AN ECOSYSTEM–BASED APPROACH TO MARINE FISHERIES MANAGEMENT

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Abstract

Large-scale, multiple-use management is an ideal vehicle to implement and develop a holistic, integrated, ecosystem-based approach to fisheries management. It is now widely recognised that fisheries management must comprise a subset or component of a broader management of the whole ecosystem. Because of the "connected" nature of the marine environment, marine ecosystem management must address both system-oriented strategies, to prevent harm from pollution and overuse, and site-based strategies to protect habitats or to allocate and separate conflicting use. Large-scale, multiple-use managed areas, such as marine protected areas (MPAs), provide an ideal tool for implementing such an ecosystem approach to fisheries management.

The role of the 'fisheries manager' should be to provide input into: (i) the broad strategic approach to ecologically sustainable management, which will involve the use of environments and natural resources on a regional scale which matches the scale of marine ecosystems, and (ii) tactical habitat management, which will address a range of specific objectives such as biodiversity preservation, research, education and recreation, in addition to fisheries management.

The goal of the 'fisheries manager' should be to ensure the sustainable utilization of species and ecosystems. Inevitably, this will be linked with the maintenance of essential ecological processes and life-support systems, and also, the establishment of research and monitoring programs to monitor the effectiveness of management strategies. The challenge for 'fisheries managers' will be to redefine and broaden their role as 'habitat managers' within a new, integrated, ecosystem approach to management.

Introduction

In recent years there has been a new ecosystem-based focus in the field of natural resource management. This has arisen primarily from the continued decline of our natural resources despite massive regulatory efforts, and the recognition that there is a need to sustain ecosystems, in addition to the resources they produce (Kessler *et al.* 1992). In this new approach, ecological processes are given value and importance beyond the traditional commodity and amenity uses of ecosystems. These ecological processes include the provision and maintenance of a wide range of ecological "services", from climate regulation, protection from erosion, nutrient storage and cycling, pollutant breakdown and absorption, to, in terrestrial ecosystems, soil production and the maintenance of hydrological cycles (ie. groundwater recharge, watershed protection, and the buffering against extreme events). These ecological "services" and functions not only produce and sustain our natural resources but also underpin the quality of our life and our economy. In terrestrial eco-

systems, this philosophy has been embodied within the concept and practice of "total catchment management".

In marine resource management, as in terrestrial resource management, there is also a growing awareness of the need to adopt a holistic, ecosystem-based approach to the management of our marine resources (Commonwealth of Australia 1991a). Despite regulatory efforts by individual agencies, pollution from point and diffuse sources, overfishing, loss of habitat from urban growth and coastal developments, and conflicts between competing user-groups (ie. fishing, aquaculture, tourism, recreation and conservation groups) continue to threaten our marine habitats and fisheries (see Commonwealth of Australia 1991b). Further, the greater degree of "connectedness" in marine ecosystems, compared to terrestrial ecosystems; the great mobility of organisms; and the extraordinary ability of water to transport both substances and organisms, result in the activities of one user group being more likely to directly and indirectly affect the activities of another (Kelleher and Kenchington 1991). For these reasons there is a greater need for integrated management of marine ecosystems.

In order to sustain our marine resources, it is now increasingly being recognised that fisheries management must be considered a component or subset of multiple-use, whole ecosystem management (Commonwealth of Australia 1991a). In this ecosystem-based approach to management, fisheries management is integrated and coordinated with the management of other uses and activities such as wastewater, shipping, tourism, recreation, conservation, mining, and industrial uses. While sectoral tasks and management to some extent may still use traditional methods, the real challenge in this new approach lies in ensuring effective intersectoral management. One of the greatest challenges for fisheries managers as we approach the next century will be to redefine and broaden their role as 'habitat managers' within this new framework of marine habitat management.

Developing a marine ecosystem management framework

Proponents for the sustainable use of marine resources have long recognised the need for the protection and maintenance of essential ecological processes. For instance, the World Conservation Strategy in 1980, clearly identified the preservation of life support systems as one of the four key elements in its global survival strategy. The four elements of this strategy include:

- the maintenance of essential ecological processes and life-support systems;
- the preservation of biological diversity at all levels, from ecosystem to genetic diversity;
- the sustainable utilization of species and ecosystems; and
- the establishment of research and monitoring programs to monitor effectiveness and environmental and global change (IUCN/WWF/UNEP 1980).

In translating this conservation strategy to our oceans and coastal ecosystems, we must recognise the strong linkages between the land, the ocean and the atmosphere, as well as recognising the "connectivity" of marine ecosystems. As such, land-based activities greatly influence the state of our coastal regions and its resources. At a global level, almost 80% of marine pollution is derived from land-based sources, with direct discharges accounting for some 44% and approximately 33% entering the marine environment as atmospheric inputs (GESAMP 1990). For this reason the conservation and management of marine ecosystems and their resources must ultimately entail effective management of land-based activities. At a global level this concept of integrated management of the land:sea boundary is known as Integrated Coastal Zone Management (ICZM).

