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Mapping and MPAs: Practitioners Work to Define Resources, Boundaries

Maps play an integral role in the operation of marine protected areas. Used to define boundaries and to mark the locations of marine resources, human uses, and natural processes, maps provide essential information for planning and management.

MPA practitioners' mapping strategies are often affected by the world around them, including such factors as funding, available technology, and political concerns. This month, MPA News examines how several practitioners have adapted their mapping strategies to suit their situations.

Incorporating many data sources

Citing the need to create resource baselines for long-term monitoring of coral reefs, the US Coral Reef Task Force this year called for the production of digital maps of all US reefs by 2007 (MPA News 1:6). Stating that most coral reefs in US waters "have not been accurately mapped with modern techniques and at a scale relevant to emerging conservation issues," the task force called for the development of high-resolution benthic maps of regional coral reef ecosystems, with particular emphasis on MPAs and reefs at risk. The US has 17,000 sq. km of coral reefs.

"The work we're doing really ranges in technology and complexity," said Mark Monaco, a team leader on the US $10 million coral-mapping project for the National Oceanic and Atmospheric Administration (NOAA). "We're trying to integrate methodologies and techniques, depending on the size of an area, the nature of problems in that area, and the priorities of area managers."

The team is collecting a mix of data from satellites, low-flying aircraft, and on-site surveys to generate a database that could be used for, among other things, siting new MPAs. Satellite imagery, which is relatively inexpensive for NOAA to obtain, is best for generating large-scale, low-resolution maps. Photos taken from low-altitude aircraft — pricier to obtain — offer more robust images of seagrass, coral, and other benthic features.

Monaco expects that by 2005, the team will have mapped all US coral reefs to habitat groups; that is, maps will delineate hard, soft, and green bottoms. At that point, the team will "marry" the habitat database with data on living-resource affinities for those habitats. With a computerized geographic information system (GIS), the team will be able to determine the distribution of corals and fish.

By digitizing the whole process, including the aerial photography, the time it takes to map a single site can be reduced by more than a year, said Monaco. Before digital photography, multiple photos of an area had to be "mosaic-ed" manually over the course of months to form a composite picture; now the photos can be downloaded from the camera to a computer and mosaiced in days. "Analog film still works," said Monaco, "but using an analog process to map all of the US' coral reefs would take way too many years and way too many dollars."

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Using GIS

GIS technology has revolutionized how many mappers do their work, allowing them to overlay multiple datasets to view resource trends and policy consequences. One US initiative, the Ocean Planning Information System (OPIS) project for the southeastern United States, has established a Web-based database to help resource managers make decisions on complex and often conflicting jurisdictional issues. Incorporating data on boundaries (e.g., state and federal waters, MPAs, and offshore oil leases) with state and federal regulations, OPIS is intended to provide a starting point for resource managers who need information.

Gathering data and defining boundaries have posed some of the biggest challenges for the project's mappers. Eric Treml, the project's technical leader, said that finding high-resolution bathymetric data — offering the greatest value to decision-makers — often involves tracking it down in state and local agencies. "We've come to realize the value of local partnerships," said Treml.

Boundary lines, as for MPAs, have been especially tricky to set, he said. The federal code of regulations might give a set of boundary coordinates for a marine sanctuary, but some coordinates may simply be incorrect. In addition, the thickness of a boundary line on an existing, non-digitized map can cover kilometers of actual space, depending on the map's scale. Delineating an MPA's exact offshore and inshore boundaries can have policy implications for activities like fishing and coastal development. The team will produce a guide on generating an OPIS-style Web-based database by next year.

Web site for OPIS project

The web site for NOAA's Ocean Planning Information System offers advice to resource managers in the southeastern US on how to use the OPIS database for quick access to regulations, jurisdictional information, and resource maps. Go to:

http://www.csc.noaa.gov/opis/index.htm

The web site's on-line mapping feature also provides a GIS-like interface allowing users to highlight dozens of available map features, including MPAs, state boundaries, the Exclusive Economic Zone, and benthic habitat structure (hard or soft bottom).

A research team in Scotland, selecting a site for an artificial reef in the country's Moray Firth, also used a GIS to manage data. Led by Robert Wright of the University of Aberdeen, the team found that the range of available datasets for the Moray Firth's marine environment were of widely disparate coverage, detail, and currency — a common find in ocean mapping. To counter this, the team surveyed 47 public and private organizations with an interest in the marine/coastal environment to provide an inventory on the type and availability of relevant data. The survey established that much data of value for environmental management existed, but most of it had been collected for a single purpose and seldom with GIS applications in mind. Because a GIS requires datasets to be compatible so that they overlay correctly, Wright's team had to manipulate each one to make it fit into the system — a lengthy process.

Access to some of the data was difficult, too, according to Wright, who published the project's results in the journal *The Science of the Total Environment*. "Many organizations indicated that none of their datasets would be made available, even to a non-commercial research project," he wrote. "'Confidentiality' was a frequent reason for refusing access to datasets, especially where names/addresses were part of a database or where national security might be involved."

Maps and compliance concerns

Marc Pakenham, a community advisor for Canada's Department of Fisheries and Oceans (DFO), said the maps used to plan the Race Rocks Pilot MPA, off the nation's west coast, have held different meanings for different people. "They're a visualization of what's being set aside, from one perspective, and what's being taken away, from another perspective," he said.

