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Towards sustainability: the fishery experience

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Abstract

The fishery, with its inherent complexity and its long history of debate over matters of sustainability, provides an important case study on sustainable development and the routes to its achievement. This paper (a) reviews the evolution of sustainability concepts and management paradigms in the fishery, (b) draws on this experience to develop an integrated "sustainability assessment" framework involving the evaluation of Ecological, Socioeconomic, Community and Institutional sustainability, and (c) analyses potential policy directions for sustainable development. The latter include: use of adaptive management measures to "live with uncertainty," development of integrated strategies to cope with resource system complexity, enhancement of local control and decision making, establishment of appropriate property rights systems, and the combination of comprehensive planning with economic diversification.

Keywords: Fishery; Policy analysis; Resource management; Sustainable development

1. Introduction

Fisheries are among the most complex of human activities. The fishery system involves an inherent interplay between humans and the natural world, as both an economic "industry" and a socio-cultural foundation for people and communities. This has made the challenge of maintaining a healthy resource base fundamental to fisheries, as to forestry, wildlife management and other renewable resource systems, over the millennia (e.g., Peet and Peet, 1990). Indeed, a rich history of research on this theme has built up over time, emerging recently as a new "science of sustainability." This combination of history and complexity make the fishery an ideal case study for those concerned with questions of sustainable development.

This paper presents an historical review of the evolution in sustainability concepts and management practices within the fishery sector, leading to a discussion of an integrated framework for the evaluation of sustainability. This is followed by the analysis of a number of issues, insights and lessons arising in the fishery sector, but of potential applicability in current debates over sustainable development and the routes to its achievement throughout society.

2. Evolving views of sustainability

This section explores (a) the evolution of sustainability ideas within the fishery, (b) ongoing disputes over the practical meaning of "sustainability" amongst differing fishery philosophies

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(Charles, 1991, 1992a,b) and (c) a synthesis of these ideas in a framework for assessing sustainable development options.

2.1. The need for management

In most fisheries, the need to control exploitation through management has become clear over time for several principal reasons:

(a) fish stocks are not only depletable, but have the potential to be driven to extinction if exploitation is uncontrolled; this is notably the case within complex, uncertain aquatic ecosystems where poorly-understood interspecies effects make "laissez-faire" all too likely to produce over-exploitation of one or more interacting species.

(b) conflicting biological, social, economic and cultural goals inherent in most fisheries must be balanced through management, if resource owners are to maximize total fishery benefits, and

(c) controls are needed over the rate of fish stock exploitation, to balance present-day needs with maintenance of the resource at suitable levels for future use.

The extent of these concerns depends in part on the type of fishery in question. Historically, management is well-established in local-level (and therefore vulnerable) fisheries, as in those for salmon stocks or sedentary species such as lobster. For example, it is well understood that in the case of salmon (Parsons, 1993), which are harvested primarily on returning from the open sea to reproduce in their native rivers, the simple act of placing nets across river mouths could result in all returning adults being caught, with extinction the eventual undesirable result.

Recognition of the need for management also varies across the various fishery ownership structures ("property rights"), i.e., whether private, communal, state, or non-ownership (Berkes, 1989). Such recognition came most quickly in the relatively less common cases of private or communal ownership since these involve local-level and more easily-controlled fishery systems, such as riverine fisheries on privately-owned land in the case of private property, or coastal reef fisheries of the South Pacific islands in the case of communal property (Johannes, 1978).

In contrast, the "worst case" scenario from a sustainability perspective is indeed the most common one in the past, non-ownership. Reflecting a view of the oceans as a "vast unlimited frontier" with abundant resources for all, this gradually proved unworkable as an increasing demand for fish, increasing numbers of resource users and expanding harvest technology led to stress on the resource. Controls over exploitation were introduced, legislation transformed un-owned resources into the collective property of the nation's citizens, and accordingly, in most cases non-ownership gave way to state property.

Within this dominant model of state property, the need for management has come to be widely accepted, providing a means to shift common property resources away from "open access" exploitation to resolve conflicts over fishery priorities (Charles, 1992b) and to move towards "optimal" harvesting dynamics that achieve a socially-desirable balance of current and future benefits (Clark, 1990).

