The case for data-less marine resource management: examples from tropical nearshore finfisheries

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Managing most marine finfisheries to achieve optimum yields is an unattainable dream. Protecting these resources from serious depletion through precautionary management seems the only practical option. But even this is of limited application if we demand scientific data for each managed fishery. There are too few researchers to do the work and, in any event, such research would usually not be cost-effective. Thus, we need not merely precautionary management; we need data-less management.

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Confront uncertainty. Once we free ourselves from the illusion that science or technology, if lavishly funded, can provide a solution to resource or conservation problems, appropriate action becomes possible.

Two major problems limit our ability to manage most marine finfisheries. The first is that research generally does not provide us with sufficient knowledge of their dynamics to enable us to manage them so as to achieve any kind of optimum yield, whether it be biological, economic or social. Nature is too complex and too variable. The notion that 'we'll get it right if you'll just let us do some more research' has been laid to rest.

Tropical nearshore marine fisheries provide an especially bleak example of the impotence of classical fisheries management. No other fisheries involve so many species. such complex and diverse habitats, so many fishers, gear types, landing sites and distribution channels per unit of catch. In the face of such Gordian complexity there is little consensus among fisheries biologists concerning even the basic dynamics of such fisheries. Their management, which has been characterised as 'dismal', is far from achieving any kind of optimality. Managing fisheries sub-optimally, however, is preferable to not managing them at all. Whereas suboptimal management produces results that are, by definition, less than ideal, the absence of management leads almost inevitably to severe depletion and commercial extinction of exploited fish stocks'.

Precautionary management

We are entering an era of precautionary marine resource management - management that greatly reduces the likelihood of stock collapse or severe environmental degradation. The main aim of precautionary management is not to control the production of living resources, but simply to protect them, to maintain their viability. Even in the less data-demanding context of precautionary management, however, our scientific limitations are still severe because of a second problem so basic and undramatic that it seems to have been completely ignored. The implicit assumption seems very common among marine biologists and marine resource managers that quantitative information about a natural resource is essential for any kind of management. If this assumption were true, however, it would mean that even precautionary management would be impossible in many thousands of square kilometers of heavily exploited tropical marine communities. As Jennings and Polunin have recently pointed out, 'vast areas of tropical reef have not been studied'. The same is true of tropical seagrass, mangrove and soft-bottom communities. We do not have the resources to collect and process management data for the great majority of these communities - nor will we in the foreseeable future.

Nowhere is this more apparent than in the western Pacific and adjacent Southeast Asia, in countries like the Solomon Islands, Papua New Guinea, the Philippines and Indonesia. Here there are tens of thousands of kilometers of tropical coastline occupied by millions of people who depend for their livelihood on their nearshore fisheries. These countries cannot afford such research. And, even if they could, it would, in most cases, be grossly cost-ineffective.

In coral reefs, under such circumstances, underwater censuses are often employed to obtain rough appraisals of the status of its populations. It takes two people one day to carry out underwater visual censuses of coral reef fish sufficient to get a statistically useful data set on fish abundance along a 1-krn strip of fringing reef. Consider the implications of this for the management of, say, Indonesia's coral reefs. Of the 71000 km coastline of this country, five-eighths is fringed by coral reefs. It would thus take 400 person-years to complete one transect survey of fish on the country's fringing reefs. Subsampling could, of course, be employed to reduce this effort. But even if we randomly sampled, say, ten percent of the coastline, it would still take 40 person-years. And this would yield merely a snapshot of fish abundance - and only in the shallowest and most accessible portion of the country's reefs. It would thus provide only a tiny fraction of the kind of data usually considered necessary for management.

Another class of approaches, developed in recent years in recognition of the impracticality of getting comprehensive information for natural resource management in reasonable time and at reasonable cost, is rapid appraisal techniques, some of which have been employed in tropical fishing communities. During such assessments, interdisciplinary teams quickly characterize fishing communities and the coastal ecosystems on which they depend. No specific time has been specified for such assessments. But, based on my reading of relevant literature, a conservative estimate of the mean time for professionals to complete a rapid assessment would be three person-months. There are more than 7000 coastal fishing villages in Indonesia. To carry out such rapid assessments in each would thus take more than 1700 person-years. Subsampling would be of questionable value, since coastal fishing villages differ so greatly and unpredictably in the social, political, educational, environmental and ecological characteristics that define the options of their fishers.

