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FISHERIES AND COASTAL ECOSYSTEMS: THE NEED FOR INTEGRATED MANAGEMENT

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INTRODUCTION

How can it be that fisheries appear in trouble every time newspapers report on them? Coastal and marine fisheries have existed for a long time. Initially, people waded along the shore gathering shells and harpooned whatever marine mammal or large fish ventured inshore. Only those fish and other animal species that were large and had very narrow coastal distribution were then in danger of being over-fished. The invention and increased sophistication of crafts gradually extended our reach offshore but, for millennia, the elements and the very vastness of the ocean protected most fish populations from being over-fished; hence the notion that earlier, pre-industrial fisheries were 'sustainable' (Pauly et al. 2002). The gradual expansion of European fishing fleets in the 17th and 18th century, and their impact on the cod and other fish populations they exploited in European waters and off New England and Eastern Canada did not appear to change this, though signs of localized, fisheries-induced depletion were already then beginning to occur.

Things really changed when, as a result of the Industrial Revolution, steam trawlers began to expand into the North Sea, gradually mowing down one coastal stock after the other, then moving on to do the same offshore, inducing the first 'serial depletions' on record (Pitcher 2001). Further technical developments – the invention of hydraulic winches, inboard refrigeration, acoustic fish finders, etc. – increased the ability of these boats to effectively locate and catch

large quantities of fish and to bring them back from longer distances, thus opening up the entire North Atlantic to fishing operations (Cushing 1988).

Similar development occurred in other industrialized parts of the world; e.g., in North America, North Asia, Australia. There as well, this occurred in waves following on the two World Wars, both of which accelerated the development of technologies that were later transferred to fishing operations.

Thus, in the early 1950s, the industrial fleets of the world were poised for global expansion. Their effects became intensified by another great wave of fisheries industrialization, this time in newly independent and other countries of Southeast Asia, Africa, and South America. As a result, global catches strongly increased in the 1950s and 1960s, grew more slowly in the 1970s, and peaked in the late 1980s, as for the first time, catches from newly exploited stocks failed to compensate for depleted ones. Global catches have been declining since, despite the ever-increasing capacity of the world's fishing fleets (Watson and Pauly 2001; Figure 1). This implies a massive decrease in the inherent profitability of these fleets now maintained in most parts of the world by massive government-sponsored subsidization schemes (Munro and Sumaila 2001).

Growing populations in developing countries, and a growing taste for fish in many developed countries led at the same time to a great increase in demand which, being increasingly hard to meet, is causing fish prices to increase more rapidly than that of most other foodstuff (Sumaila 1999). This has also led to an increasing export of fish from developing to developed countries, thus reducing access to the poor of many developing countries of a previously cheap source of animal protein.

While it is usually possible for the agricultural sector to intensify its productivity in response to increase in demand and thus to preserve food security, yields from fully developed fisheries can, at best, be maintained (Ricker 1975; Hilborn and Walters 1992). It is more common, however, for yields to decline due to excessive levels of fishing effort, and for over-expansion of fishing and coastal developments (including mariculture — the farming of marine fish and shellfish)

FIGURE 1: **Trends in world global marine fisheries catches**

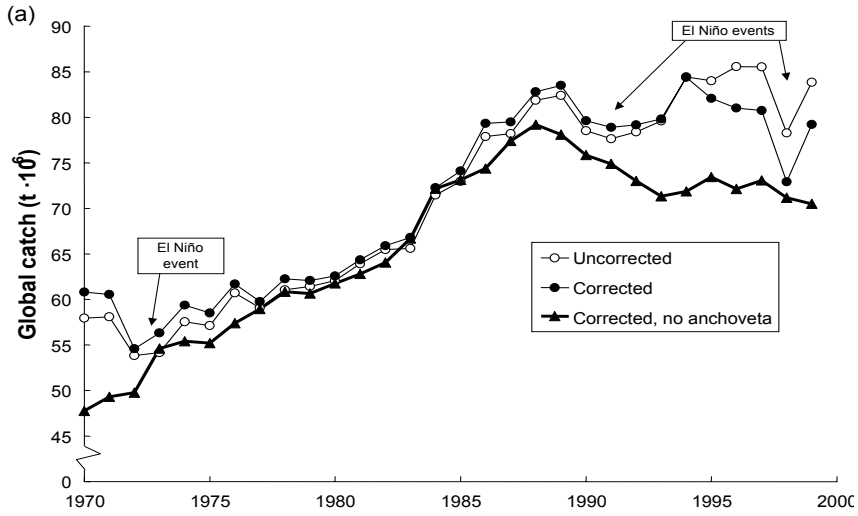


Figure note: excluding freshwater catches and aquaculture production, displaying - since the late 1980s - a downward trend that is visible once the over-reporting of catches from China is corrected for, and the widely fluctuating Peruvian anchoveta is disconsidered (modified from Watson and Pauly 2001.

to destroy the structural integrity of coastal and other marine food webs, as is presently occurring in most parts of the world (Pauly et al. 1998, 2002).