This consensual concern for the state of the fish stocks led naturally to the dominance in fishery thinking of a "Conservation Paradigm" or world view (Charles, 1992a,b). Long advocated by biological scientists, this perspective equates sustainability with long-term conservation, so that any activity is judged "sustainable" if it protects the fish stocks, regardless of human-oriented fishery objectives. This view recognizes the possibility that resource depletion, or even extinction, could be the potentially "rational" outcome of unmanaged resource industries. Hence a reliance on market forces, privatization and deregulation, so widely promoted elsewhere in the economy, is widely seen to be infeasible in the fishery.

2.2. The science of sustainability

With the fundamental realization that fish stocks are not infinitely renewable, the question naturally arises: How much fish can be harvested from the sea without being detrimental to fishing in future years? This question and its equivalents in forestry, wildlife management and other renewable resource sectors, has been addressed to a varying degree over the past several centuries, and has become, within this century, a full-fledged "science of sustainability," known as resource management science (Gulland, 1977).

A principal goal of this field of study is to operationalize the balancing act, inherent in all renewable resource harvesting, between present-day benefits and future rewards. To this end was developed the concept of the "sustainable yield," an allowable annual harvest which, even if repeated indefinitely into the future, would not lead to excessive depletion of the fish stock. The concept of sustainable yield has long dominated the analysis of renewable resources (e.g., for the fishery case, see Schaefer, 1954; Beverton and Holt, 1957; Gulland, 1977; FAO, 1983).

Fishery researchers have developed a wide variety of tools to determine sustainable yields, and the corresponding level of fishing activity ("fishing effort") that can be safely allowed without over-harvesting the stocks. For example, one of the most common tools is a graph (Schaefer, 1954) showing how any given annual level of constant fishing effort, applied indefinitely into the future, will produce a certain sustainable yield from the fishery (Fig. 1). This graph is highly simplified – based on a single fish species, an aggregated fishing effort, a lack of uncertainty and a static equilibrium – but has nevertheless proven useful for purposes of illustration.

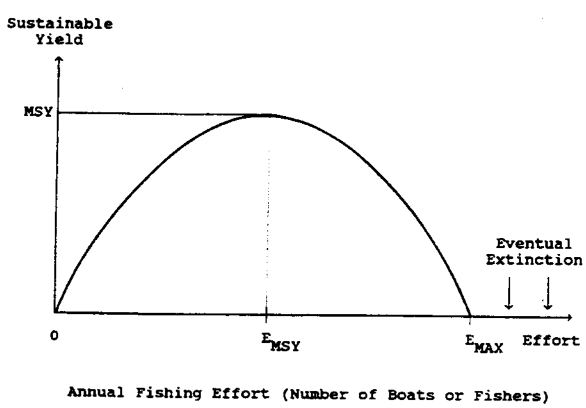

Fig. 1. The long-term equilibrium "sustainable yield" is shown as a function of annual fishing effort (assumed to be applied indefinitely into the future). Sustainable yield is zero when the annual effort is zero, and when the effort lies above a critical upper limit (which implies eventual extinction of the stock). Maximum Sustainable Yield (MSY) is achieved at an intermediate effort level.

Fig. 1 shows how, given certain assumptions, any combination of effort and yield lying on the curve is sustainable biologically. The idea of Sustainable Yield is thus compatible with a spectrum of harvesting options, the choice of which will depend on the goals being pursued (Charles, 1988). The best known of these goals is that of "Maximum Sustainable Yield" (MSY), the largest annual catch that can be taken while maintaining resource sustainability. However, alternative objectives are also possible. For example, if society views the catching of a particular species as immoral, it may prescribe no fishing effort (implying a zero yield); in some countries marine mammals might fall into this category.

2.3. Sustainability and rationalization

In the 1950s, the dominant Conservation paradigm was challenged by a Rationalization Paradigm (see Charles, 1992a,b) focusing on achievement of an economically "rational" or "efficient" fishery. This is based on maximizing resource rent (Anderson, 1986; Clark, 1990), the return to resource owners from the fishery (analogous to the profits and wages that investors and fishery workers, the owners of capital and labour, receive for their inputs). Such rents might be collected by government on behalf of society as the resource owner or remain with the fishers as above-normal profits (Anderson, 1986).