These short-cut methods are instructive, but they are not the solution to our problem. There is not enough time, money nor trained personnel to employ them widely - nor will there be in the foreseeable future.

Data-less management

In situations like this we need not only the simplifications afforded by precautionary management. We need the much greater simplifications of what might be called data-less management - that is, management carried out in the absence of the data required for the parameterization and verification of models that predict effects of various management actions with useful statistical confidence limits. There is nothing new about data-less management, except perhaps the name. Some tropical fishing cultures, for example, have been doing it for a very long time. In some Pacific island groups almost all of the basic fisheries conservation measures that Europeans developed only in the past century, were already in use centuries ago - closed areas, closed seasons, size restrictions, restricted entry - all without data.

Data-less management does not mean management without information. Even in the remotest unresearched areas of, say, Irian Jaya, or the Andaman Islands, the information baseline is by no means zero. It comes from two sources. The first consists of the knowledge gained from research on other, similar systems. The second source (in all but unexploited regions, of which there are increasingly few) is the knowledge possessed by fishers concerning their local marine environments and fisheries. This knowledge can be extremely useful for management purposes; in some areas it has proven to be encyclopedic.

I do not want to imply, however, that tropical fishing communities can be expected to 'go it alone' in managing their marine resources. Even where traditional management regimes and local knowledge remain strong, villagers are often not equipped to respond to today's altered circumstances, The introduction of cash economies, rapid population growth, commercial fishing, new export markets, the use of new fishing gears and faster boats have all brought new management challenges with which traditional arrangements and indigenous knowledge are not always able to cope unaided. Villagers may not understand the need for certain types of management. Or, if they do, they may not know how to formulate plans to address that need effectively.

Two examples of indigenous data-less management

The first example involves groupers (serranids). Typically, they constitute roughly ten percent of total coral reef finfish yields. They are among the most endangered of reef fish. In 1996, 21 species of grouper were proposed for inclusion on the IUCN Red List as vulnerable or endangered - three of them critically endangered. The commercial extinction of increasing numbers of grouper stocks has been described in the past few years, especially in the Caribbean, but also in some Pacific Islands. These stocks dwindled and disappeared because they were unprotected, not because they were uncontrolled.

We recently completed a research protection groupers in Palau to determine if data on spawning aggregation sizes would enable us to design a management program that improved upon the basic data-less management approach already operating in Palau, which consisted simply of closing the grouper fishery during the peak spawning months. It was a regulation that was specifically requested of the Palauan government by Palauan fishermen, who patterned it on their own traditional management methods, and who argued the need for it based on their observations that some grouper aggregations had been fished out, while others were declining alarmingly.

Our results enabled us to improve upon Palau's existing data-less grouper management regime a little. But it yielded no fundamental improvements; we found that statistically rigorous monitoring would not enable us to detect stock declines clearly attributable to fishing pressure - or stock increases clearly due to management - in timeframes useful for rigorous management. There was too much interannual variation in aggregation sizes that was un-related to fishing pressure or management measures, but instead resulted from un-determined 'natural factors'. Nature, once again, proved too variable.

In the mid 1980s. before our research on grouper spawning aggregations, an aggregation that fed Palauans for centuries was wiped out in just three years of intensive fishing. It would have been easy to prevent the collapse of this aggregation -without previous data - simply by implementing a closed season, as was subsequently done for Palau's other grouper spawning aggregations.

The second example is from another Pacific Island country. Vanuatu. Here, village-based marine conservation experienced a remarkable upsurge beginning in 1990 when the Fisheries Department's village-based trochus management program began. In a handful of Vanuatu's hundreds of fishing villages, the Department taught villagers the principles of trochus management - basically that stocks should be harvested about once every three years and the fishery closed during the intervening periods. These villagers accepted the Department's advice. According to them, the results were highly successful.