Clearly, we must try to prevent the situation from worsening by searching for proactive and integrative measures for managing our fisheries and other coastal activities, and for minimizing negative environmental impacts on our coastal ecosystems (Costanza et al. 1998). The task for scientists and others engaged in coastal and marine resource management is thus to find ways to accommodate the need of coastal populations for sources of food and gainful employment with practices that are compatible with the continued productivity of natural coastal and marine resources. Or, in other words, we must show that fisheries exploitation and resource conservation are mutually compatible.

This contribution discusses related fisheries research and coastal

area governance issues based mainly on (a) insights gained during the first years of the 'Sea Around Us' project devoted to studying global fisheries impacts on coastal and marine ecosystems, initially focused on the North Atlantic, led by the first author (see www.seaaroundus.org), and on (b) research by the second author on innovative methods for involving stakeholders in decision-making process for ecosystem-based management.

These issued are presented under three headings, dealing with:
(1) Downstream implications of fisheries impacts on marine ecosystems;
(2) Fisheries and other human impacts on coastal systems; and
(3) Alleviation of fisheries and other impacts at local and regional levels.

DOWNSTREAM IMPLICATIONS OF FISHERIES IMPACTS ON MARINE ECOSYSTEMS

Marine fisheries systems comprise the productive shelves surrounding continents down to a depth of 200 m, and the deeper, oceanic waters of tropical, temperate and polar areas. In these systems, fisheries activity is the dominant force behind environmental change. Though extremely variable in term of their physical features, these systems are all strongly and similarly impacted by fisheries. Those biomass withdrawals modify ecosystem biodiversity and functioning, the latter also through habitat modification resulting from bottom trawling (Watling and Norse 2000). The polar components of these systems are also beginning to show direct effects of global warming.

As mentioned above, reported global marine fisheries catches (or more precisely: landings), now of the order of 80 million tonnes per year (incl. 30 million tonnes used for fish meal and oil), which had increased rapidly following World War II, have peaked in the late 1980s. This is in spite of continued massive private investments and government subsidies which have increased fishing capacity several times beyond that required, given the size of global marine fisheries resources (Mace 1997). Continuation of present trends will thus lead to a significant decrease in global fish supply. This potential shortfall

is particularly worrisome given an increasing demand unlikely to be met by fish farming (especially not the farming of carnivorous fishes such as salmon, which requires meal and oil derived from small fishes also suited for human consumption; Naylor et al. 2000).

Considering other components of fisheries catches, i.e. discarded by-catch (20-30 million t), and illegal/unreported catches, including 'ghost fishing,' i.e. fishing by lost gear (another 20-30 million t; Pauly et al. 2002) results in a global marine catch largely exceeding previous estimates of potential yields (Pauly 1996). Available ecosystem indicators suggest present catches (and especially fishing effort) levels to be unsustainable, despite institutionalized systems for 'single-species' assessments and management of fleet operations (Ludwig et al. 1993). Fisheries impacts have caused shifts in species composition, notably toward species with lower sizes and trophic levels (Pauly et al. 1998; Figure 2), and decline in biomass (often by one order of magnitude; Christensen et al. 2003).

Also, with onboard high technology (fish finding and navigation) having enabled access to previously inaccessible natural refugia (great depths and distances offshore, rough bottoms, etc.), fisheries have caused numerous local extinctions of marine fish and higher vertebrate populations and caused widespread habitat alteration and loss. As some of these are still reversible, this has led to increasing calls for the (re-)establishment of marine refugia and other forms of ecosystem-based management (National Research Council 1999; Pauly et al. 2002) that would encourage resource conservation.