Rationalization advocates emphasize that in laissez-faire, open-access fisheries (without governmental or social controls on fishing) a so-called "open access dynamics" will result: (a) fishers increase their effort (and investment), attempting to gain a greater share of the above-normal profits, and (b) this extra effort causes aggregate opportunity costs of fishing to increase until at the level of revenues, at which point rents are completely "dissipated." In other words, resource rents will be unsustainable if in the form of above-normal profits. To overcome this, the recommended approach involves joint use of property rights, discussed below, and controls on fishing activity to provide the "Maximum Economic Yield" (MEY).

The MEY strategy, and in general the push for greater attention to economic factors, have become popular not only with economists, but also with many fishery biologists (see, e.g., Larkin 1977). The latter is perhaps surprising since there is no implication of ecological sustainability within the Rationalization paradigm. Indeed, Clark (1973) demonstrated that a "rational" fishery may not be biologically sustainable; the "optimal" pursuit of maximum rents (MEY) could drive fish stocks to extinction. For example, in the case of whaling, Clark notes that if interest rates (for money in the bank) are higher than biological growth rates (for whales in the sea), returns to financial capital may well be greater than those for natural capital. Hence rent maximization may involve "liquidating" the natural capital and banking the proceeds.

2.4. Sustainable communities

In contrast to the inherent concern for fish conservation and resource rents in the Conservation and Rationalization paradigms, public policy debates often revolve more around human concerns. Such concerns for the fishery's social fabric and for cohesive fishing communities has a base in the "Social/Community Paradigm" (Charles, 1992a,b). Within this perspective, the best means to achieve sustainability is seen to be through small-scale community-based means, capable of controlling harvests, making use of appropriate technology, and promoting long-term resilience and diversity.

Maintenance of a sustainable yield is seen as important, not due to an inherent concern for fish (as in the Conservation paradigm), but rather as a means to preserve the way of life in fishing communities. The appropriateness of the sustainable yield's distribution is seen as being as important as its magnitude; this favours sustainable yields at higher effort (more fishers) and lower rents than at either Maximum Sustainable Yield or Maximum Economic Yield (Charles, 1988).

2.5. An integrated sustainability framework

The above visions of a "sustainable fishery" vary widely. While there is general agreement that resource conservation is necessary for sustainability, the concept of sustainability must involve more, since there are an infinite number of different use options that will result in biologically-sustainable yields. The choice amongst these options depends on a wide range of human concerns in addition to conservation goals – a point implicit in the broadening of MSY and MEY goals into the "Optimum Sustainable Yield" (OSY), now reflected in some national legislation. (For an interesting discussion of OSY from an economic perspective, see Cunningham et al., 1985.)

Accordingly, a view of sustainable development that explicitly recognizes the fishery's multiple objectives could express the idea of sustainability as the simultaneous pursuit of four components:

- *Ecological sustainability*. The single most crucial component of sustainability involves (a) maintaining individual stocks and species at levels that do not foreclose future options, and (b) maintaining or enhancing the capacity and quality of the ecosystem (and of the environment more broadly).
- *Socioeconomic sustainability*. This component of sustainability focuses on socioeconomic welfare, measured at the level of individuals, and aggregated across the resource system. It blends together economic criteria (such as the level of resource rent) and social criteria (such as overall distributional equity), recognizing that these are inseparable at the policy level. In other words, the maintenance of aggregate welfare involves generating sustainable net benefits, suitably distributing these benefits amongst participants, and maintaining overall viability within local and global economies.
- *Community sustainability*. While socioeconomic sustainability is focused on well-being at the "individual" level, this component can be viewed as sustainability at a "group" level, recognizing that a community is more than a collection of individuals. Hence, emphasis is on

maintaining or enhancing "group" welfare of participating and affected communities (including economic and sociocultural welfare, overall cohesiveness, and the long-term health of the human systems).

- *Institutional sustainability*. A prerequisite for sustainability in each of the above three components is the maintenance of suitable financial, administrative and organizational capabilities over the long-term; this institutional sustainability is related in particular to the manageability and enforceability of fishery regulations.

The first three of these sustainability components can be viewed as the fundamental "points" of a Sustainability Triangle. The fourth, institutional sustainability, interacts amongst these, potentially affected (positively or negatively) by any policy measure focused on ecological, socioeconomic and/or community sustainability (Fig. 2).