Word of their successes soon spread to other villages that had not been visited by the Fisheries Department. And within fewer than four years many villagers were, for the first time, managing their trochus stocks. Moreover, the practice was so enthusiastically received that many villages also began to implement controls on fishing for other species, finfish, lobsters, octopus and so forth. Within four years 26 of the 27 villages I surveyed had implemented new fishing controls.

The Vanuatu Fisheries Department's modest efforts in a few villages had thus been favored by a large multiplier effect - all without data other than that possessed by the Department concerning trochus growth rates for the general region and that obtained by the villagers themselves in the form of increased income associated with their trochus management (Fong recently reported a similar rapid spreading of marine conservation measures beyond the villages initially targeted for cooperative management by the Fiji Fisheries Department).

Vanuatu fishing villages are carrying out, in essence, an indigenous version of what has come in the past decade to be called adaptive management - that is, management by trial and error. This kind of experimentation, while not scientific according to fashionable neopositivist definitions, nevertheless plays a major role in the real history of fisheries research. For centuries before marine biologists appeared on the scene, fishers had been experimenting not only with fishing and navigating gear and methods, but also with fisheries management methods. Our textbooks, however, read as if fisheries management research began only in the late 19th century.

Practical measures

I am not implying here that we should do away with quantitative research. We must obtain detailed quantitative information in some areas. The current research on the design, operation and consequences of marine protected areas (MPAs) is a good example. Many developing countries wanting MPAs cannot afford to carry out comprehensive research for all, or even the majority of them. Sound quantitative research in a few, however, provides vital information and experience that can be applied judiciously in similar areas where such research is impractical. Regional and international agencies can play an important role in facilitating such research.

Marine protected areas are the most widely discussed precautionary measure used in tropical nearshore resource management. We could improve upon the design and implementation of many such reserves without additional data in the following way. It is often said by proponents of MPAs that their prime objective is to protect critical spawning stock biomass. Clearly, for this reason, the boundaries of coastal marine reserves should, wherever practical, encompass irnportant spawning aggregation sites. Moreover, the presence of an important spawning aggregation site should, in some cases, be justification in itself for the establishment of a marine reserve. Yet, there is no evidence in the literature to suggest that spawning aggregation sites were given any consideration when the boundaries of most tropical marine reserves were drawn. Conventional fisheries data are not essential to set up such reserves. All that is needed is information on timing and location of spawning aggregations (often well known to fishermen) and the perception of local fishermen that these aggregations are threatened.

Research in both the Caribbean and Indo-Pacific show that larger reef fishes of many different species tend to choose the same specific locations and same seasons n which to spawn16-28. More than 40 species of reef fish spawn at the three aggregation sites we have been studying in Palau. Protecting major spawning aggregation sites can thus help protect spawning stocks of many species. Here, then, is a form of data-less management that helps protect fish stocks from severe depletion or extinction. Clearly it does not lead to optimal use (as conventionally defined) of the resource. But this is immaterial, since nothing else that is practical does so either.

Researchers, with the assistance of fishers, should make much greater efforts to document spawning aggregation sites and timings, and managers should use this information to design regulations to protect important aggregation sites. This protection could take the form of species closures - that is, prohibition of fishing for species during their spawning season - or partial closures, that is, prohibition of fishing on the spawning grounds.

Restricting gillnet and trap mesh sizes another management measure that can usefully applied in coral reef fisheries without need of local fisheries data. Indeed, increasing the legal net mesh size was another regulation that Palauan fishermen successfully petitioned their government to enact on the basis of their perception that small mesh nets caught too many small fish.

Many marine researchers and resource managers have not really considered the need for data-less management; it involves simplification that goes beyond anything have been taught. Management not preceded by conventional research or followed by scientific monitoring may verge, to some people, on heresy. But the time is overdue for us to consider carefully the management objectives and controls that are practical for threatened marine resources for which few or no data are, or will be, available.