FISHERIES AND OTHER HUMAN IMPACTS ON COASTAL SYSTEMS

A large fraction of the global human population lives on coastal lands, and the building of cities and their resulting effluents have always had a strong impact on coastal ecosystems. These impacts have much increased in the last decades, especially in tropical developing countries which saw, besides the expansion of cities, a massive expansion of brackish water shrimp culture in areas previously covered by mangrove (Pauly and Ingles 1999; Chuenpagdee et al. 2001a), direct

FIGURE 2: **Schematic representation of 'fishing down food webs**

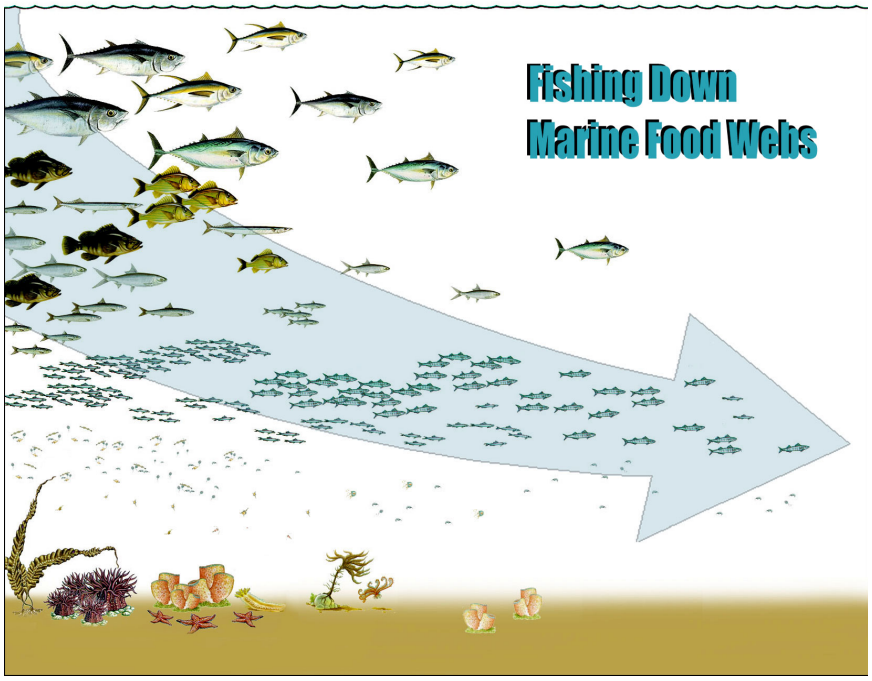


Figure note: wherein a fishery starts by catching abundant large fish high in the food web (upper left corner), then gradually shifts to smaller fish, lower in the food web, as the former resource becomes less abundant. This process, which occurs in virtually all fisheries of the world, usually goes along with habitat destruction, as illustrated here by the gradual disappearance of the bottom structure created by bottom organisms (see text).

exploitation of coral reef for lime and building materials, dredging of seagrass areas, etc.

This makes ecosystem-based management even more important in coastal waters (down to 30-50 m), whose previously abundant fisheries resources have traditionally been managed based on single-species, sectoral approaches. Given the downstream impacts of land-based activities on coastal productivity, these approaches were even less justified than further offshore.

A consensus is slowly emerging among fisheries scientists and conservationists that ecosystem-based management must consider the following:
(a) The trophic relationship between exploited species and their supportive forage base;
(b) The competition between fleets or sectors that express themselves through trophic linkages within ecosystems; and
(c) The direct and indirect habitat impacts of fishing.

It is also becoming evident that ecosystem-based management requires mapping of the interactions of the effects of (a) to (c) onto bio-geographically defined ecosystems, and hence the use of approaches based on Geographic Information Systems, a tool that has so far found surprisingly little application in fisheries research.

In terms of research, extending coastal fisheries ecosystems to include the adjacent coast lands zones requires, additionally, the identification of land-based activities impacting on the relationships in (a), (b) and (c), and quantifying, as opposed to only assuming, relationships between mangroves and coastal fisheries productivity (Pauly and Ingles 1999). Similar research is required for seagrasses, estuaries, coral reefs and other sensitive coastal features in order to allow consideration in coastal project developments of the benefits foregone by the loss of such features (Costanza et al., 1998). Valuation of the importance of these ecosystems can be undertaken using the damage schedule approach, a non-monetary valuation method developed by Chuenpagdee et al. (2001a; see also Appendix 1).