If each of the components is viewed as crucial to overall sustainability, it follows that "sustainable development" policy must serve to maintain reasonable levels of each. In other words, system sustainability would decline through a policy seeking to increase one element at the expense of excessive reductions in any other.

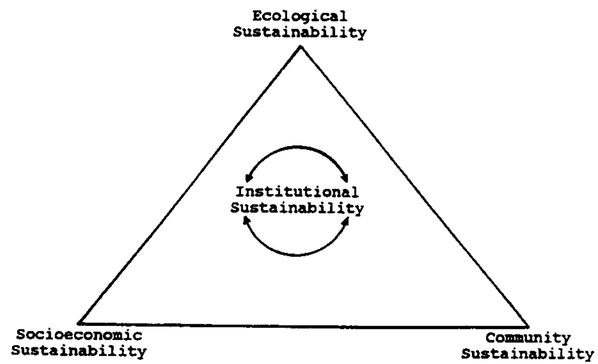

Fig. 2. The Sustainability Triangle forms the basis of a framework for sustainability assessment, based on three fundamental components as corners: ecological, socioeconomic and community sustainability. A fourth component, institutional sustainability, interacts with each of the "corners."

This framework, which draws together the various philosophical "threads" that have developed over time in the fishery sector, could form the building blocks of a "Sustainability Assessment" process to evaluate the current level of sustainability, or predict its future, within a specified

Table 1
A sustainability checklist

Ecological sustainability
– Is there reasonable assurance that resource exploitation levels on directly impacted species are and will remain sustainable?
– Are indirect biological impacts reasonably understood, to the extent required to ensure ecological sustainability?
– Are impacts on the ecosystem as a whole reasonably understood, to the extent required to ensure ecological sustainability?
– Are imposed stresses and rates of change likely to be within the bounds of ecosystem resilience?
Socioeconomic sustainability
– Will aggregate long-term employment, food security and livelihood security be maintained or enhanced?
– Will the economic viability of each economic "player" in the region be maintained at or increase to acceptable levels?
– Are possible impacts on input and output prices understood?
– Is resource depreciation, and changes in natural capital more generally, incorporated into national accounting practices?
Community sustainability
– Will long-term stability of affected communities be maintained?
– Does the local population have access to the resource base?
– Is the local population integrated into resource management and development practices, with traditional management approaches utilized to the extent possible?
– Are local socio-cultural concerns (traditional practices, community decision-making structure, etc.) incorporated?
– Are there adverse impacts on any components of the human system, such as women, youth, particular religious groups, etc.?
Institutional sustainability
– Will the long-term capabilities of relevant institutions be maintained or enhanced over time?
– Are institutions financially viable in the long term, or of such intrinsic importance as to justify support regardless?

system. Such a process can be elaborated through a comprehensive "checklist" to evaluate ecological, socioeconomic, community and institutional sustainability (see, e.g., Table 1), the elements of which could be quantified as "sustainability indicators."

3. Policy directions for sustainable development

From the foregoing historical review, it is apparent that within the fishery system, matters of sustainability are approached from a wide range of perspectives. This section draws on fishery experience and utilizes the integrated framework presented above to analyse a number of policy directions which may be appropriate in the pursuit of sustainability within the fishery and elsewhere. These approaches involve: (1) living with uncertainty, (2) coping with complexity, (3) improving local control, (4) establishing appropriate property rights, and (5) combining internal planning with suitable external economic diversification.

Three clarifications should be made at the outset regarding these approaches. First, there is no claim that they are in any way novel proposals, nor that they are "universal truths"; this section simply notes that experience in the fishery supports an increased policy focus in these directions. Secondly, while the points made here seem of particular relevance, they are not intended to provide a comprehensive, exclusive package; other measures may well be of equal relevance. Finally, it is not being suggested that policy directions elaborated here have been universally implemented in fishery systems. Indeed, to the contrary, what is perhaps most notable is the degree to which this is not the case; we return to this at a later point.

3.1. Living with uncertainty

The fishery is an unusual economic activity in that no one can be certain how much of the key ingredient is available in any given year, what amount of product should be produced that year, or what effect that production will have on future availability of the fish. This uncertainty is dealt with through two principal approaches:

(a) "Adaptive management." In the salmon fisheries of North America's Pacific coast, for example, high levels of uncertainty in stock abundances have led to interactive management approaches in which allowable catches are adjusted incrementally; fisheries are opened and closed, sometimes from day to day, as managers learn more about the abundance of the stocks (Walters, 1986; Parsons, 1993).