In focusing here on data-less management I have deliberately chosen, for ease of discussion, a scenario that contrasts in the greatest extreme with the ideal of management based on 'enough data'. Many management situations will, of course, fall between these two extremes; that is, in the ‘data-poor' category. Indeed, all tropical nearshore finfisheries management areas for which there are any data fall into this category.

I have given examples of how data-less or data-poor management can work in a particular set of fisheries, those of nearshore tropical waters. With the exception of mesh size restrictions, the approaches I have suggested are not appropriate to highly mobile fish stocks. Neither are they easily applied in regions where local control over the fishing grounds is absent. The data-less management measures implemented in Palau and Vanuatu would have been quite impractical in the absence of government recognition and support of local marine tenure. Its absence in some other countries in Southeast Asia and elsewhere, and the unwillingness of their governments to recognize its critical significance, is often the biggest impediment to effective fisheries management in these areas - rather than lack of data on their marine resources.

Fruits,"not roots

Conventional biological training has focused our attention so single-mindedly on the rigorous quantitative description of marine resources before committing ourselves to managing them, that we are liable to feel guilty if we diverge from this track - and worse still, may even criticize others who do so. But when vital resources are rapidly degrading, as are coral reefs and other nearshore tropical habitats around the world, we often have neither the time nor the resources for such data-gathering. The choice is not between giving perfect or imperfect advice to managers. It is between giving imperfect advice or none at all.

Data-less and data-poor management are, under the circumstances, not just valid alternatives. They are an imperative. It may be argued that such activities are not science. But surely this is immaterial. Doing them well will not be easy, and success will depend heavily on good scientists helping fishing communities and government management agencies to plan objectives and controls.

In most instances, fisheries management is carried out without the data that fisheries textbooks and graduate schools teach us are essential for the purpose. If such management is judged on the basis of its data underpinnings, it will be judged poorly. But this criterion is inappropriate. Management should be judged by its fruits, not its roots And, as stated earlier, no data are needed to assert with confidence that precautionary, data-less or data-poor management will perform better on average than the only real alternative - no management at all. Here, the key management question should not be 'what data do we need to make sound management decisions?' but rather, 'what are the best management decisions to make when such data are unobtainable?'. We must decide carefully, but we cannot afford to wait. For if we do, we can be gloomily confident that the collapse of increasing numbers of unmanaged fisheries is not only inevitable, but also, in many cases, imminent.

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References

1 Ludwig, D., Hilborn, R. and Walters, C. (1993) Uncertainty, resource exploitation, and conservation: lessons from history, *Science* 260, 17,36

2 Hilborn. R. and Walters. C.J. (1992) *Quantitative Fisheries Stock Assessment, Choice, Dynamics and Uncertainty*, Chapman & Hall

3 Sainsbury, K.J. (1988) The ecological basis of multispecies fisheries, and management of a demersal fishery in tropical Australia, in *Fish Population Dynamics* (2nd edn) (Gulland, J.A.. ed.), pp. 349-382, Wiley & Sons

4 Medley, P.A_ Gaudian. G. and Wells, S. (1993) Coral reef fisheries stock assessment, *Rev. Fish Biol, Fisheries 3*, 241-285

5 Munro. J.L. (1996) The scope of tropical reef fisheries and their management, in *Reef* Fisheries (Polunin, N.C.V. and Roberts, C.M.. eds), pp. 1-14. Chapman & Hall

6 Jennings. S. and Polunin. N.V.C. (1996) Impacts of fishing on tropical reef ecosystems, Ambio 25. 44 -49

7 Samoilys, M.X and Carlos. G. (1992) Development of an underwater visual census method for assessing shallow water reef fish stocks in the south west Pacific, ACIAR Project PN8545 Final Report. April 1992

8 Townsley, P. (1993) A *Manual on Rapid Appraisal Methods for Coastal Communities*, Bay of Bengal Pro.grarnme

9 Pido. M.D. *et al.* (1996) A *Handbook for Rapid Appraisal of Fisheries Management Systems*, International Centre for Living Aquatic Resource Management