As stated in the World Conservation Strategy, a management strategy for conserving and managing ecosystems must include not only

protection of the diversity of life, but also the essential ecological processes and life-support systems which support it. Hence, for marine ecosystems, an integrated management strategy must comprise conservation of the attached fauna and flora of the seabed; water quality; the fauna and flora which live in the water column; and the key ecological processes (such as currents, tides, etc.) which sustain the ecosystem. Management of a seabed by itself without addressing pollution or overfishing will have little effect in the conservation or sustainable use of marine ecosystems. As such, an integrated management framework for natural ecosystems must comprise two essential components:

(1) general *ecosystem* protection to prevent harm from pollution and overuse; and

(2) *site-based* protection to protect habitats or to allocate and separate conflicting uses (Kenchington 1990).

For the management of marine ecosystems and their resources these components translate into two approaches:

(1) a broad strategic approach to ecologically sustainable use and management of environments and natural resources on a scale which matches the scale of marine ecosystems; and

(2) tactical site or marine habitat management to address specific objectives of biodiversity preservation, research, education and recreation.

Measures which seek to address the tactical objectives of habitat management without the broader strategic framework are likely to fail to address the broad requirements of conservation and the sustainable use of marine ecosystems (Kenchington 1990). For an integrated approach to fisheries management there is a need to include the essential components of ecologically sustainable use and also, recognition of the need for ecosystem management. The recent report released by the Ecologically Sustainable Working Group for Fisheries (Commonwealth of Australia 1991a) clearly identified these objectives and further, recommended a number of key steps to achieve the ecologically sustainable use of our fisheries resources. Many of these recommendations are useful in formulating a set of guidelines for achieving an ecosystem approach to fisheries management (see Table 1).

Multiple-use, marine protected areas and fisheries management

In recent years there has been a dramatic shift in the role of marine protected areas (or MPAs) in fisheries management. Until recently MPAs were seen primarily as sites for the protection of 'critical habitats' of economically important species. Estuaries and wetland habitats, such as seagrasses and mangroves, were included because they protected key parts of the life history of species. Specific fisheries were enhanced by the protection of identified nursery areas, feeding areas and spawning areas. MPAs however, can provide a number of other important roles in fisheries management, in addition to critical habitat protection. These include: areas for stock replenishment, ie. 'harvest refugia'; areas for monitoring the natural fluctuations in stock; and areas for resolving conflict between competing users of marine resources and habitats. In the latter regard, MPAs are increasingly being seen as a vehicle for implementing an ecosystem-based approach to fisheries management.

The essential tool of multiple-use, ecosystem-based management in MPAs is the zoning of human uses and activities on a geographical basis. Uses such as fishing, tourism, recreation, conservation and maritime shipping, are essentially coordinated and integrated through the development of a zoning plan. Zoning not only provides a mechanism for reducing conflict between competing user groups but it also provides a mechanism for the effective protection of 'critical areas' through the creation of 'buffer zones'. Probably the most well-known example of multiple-use management of a marine

ecosystem in Australia is the Great Barrier Reef Marine Park in Queensland. Within this 348 700 sq.km park, fishing and a wide variety of other human uses (including tourism, recreation, preservation and scientific research) are managed on an ecologically sustainable basis through six types of zones within the marine park (GBRMPA 1985). All activities are both managed and coordinated on an integrated basis by a single regulatory authority, the Great Barrier Reef Marine Park Authority.

Zoning of uses is a viable approach to marine fisheries management that deserves serious evaluation. Not only is it an ideal tool for implementing an ecosystem approach to marine resource management, but it also has the potential for increasing consistent sustained harvests through the creation of 'harvest refugia'. Further, zoning also allows reduced fisheries regulations and thus can simplify enforcement and compliance. It may also allow dynamic market forces to optimize harvest sizes and seasons, and may permit those same forces to drive development of more efficient nondestructive fishing gear (Davis 1989).

While multiple-use zoning has yet to be implemented in many regions and countries, habitat management is increasingly being recognised as an essential component of fisheries management, in addition to the traditional single-species approach to management. This is evidenced by a recent proposal in 1990 to establish large fishery reserves off the Atlantic coast of the South-Eastern United States. In this proposal, reef fishes would be managed by both conventional means of size and bag limits, and by the establishment of a set of marine reserves, where reef fishing would be prohibited (Huntsman and Vaughan in press). The proposed marine reserves would encompass some 20% of the region's reefs.

Large-scale zoning is also of immense value in 'adaptive management'. Management plans can use zoning as a research tool to establish a framework for scientific testing of concepts, methods and assumptions. As such, large-scale ecological experiments can be conducted through the zoning mechanism to investigate the effects of a particular management regime. For instance, in certain parts of the Great Barrier Reef Marine Park, zoning regulations are presently being used to establish the ecological effects of particular fishing methods. In this self-regulatory approach to fisheries management, the management regime is adjusted and regulated through the results of monitoring.