ALLEVIATION OF FISHERIES' AND OTHER IMPACTS AT LOCAL AND REGIONAL LEVELS

How could the dire and worsening situation of fisheries develop as it did? One answer clearly lies in the 'open-access' nature of marine resources which encourages the much decried 'race for fish.' Studying the actors involved provides another useful perspective. Who are actors in fisheries? Are they being included in or excluded from the governance of fisheries? We shall elaborate on these two questions,

as they provide a foundation for discussion of structure and power related to the principles of fisheries governance.

Actors are normally seen as those who are 'directly' or 'indirectly' related to the fisheries resources or those with 'in-vested' interests. The general public, although frequently mentioned in the fisheries management literature, is generally not well represented in such discussions, as the government agencies tasked with managing fisheries on behalf of the citizenry at large (i.e. the true owner of the resources) have been 'captured,' in most countries by the very industry they are supposed to regulate.

It is obvious, however, that unless all major actors who take part in fisheries are being effectively represented in the governance process, fisheries resource sustainability and the related food security issues will continue to worsen. As well, the inclusion of all concerned by the state and management of the coastal and marine resources must be coherent with the ecosystem-based management introduced above.

Fishers and other persons who rely on fisheries as the major sources of income (e.g., processors and suppliers) are the main, and often the only, group of actors considered in discussion about fisheries governance. Here, a gradual consensus has emerged in many parts of the world that a transition is required from a p-down, government-based, centralized approach to management to bottom-up, community-based, decentralized 'co-management' approaches (Pinkerton 1989; Jentoft and McCay 1995), which imply recognition of fishers and fishing community as quasi-owners of the resources. This movement also requires new institutional arrangements and strategies to deal with issues such as heterogeneity of user groups (Felt 1990), community representation (Jentoft et al. 1998), community support (Noble 2000), and genuine devolution of state power (Sandersen and Koester 2000).

A variant of this approach, the community-based management (CBM) model, suggests that fishers, other resource users and the community at large should become increasingly engaged in decision-making, and ultimately taking leadership in management. In this model, power is shared between 'authorized' (i.e. top-down government) managers and the community, with increasing responsibility

for management and decision-making authority for the latter.

One of the most important issues associated with this model is the 'inclusiveness' of the actors in the community, and their interactions, which can be either positive or negative. Positive interaction involves open dialogue, communication, negotiation and transparency, which are expected to result in conflict resolutions and collaboration. Negative effects, on the other hand, are partly caused by marginalization (Pauly 1997), when interaction is not considered fair or just by all involved parties. This may consequently result in rejection of the interactions or at least the growth of mistrust.

While the CBM model acknowledges the need to involve a wider range of actors than the naïve versions of co-management models, it fails to recognize that the fishers themselves may have short-term interests, such as repaying the loan used to purchase a new fishing vessel, that are incompatible with the continued existence of sensitive coastal or marine resources, and hence at variance with the non-extractive interests of other actors. This problem becomes even more acute (for example, in Southeast Asia) where growing numbers of impoverished coastal fishers are forced by circumstances to eke a living from finite coastal resources; i.e. from resources which, in the process, they may effectively annihilate.

Management models structured around fishers' (quasi)-ownership of coastal fishing grounds fail in such cases, as they lead to impoverished fishers being the owner of a non-existent resource.

Put differently: while some authors claim that small-scale fishers' ownership of the resources would lead to good stewardship practices and sustainable fisheries, the field evidence shows that in the absence of formal property rights, these fishers overwhelmingly compete for the resources, with the short-term objective of maximizing their individual benefits with no consideration of the costs to society, as do the owners of large industrial fleets (see contributions in Coward et al. 2000). While the CBM model appears a useful component of our response to the crisis in fisheries around the world, it is by no mean sufficient. A 'proactive' governance model is urgently needed that would help us quickly halt further destruction, and to foster ecosystem-based management principles. Moreover, resources will have to