(b) "Annual business plans." In the groundfish fisheries of Atlantic Canada, for example, there is also uncertainty in the abundance of species such as cod and haddock, yet this uncertainty tends not to be incorporated into within-season management plans. Since the stocks were viewed as rather immune to the risk of stock collapse, strict adherence to conservation goals was viewed as less crucial. Hence, management is less interactive (based more on annual catch quotas), and the fishing industry adopted "annual business plans" comparable to those in non-resource sectors.

Unfortunately, a crisis has developed in the Atlantic Canadian groundfish fishery as abundances have declined to unprecedented low levels in the early 1990s (Fisheries Resource Conservation Council, 1993). Although any cause-and-effect conclusion is tenuous, it does appear that a neglect of uncertainty has been one cause of this.

Certainly, other things being equal, it would be desirable from the fishing industry perspective to be able to follow fixed annual harvest plans and deterministic production methods. Yet there appears to be a tradeoff between the superficial stability obtained by such an approach and the ecological risks involved. If fisheries are to be managed sustainably within an uncertain environment, it may be desirable to follow "robust" methods of management more in keeping with the salmon management model. This requires a flexibility that, to salmon fishers, is undoubtedly disliked yet widely accepted. Such an approach is designed to withstand unexpected changes in nature's course, with harvesting decisions based on "conservation first."

3.2. Coping with complexity

The fishery is a highly complex bio-socio-economic system. As noted earlier, there are typically many different species involved and a wide variety of ownership forms. On the operational side, a spectrum of fishers are involved; full-timers and part-timers, "fixed" gear (e.g., hook-and-line or gillnets) and "mobile" gear (e.g., trawlers), small-scale (artisanal, usually inshore) and large-scale (industrial, typically offshore). Beyond the harvesting sector the system also involves processors, distributors, marketing channels, consumers, government regulators and support structures.

The existence of complex interactions between components of the fishery system and beyond are well established, but are not always incorporated into fishery management and development. There is now increased awareness of the value of this integration to fishery sustainability, leading to an increased interest in two key areas:

(a) Multi-disciplinary research, based on a fuller understanding of interactions between the fishery and the broader ecosystem/human system, crosses traditional borders between natural science, social science and technological studies, and involves participation by resource users with a focus on meeting the informational needs of those users (Charles, 1991; Durand et al., 1991).

(b) Integrated developmental strategies deal with the full complexity of the fishery system *and* associated activities outside the fishery. This approach, reflected, for example, in the concept of "Integrated Coastal Development" (e.g., Arrizaga et al., 1989), is undoubtedly challenging to implement. Consider, as but one example, efforts to promote fisher marketing cooperatives as a tool to bypass "middlemen" and thereby improve the socioeconomic sustainability of fishers. A system-based analysis suggests this is likely to be successful only under certain circumstances in which the "middlemen" so displaced are external to the local fishery system. In fact, these individuals are often women in the local community (see e.g., FAO, 1984; CIDA, 1993); removing their means of livelihood could increase differences in income levels amongst local families, producing internal conflict and resulting in a loss of community sustainability.

3.3. Local control

In most fisheries worldwide, management has been implemented in a centralized manner, typically through a regulatory framework that (a) is imposed in a uniform, "top-down" manner over a broad region, ignoring the diversity of localized environments, (b) is based on efforts to control an exceptionally complex system of fish stocks, fishing fleets, processors, and even fishing communities, and (c) is designed with at most limited decision-making power on the part of fishers and others involved in the industry.

In many cases, this has led to an "us versus them" attitude in which fishers view the flaunting of regulations as "fair game," regardless of impacts on the resource. There is typically little social or peer pressure to follow the imposed regulations, which results in both legal measures to thwart the restrictions and illegal fishing. The creation of sustainable fisheries has been clearly very difficult under such conditions, even with the addition of expensive research, enforcement and consultative processes.

While the above management approach may be inescapable in some fisheries, such as those of an international nature and/or those exploiting migratory or widely distributed stocks, in general the achievement of long-term sustainability requires fishers to "buy into" management. This seems most likely if top-down regulations are replaced by decentralized arrangements that give fishers, their organizations and their communities a clear stake in managing local resources, a degree of decision-making power, and the responsibility (with government) to ensure the fishery's sustainability.