10 Haeruman, H. (1988) Conservation in Indonesia, *Ambio* 17. 218-222

11 Johannes R.E. (1978) Traditional marine conservation methods in Oceania and their demise, *Annu. Rev. Ecol.* Syst. 9, 349-364

12 Johannes, R.E. (1981) *Words of the Lagoon:Fishing and Marine Lore in Me Palau District of Micronesia, University* of California Press

13 Toloa, F., Gillett, R. and Pelaslo, M. (1991) *Traditional Marine Conservation in Tokelau. Can it* be *Adapted to Meet Today's Situation?* Working Paper 7, Regional Technical Meeting on Fisheries, South Pacific Commission, Noumea

14 Hudson, E. and Mace, G., eds (1996) *Marine Fish and the JUCJV Red List of Threatened Animals*, Report of the workshop held in collaboration with WWF and JUCN at the Zoological Society of London, 29 April - 1.May 1996

15 Sadovy, Y. (1994) Grouper stocks of the western central Atlantic: the need for management and management needs, Proc. *Gulf Carib. Fisheries Inst.* 43. 43- 64

16 Johannes, R.E. (1991) *Some Suggested Management Initiatives in Palau's Nearshore Fisheries, and the Relevance of Traditional Management*, Palau Marine Resources Division Tech. Rept. 91/14

17 Johannes, R.E. Government-supported village-based management of marine resource in Vanuatu, *Ocean Coastal Manage.* (in press)

18 Fong, G.M. (1994) *Case Study of a Traditional Marine Management System: Sasa Village, Macuata Province, Fiji*, FFA/FA0 Field Report 94/1

19 Walters, C.J. (1986) *Adaptive Management of Renewable Resources*, Macmillan

20 Hatcher, B.G. *et al*, Testing mechanisms by which marine protected areas export fish to adjacent habitats: the Soufriere experiment in Reef Fisheries Sustainability (SERFS), *Proc. Gulf Carib. Fisheries Inst.* (in press)

21 McClanahan. T.R. and Kaunda-Arara, B. (1996) Fishery recovery in a coral-reef marine park and its effect on the adjacent fishery, *Conserv. Biol. 10*, 11877-1199

22 Russ, G.R. and Alcala, A.C. (1996) Marine reserves: rates and patterns of recovery of large predatory fish, Ecol. Appl. 6, 947-961

23 Jennings, S., Marshall. S.W. and Polunin. N.C.V. 29 (1996) Seychelles' marine protected areas: comparative structure and status of reef fish communities, Biol. *Conserv.* 75, 201-209

24 Bohnsack, JA. (1993) Marine reserves, *Oceanus* Fall 1993. 63-71

25 Roberts, C.M. (1997) Ecological advice for the global fisheries crisis, *Trends* Ecol. Evol. 12, 35-38

26 Randall, J.E. and Randall, H.A. (1963) The spawning and early development of the Atlantic parrotfish, Sparisoma r*ubrippine*,with notes on other scarid and labrid fishes, Zoologica 48, 4 9 - 60

27 Johannes, R.E. (1978) Reproductive strategies of coasW marine fishes in the tropics~ *Environ. Biol. Fish.* 3, 65-84

28 Domeier, M.L. and Colin, P. (1997) Tropical reef fish spawning aggregations defined and reviewed, Bull. Mar. Sci. 60. 698-726

29 Sary, Z., Oxenford, H.A. and Woodlev. J.D. Effects of an increase in trap mesh size on an overexploited coral reef fishery at Discovery Bay, Jamaica, Mar. Ecol, *Prog- Ser* (in press)

30 Birkeland. C. (1997) Present conditions of coral reefs, in *Life and Death of Coral Reefs* (Birkeland, C., ed.), pp. 6-10, Chapman & Hall

31 Wilkinson, C.R., ed. (1994) *Living Coastal Resources of Southeast Asia: Status and Management,* Australian Institute of Marine Science