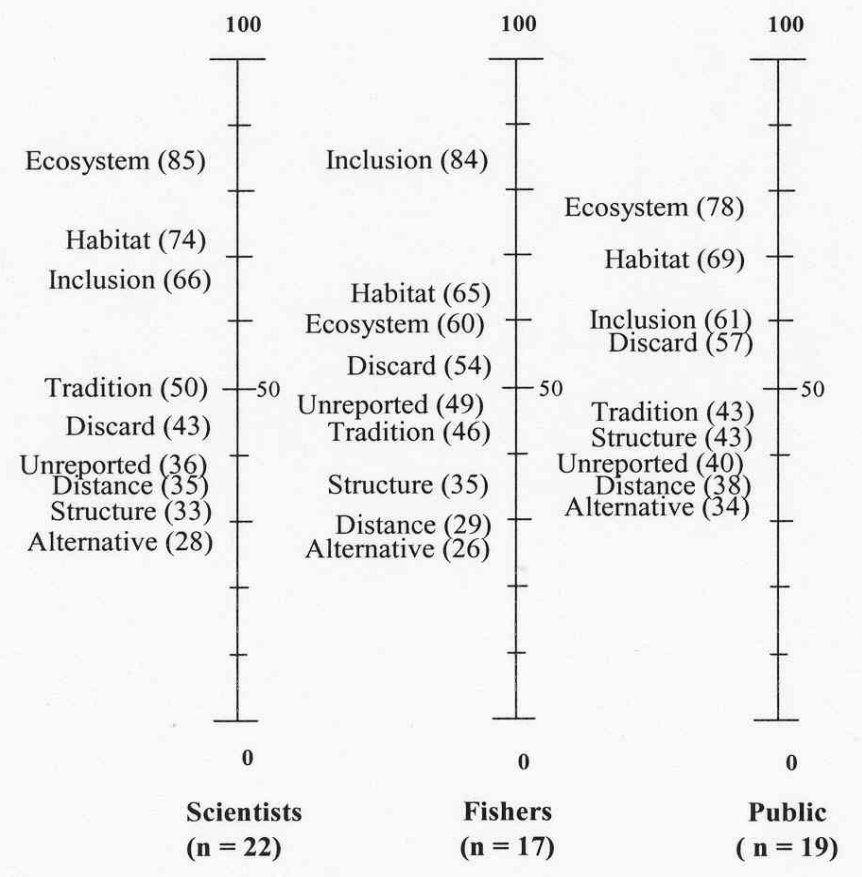
be extended to motivating small-scale fishers (and especially their young sons) out of fishing, through training and livelihood schemes. This is in contrast to most field-based fisheries projects run so far, which seek to improve the conditions of existing fishers and thus contribute to attracting more landless farmers and other rural poor into fishing (Pauly 1997). Appendix 1 presents an approach through which the views of communities regarding perceived impacts or merits of various interventions can be elicited without undue bias due to the subjective perceptions of individual benefits alluded to above. As illustrated in Appendix 1, scientists, fishers and representatives of the public at large agreed that human influence of fish habitats, fishing impacts on ecosystem, and inclusion of fishers in fishery management were the most important considerations in the design of fishery policies (Figure 3). Incorporating community's perspectives into ecosystem-based management framework, such as shown in Appendix 1, is one important step toward proactive governance.

At levels above that of fishing communities, dealing with overfishing will require abolishing the government subsidies that have so far kept the industrial fleets of the world's fishing nations afloat (Munro and Sumaila 2001, Pauly and Maclean 2003). It is hard to conceive that such economic intervention, and the large-scale vessel decommissioning schemes that it implies, could be implemented by the agencies presently responsible for managing the fisheries of various fishing nations. Rather, it will probably be necessary to create new institutions for the purpose, in which the interest of the public at large (in functioning ecosystems, and in economically viable, smaller fisheries) would be represented. This approach would be guided by a restorative ethic (see contributions in Coward et al. 2000), structured around what may be called 'fisheries conservation biology,' a discipline that would need to be created around concepts drawn from fisheries biology and conservation biology.

CONCLUSIONS

Marine fisheries catches are globally declining, mainly due to overfishing, although other anthropogenic impacts in coastal areas have

FIGURE 3: **Damage schedule of fishery management decisions** based on three respondent groups (see text in Appendix 1).



CODE	MANAGEMENT CONSIDERATIONS
Ecosystem	Fishing impacts on fisheries ecosystem
Habitat	Human influences on fish habitats
Inclusion	Inclusion of fishers in fishery management
Discard	Level of utilization of fish which are caught in a fishery
Tradition	Existence of traditional or historical fishing access
Unreported	Existence of fishing practices beyond regulations
Distance	Distance to and the reliance on the fishery
Structure	Existence of social/political structures influencing fishers' values
Alternative	Existence of alternative sources of livelihood

contributed to reducing the high productivity of inner shelf waters. The strong increase in small-scale fishers in the last decades implies decreasing catches for millions of small-scale fishers as well as declining incomes, as the increase of fish prices in the market place is not sufficient to compensate for the declining catches per fisher.