Depending on the circumstances, this might take the form of *fisher* (industry) involvement and/or *local* (community) involvement. In both cases, the technical expertise built up in centralized fishery management structures needs to be devolved to, or at least available at, the local level. Two key approaches to local control have been promoted. One, based on fishery property rights, will be discussed in detail below. The other, "co-management," involves the joint development and enforcement of regulations by fishers, communities and the government (e.g., Berkes, 1989; Pinkerton, 1989).

Co-management has evolved in a variety of jurisdictions in both developing and developed regions. For example, in the mid-1980s, a co-management system for fish and marine mammal management developed in the Canadian Arctic as a result of aboriginal (Inuit) resource claims; the Fisheries Joint Management Committee, comprised equally of Inuit and government members, emphasizes "resource users making resource management and socio-economic decisions" (Department of Fisheries and Oceans, 1990).

3.4. Appropriate property rights

The existence of property rights, or the lack thereof, can have major implications for fishery sustainability. Indeed, the greatest threat to sustainability comes in cases where resources are unowned, as in high seas fisheries located outside 200-mile limits of national jurisdictions. At the other ownership extreme, fishery privatization may also be incompatible with full system-wide sustainability, if potential benefits in improving rent generation are counteracted by losses to ecological, socioeconomic and community sustainability.

In fisheries under state property, there is an increasing trend toward the use of "quasi-property rights," under which portions of the allowable harvest are allocated each year as a form of property to individuals, fishing firms, communities or cooperatives. Dividing up the harvest in this manner supposedly means that one's own fish allocation can be caught whenever convenient (and/or profitable), thereby avoiding the "rush for the fish" and the resulting rent-dissipation common in many competitive fisheries.

The Rationalization-oriented version of such arrangements focuses on increasing economic efficiency through market mechanisms, notably "individual transferable quotas," which allow companies and individuals to buy and sell fishing rights (Moloney and Pearse, 1979; Clark et al., 1988). Such measures may improve the sustainability of resource rents, but cannot ensure that ecological sustainability is maintained at a reasonable level, since incentives may be created to "dump" (over-exploit) small or low-valued fish so as to maximize the value of each quota allocation. Community welfare and socioeconomic sustainability may also decline if inequities are created through the concentration of fishing rights.

On the other hand, when fishing rights are allocated at the group level, the quasi-property rights system involves communal property, community-based management and self-governance (Berkes, 1989; Ostrom, 1990). Such arrangements often involve collective rights known as "Traditional Use Rights in Fishing," or TURFs (Christy, 1982), and are based not on market forces, but rather on local institutions. This institutional environment creates an incentive for the community collectively to (a) ensure that the resource is managed wisely, (b) efficiently manage allocation of catches and fishery access (also helping prevent the "rush for the fish" noted above), and (c) develop local enforcement tools.

Individual transferable quota schemes may be most feasible in industrially-oriented fisheries where the goal of rent generation may dominate over such community and socioeconomic sustainability considerations as employment stability and an equitable catch distribution. On the other hand, the policy instruments of community-based management may best serve sustainability goals in small-scale artisanal fisheries where history and tradition play a major role, and where fishers have clear ties to their coastal communities. Examples here include aboriginal fisheries and Northwest Atlantic lobster fisheries (Johannes, 1978; Christy, 1982; National Research Council, 1986; Acheson, 1989; Berkes, 1989).

An intermediate property rights proposal involves "community quotas," fishing quotas allocated by government to communities rather than to individuals or companies. This interesting approach may have the potential to enhance community sustainability, allowing each community to decide for itself how to utilize its quota, whether by allocating it in a rent-maximizing auction or by distributing the quota so as to achieve other objectives.

3.5. Fishery planning and economic diversification

While appropriate policies for sustainable development in the coastal context are best left to local determination, it seems that these must involve a careful combination of internal planning and external diversification, particularly in fisheries that face the trio of fundamental problems – over-exploited resources, over-extended fleets, and a lack of non-fishing alternatives.