In recent years the establishment of large, multiple-use managed marine areas in Australia has received greater attention with the announcement of a national, 10-year marine conservation program called 'Ocean Rescue 2000'. One of the essential elements of this program is the establishment of a national, representative system of MPAs. While some states in Australia (such as Queensland and Western Australia), have established several large, multiple-use marine parks, some states such as South Australia have yet to establish large, multiple-use managed areas (Table 2). In these States, continued funding under 'Ocean Rescue 2000' will be critical in establishing such areas.

In summary, the increasing importance of MPAs as tool for fisheries management is a sign of a new ecological order for fisheries management. This recent change in focus stems primarily from the failure of traditional single-species based management practices to halt the decline of fisheries resources. More than ever, MPAs are increasingly being seen as a vehicle for a new order of ecosystem-based management of fisheries, rather than the traditional single-species approach to management. The challenge for 'fisheries managers' will be to redefine and broaden their role as 'habitat managers' within this new, integrated, ecosystem approach to management.

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Table 1. Guidelines for achieving an ecosystem approach to fisheries management (adapted from ESD Fisheries 1991)

An Ecosystem-Based Approach to Fisheries Management

Goals

- Recognition of fisheries management as a subset or component of ecosystem management.
- Adoption of ecologically sustainable use and inter- and intragenerational equity as goals of fisheries management:
  - sustainable utilization of species and ecosystems;
  - maintenance of essential ecological processes and life-support systems;
  - the preservation of biological diversity at all levels, from ecosystem to genetic diversity.

Management

- Establishment of Marine Protected Areas (MPAs) involving large-scale, regional management of multiple-use areas for:
  - resolving conflict by competing user groups through zoning activities;
  - protection of biodiversity;
  - enhancement of fisheries management, through refuge sites for stock replenishment, and protection of fish nursery areas.
- Adoption of adaptive and flexible management methodologies (such as Adaptive Environment Assessment and Monitoring), which recognise the uncertainty associated with resource management of biological systems.
- Promotion of habitat amelioration and enhancement (adopt principle of 'no net loss' of habitat).

- Conservation of both 'critical' and 'ecologically representative' habitats for fisheries management.
- Management of environments and natural resources on a regional scale which matches the scale of marine ecosystems, for instance:
  - Marine Protected Areas (MPAs);
  - National Maritime Authority (proposed by Gilmour and Connor 1991);
  - Coastal Zone Management Authority (proposed by Kelleher 1991).
- Development of an integrated management framework:
  - 3–5 year strategic management plans for *all* fisheries (including critical habitats and ecological processes, potential threats, and performance and sustainability criteria);
  - greater community and industry involvement in decision-making processes;
  - management of fisheries on a multi-species level;
  - initiation of intersectoral management mechanisms:
    * regional and State "ecosystem" committees (to address intra-sectoral and intersectoral issues), in addition to traditional single-species fishery committees;
    * use large-scale, multiple-use MPAs as a tool for fisheries management and vehicle for ecosystem management.

Research

- Identification and conservation of the critical ecological processes and habitats which sustain fisheries, eg. upwellings, environmental "cues", nursery areas, feeding areas, breeding areas, "sinks" or "sources" for larvae.
- Identification of the spatial and temporal scale of the critical ecological processes.
- Assessment of the impacts of pollution, fishing, aquaculture and fishing methods on critical ecological processes and habitats (ie. assess ecosystem and habitat integrity).
- *Separation* of the effects of overfishing from the effects of habitat degradation (a combination of both?) by identifying:
  - relationship of fish to habitat;
  - effect of environmental influences on habitat.
- Determination of the need, purpose, location, design and size of marine protected areas and their role in maintaining a particular species and/or aquatic ecosystem.
- Development of more robust predictive tools for stock assessment, environment assessment and bioeconomic analysis.
- Development of data information/retrieval systems such as GIS (Geographical Information System).
- Development of predictive, adaptive, GIS-based, multi-species models to manage fisheries (eg. AEAM (Adaptive Environmental Assessment and Management) and ecosystem-based models).
- Development of biological and ecological criteria to assess the goals of sustainability and "ecosystem health", with statistical power to detect effects of unsustainable use.
- Development of economic criteria to assess sustainability.

Table 2. Marine protected areas (MPAs) in Australia, up until 31 May 91 (adapted from McNeill 1991). Figures include the number of MPAs in each State/Territory; total area of MPAs in each State/Territory; area of MPAs as a percentage of total State/Territory waters; area of MPAs as a percentage of total area of MPAs in State and Commonwealth waters; area of MPAs as a percentage of total area of MPAs in State and Commonwealth waters minus the area of the Great Barrier Reef Marine Park (GBRMP)

State/Territory	*No.*	*Area km2*	*% Area State*	*% Area Total*	*% Area Total -GBRMP*
Queensland	139	354 799	24.5	90.5	21.2
External Territories	4	17 975	–	4.6	38.0
Western Australia	19	14 328	20.3	3.6	30.4
Northern Territory	10	2 841	8.2	0.7	6.0
New South Wales	22	924	8.7	0.2	2.0
Victoria	27	537	5.4	0.1	1.1
Tasmania	17	488	2.8	0.12	0.6
South Australia	28	295	1.4	0.07	0.6
ACT	4	8	4.0	0.002	0.02