There is no techno-fix that will allow meeting, in the next decades, an increasing global demand for fish driven by increased population, increased incomes, increased taste for fish, and increased requirements for fish meal and oils for use in fish culture such as salmon farming. Indeed, maintaining present catch levels will not be possible if the present trend toward increasing fishing pressure continues.

Present government arrangements, though they usually do not formalize property rights over marine resources, imply their quasi-ownership by the fishing industry. This can be inferred by the deferential treatment given to that industry by the government agencies tasked with regulating fishing fleets and gear deployment. It is clear that the public interest will have to be considered more explicitly in the governance and management of fisheries. This will involve the following:

1) The maintenance of marine ecosystems and their biodiversity as a public resource to be bequeathed to future generations;
2) A steady reliable supply of marine food stuffs, rather than the boom and bust operations resulting from serial depletions of marine resources;
3) An equitable use of the tax money presently wasted as subsidies whose major result is to maintain destructive fisheries that would otherwise have gone bankrupt;
4) Addressing the issue of poverty represented by millions of desperately poor Southeast Asian and other developing country fishers locked into a mode of resource exploitation that cannot support their activities in the long term, nor indeed meet their needs or those of their families; and
5) A transparent and inclusive process for incorporating communities' perspectives into an ecosystem-based management framework for fisheries and marine resources.

Despite encouraging noises (e.g., at the recent World Conference

on Sustainable Development in Johannesburg) we cannot at present conceive of the societal framework within which these issues would be seriously addressed and some of the mitigating approaches mentioned above implemented. As is the case for the issue of global warming (which, incidentally, also impinges on fisheries, by threatening the coral reefs sustaining many tropical fisheries, for example), these issues will not go away, and the underlying trends, notably a declining fisheries catch, will worsen until they are effectively addressed. Capacity building at the local level, particularly for alternative employment, and an education and public awareness program for marine conservation and stewardship are two initiatives that need active promotion and firm support from all government levels and governance institutes as they are promising means that can help alleviate the current fisheries crises.

Overall, we must conclude with an observation by Professor Katherine Richardson, Chair of the International Council for the Exploration of the Sea's Advisory Committee for the Marine Environment, that "Sustainable management of fisheries cannot be achieved without an acceptance that the goals of fisheries management are the same as those of environmental conservation."

APPENDIX 1: The damage schedule approach and its applications to coastal and marine ecosystems.

One promising valuation method to elicit preferences of stakeholders concerning the perceived impacts or merits of various interventions is called the 'damage schedule' approach. This methodology is based on the observation that it is usually far easier for individuals to compare pairs of choices, or objects, when asked to make a decision about them. By combining a number of decisions by a group of respondents, an investigator can then obtain a list ranked by preference, from least to most desirable (or important). Empirical research in various coastal and marine systems has established that such ranked lists will tend to reflect a consensus among respondents, even when they differ strongly in their perceived interests or even compete for the same natural resources (as do, for example, coastal fishers, shrimp farmers and tourist operators; see Chuenpagdee et al. 2001b).

Recent research by Power and Chuenpagdee (2003) has shown that this 'consensus-eliciting' aspect of the damage schedule approach can be used to identify important variables to consider when formulating fisheries policies. As the damage schedule relies on paired comparisons, it is constructed in this case from individuals' responses to a questionnaire containing a series of management considerations presented one pair at a time. The respondents, including scientists, fishers, and general public, are then asked to select, for each pair, the management consideration that they consider more important. As shown in Figure 3, the ranking of important considerations varied slightly between the three respondent groups. These rankings were nonetheless significantly correlated at alpha level 0.05.

The detailed description of the approach is presented in Chuenpagdee et al. (2001a), and examples of application to coastal resources in Thailand and the Eastern Bering Sea Ecosystem are described in Chuenpagdee et al. (2001b), and in Chuenpagdee and Vasconcellos (2000), respectively. The damage schedule approach may also be used to help identify the optimal or most acceptable location of 'no-take' marine reserves and their surrounding marine protected areas (MPAs). The establishment of ecosystem-based fisheries management tools, increasingly required to restore damaged coastal and marine ecosystems, will be able to fulfill that role only with the acquiescence of the impacted communities in the context of new governance arrangements (Chuenpagdee et al. 2002).

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