ill suited to deal with multi-species stocks in coastal waters targeted by the multiple types of fishing gears that characterize small-scale fisheries in developing countries. These small-scale fisheries, based on many species and stocks and a diversity of habitats, require attention to biodiversity and ecosystem health. Management for these fisheries has to address the social context, and the benefits and costs of not just individual fishing boats and fishing fleets, but of fishing communities as well (Jentoft 2000). Such management requires a broader understanding of human behavior and how people use and misuse marine commons (Ostrom *et al*. 1999).

Fisheries are integrated social-ecological systems with two-way feedbacks, basically complex adaptive systems characterized by nonlinearity, uncertainty, scale and self-organization. Resilience is one of the emergent properties of such systems, and refers to the ability of complex systems to absorb shocks, self-organize, learn and adapt.

Sustainable livelihoods are those that are resilient to stresses, can cope with crises, and are capable of absorbing environmental and economic perturbations. Livelihoods in small-scale fisheries are often based on a diversity of species and stocks and on a diversity of other productive activities. This diversity confers resilience. The local and traditional knowledge of the fishers and their ability to learn from management outcomes also builds resilience. Thus, sustainable livelihoods and sustainable communities require managing for resilience.

Conventional fishery management science does not have the methods in its toolkit to deal with these complexities. What is needed is a different kind of management regime that goes beyond command-and-control measures, empowering fishers to self-organize and self-manage so they can learn and adapt. Co-management and other participatory approaches are consistent with ecosystem-based management. Biodiversity conservation objectives are consistent with the livelihood activities of small-scale fishers and the need to maintain the diversity of resources on which they depend.

Alternative management approaches and many of the elements of a new science of small-scale fisheries are actually in use in various parts of the world (Berkes *et al*. 2001). These alternative approaches turn the managerial approach on its head. Instead of fishing-as-business, these alternative approaches focus on sustainable livelihoods; instead of top-down decision-making, there is participatory management; instead of reductionism and positivism, there are complex system approaches; instead of sole reliance on

expert-knows-best science, local and traditional knowledge are also used; instead of control-of-nature utilitarianism, there is emphasis on humans-in-ecosystem management. Alternative approaches are appearing in a number of other areas of environmental and resource management as well, as documented elsewhere in this theme issue.

These approaches are not 'management' in the conventional sense because they effectively redefine the troublesome terms, *resource* and *management*. As redefined, resources are no longer merely commodities but elements of an ecosystem that supports essential processes as well as human needs. Such management is not control-oriented. Rather, it is about governance, learning and adaptive management; it serves to maintain the productive capacity and resilience of linked social-ecological systems.

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Author Bibliography

Dr. Berkes, Canada Research Chair in Community-Based Resource Management, works in the area of common-property theory and the interrelations between societies and their resources. He has spent some 25 years studying community-based resource management systems in northern Canada and in developing countries, and researching the conditions under which "the tragedy of the commons" may be avoided. He can be reached through the Natural Resources Institute, University of Manitoba, Winnipeg Manitoba R3T 2N2 or at berkes@cc.umanitoba.ca

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www.fes.uwaterloo.ca/research/environments/
environ@fes.uwaterloo.ca
environments@civics.ca