In terms of internal planning, the fishery must be organized with an emphasis on "intelligent fishing," in which each fish caught maximizes societal benefits while minimizing harm to the environment and to the young immature fish that determine the fishery's future. Where fleets have over-expanded and some form of fleet reduction and/or "job sharing" is needed, any such fleet reductions must be well-planned to achieve an "optimal mix" of boat sizes and types.

With respect to external action, economic diversification and the provision of employment alternatives are crucial in relieving pressure on the fishery resource as the primary source of livelihood (Smith, 1981; Charles and Herrera, 1994). From an economic viewpoint, diversification increases the opportunity costs of fishing, making that activity *relatively* more expensive and less desirable (compared to other options), so less effort finds its way into the fishery.

The need for extra-fishery diversification is widely recognized. Unfortunately, fishery policy has often been developed in isolation from that of the system as a whole, with a focus placed merely on maximizing the removal of "surplus" fishers and vessels; the matter of where the "redundant" people are to go is left to the future. This tends to produce infeasible policy, inadequate from socioeconomic and community sustainability perspectives. Such fishery actions might be better attempted in conjunction with appropriate community-based diversification. In a coastal context, for example, this could take place through creation of employment alternatives that build economic strength within the community, taking advantage of local comparative advantages in ocean-related activity (such as development of alternative fisheries, fish farming, coastal tourism, and the like).

4. Conclusions

The inherent complexity of fishery systems, combined with the lengthy evolution of sustainability experience in the sector, make the fishery a useful "case study," and indeed an ideal testing ground for those concerned with the implementation of sustainable development. This paper has attempted:

(a) to review the history of sustainability ideas and debates in the fishery sector, notably the evolution from unregulated laissez-faire to an understanding of the need for fishery management, whether based on one or another of the competing conservationist, rationalization and community-oriented paradigms.

(b) to develop, on the basis of that history, an integrated framework (the Sustainability Triangle) which views sustainable development as a multi-faceted process involving simultaneous pursuit of ecological, socioeconomic, community and institutional sustainability.

(c) to utilize that framework to describe and evaluate a set of foci for sustainable development policy: (1) development of approaches for "living with uncertainty," (2) greater recognition of inherent complexities in the fishery, (3) enhancement of local control, (4) establishment of appropriate property rights, and (5) comprehensive fishery planning combined with suitable economic diversification.

As noted earlier, despite extensive experience with matters of sustainability in the fishery, implementation of the above policy directions has been sporadic. Uni-disciplinary research, isolated development projects and top-down deterministic management remain common in fisheries. Meanwhile ecological, social and economic crises frequently engulf the fishery, despite the high levels of financial aid that are often provided to the sector.

Why has there been such frequent failure in fisheries to adopt policies favouring sustainability, despite a lengthy experience with the concept and a poor track record in achieving the four components of sustainability? There are perhaps three key reasons. First, and perhaps most fundamentally, the divergence of views across fishery paradigms over the exact elements of sustainability has prevented any practical consensus on policy directions.

Second, sustainable development policy has often focused more on the "Macro" level (global, national or regional systems) than on the "Micro" level (community-based, typically small-scale systems). While these thrusts are certainly not incompatible, an appropriate balance between them is important. In fisheries, Macro approaches may be needed in inherently large-scale situations, such as transboundary resources, foreign fishing in coastal waters, or national accounting calculations of resource depreciation. However, experience suggests that in some cases, Macro sustainability goals might be better based on community-based Micro means than on macroeconomic aggregates. [This point has also been made in a variety of contexts outside the fishery sector (e.g., Altieri and Masera, 1993).]

Third, there is an intriguing question of the balance between fishery sustainability and overall societal sustainability. It is well known that fisheries are often "employers of last resort" in rural areas; by absorbing "surplus labour" from elsewhere in society, the fishery serves a stabilizing role from the Macro perspective of national policy making. However, such a role reduces sustainability of the fishery resource and the fishery system as a whole. One might speculate that the lack of adoption of Micro-level sustainability policies, and the high levels of financial and institutional support continually provided to fisheries, simply reflect an emphasis on maintaining sustainability in the broader societal sense.

Whatever the reason for the discrepancy between sustainability needs and practical policy implementation, the fishery experience highlights the rather urgent need for research to determine the most appropriate and efficient paths toward ecological, socioeconomic, community and institutional sustainability within an inherently complex and uncertain environment.

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