Negotiations on the boundary of the Race Rocks Pilot MPA — a no-take zone for commercial and most sport fishing — were not easy. Ironically, difficulties arose over the government's attempt to define a relatively linear boundary line so as to ease compliance for fishermen; with a linear boundary, the government reasoned, fishermen would be able to tell more readily whether they were inside or outside the MPA. Fishermen, however, saw the linear boundary as an attempt to expand the MPA beyond the bounds of a 1980 declaration by the British Columbia provincial government that had already established Race Rocks as an "ecological reserve". The 1980 boundary was much more amoeba-like in shape and based on inexact bathymetric data, roughly approximating a 20-fathom (36.6 meter) contour.

"The fishermen said they were willing to agree to a no-take zone following the 1980 boundary — because Race Rocks represented an important, biodiverse area — but that they wouldn't agree to anything bigger," said Pakenham. The government and other stakeholders agreed to this, despite the compliance challenges posed

Web site on Race Rocks

A multimedia web site operated by biologist Garry Fletcher of Lester Pearson College (Victoria, British Columbia) profiles the history and resources of Race Rocks, with maps from the Race Rocks Pilot MPA planning process. Go to http://www.racerocks.com.

by a serpentine boundary. "The fact that the MPA is supported by the various stakeholders goes a long way toward ensuring better compliance," said Pakenham.

Compliance is a major issue for Race Rocks due to its small size. Consisting of exposed rocks surrounded by strong currents and upwellings, the Race Rocks Pilot MPA is smaller than one square mile (2.6 sq. km) in area. If a fishing boat crosses the boundary by 100 meters, it is already well into the no-take zone. Pakenham said he counted on the recent de-scrambling of satellite signals from the US-operated global positioning system (GPS) to aid fishermen in knowing exactly when they are in the protected area. "Mapping is only as good as people's understanding of where they are," he said.

Getting communities involved

In developing countries, some MPA-planning projects have directly engaged local stakeholders in the mapping process to encourage buy-in. For Proyek Pesisir, an Indonesian coastal resource management project, villagers are mapping their reefs with manta tows: Swimmers are towed by a watercraft as they view and record the reef resources from above. "Community-based mapping of village reefs gets the villages in tune with their marine resources," said Brian Crawford, who helps oversee the project for the University of Rhode Island (US) Coastal Resources Center.

The villagers' maps are then used to site community-based marine sanctuaries. Said Crawford, "We've found that community manta tow data were not statistically different than maps produced by professionals."

In the Philippines, it is likely that no two MPA projects have followed the exact same process for mapping, said Alan White of the USAID-supported Coastal Resources Management Project in Cebu. However, he added, MPA projects developed under local governments regularly involve community participation with mapping. The community performs a participatory resource assessment that includes sketching on a base map the locations of all important resources, fishing areas, and other things of community importance. The final map is a result of the community consensus on the actual location and extent of the resources, and is usually enlarged and painted for placement and reference in the community hall.

GPS or traditional survey equipment is used to locate boundaries, said White. Boundary setting is often done in the field so that all concerned know exactly where the boundaries are located.

"One of the key factors to success in our experience is that there is fairly rapid feedback to the communities in a form that they can understand," said White. "If this happens more efficiently with hand-drawn maps, this works. If GIS can do it quickly, this works."

He noted that his experience with using GIS has often involved working with a computer technician who was not connected with the resource problem, thereby leading to mistakes and delays. Nonetheless, he said, GIS represents the wave of the future. "It will eventually take over all mapping," he said.

Reference:

Wright, R., S. Ray, D. R. Green, and M. Wood. Development of a GIS of the Moray Firth (Scotland, UK) and its application in environmental management (site selection for an "artificial reef"). *The Science of the Total Environment* 223 (1998) 65-76.

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Closing 20% of the Ocean: Pro-Reserve Target Is Finding Way into Policies

The political target of setting aside 20% of ocean habitats as no-take zones by the year 2020, or earlier, has recently found its way into several MPA-related policies in the Western Hemisphere. Since January, government organizations in the Galápagos Islands (MPA News 1:7) and the US (1:6) have adopted a 20% closure figure as a target for protecting their coastal waters and coral reefs, respectively. A science panel advising the Bahamian government on its upcoming national reserve system recommended that the eventual network close at least 20% of the Bahamas' shelf edge (1:5). The target has appeared, too, in discussions on California's MPA system (1:3) and in a recommendation offered by several scientists and NGOs for the protection of US marine waters (1:6).

The 20% closure figure has clearly emerged as a tool in MPA negotiations and policymaking, at least in the Americas. Where did this target come from, and when is it useful?

Origin of 20%

The 20% figure has appeared in a handful of academic papers, beginning in the mid-1990s. Fisheries biologist Jim Bohnsack of the US National Oceanic and Atmospheric Administration wrote in 1994 and 1996 that various independent lines of argument converged on the need to close roughly 20% of the marine environment to rejuvenate fish stocks. Other scientists have since elaborated on those arguments (see box, right). A 1999 report, *Sustaining Marine Fisheries,* by the (US) National Research Council adopted the 20% figure, suggesting that current understanding of marine ecosystems and populations provided "a rationale for adopting a marine reserve program of this magnitude."

The target has often been cited as a precautionary measure. The US Coral Reef Task Force, which called for setting aside 20% of US coral reefs by 2010, said the figure provided a worthwhile reference point when "insufficient information is available to determine necessary no-take area size based on species life histories, use of habitat, and community function." By reason, if there were perfect knowledge of marine ecosystems, no-take zones could be sized according to the specific needs of target species and the health of communities. Some closed areas would be smaller than 20%; others would be larger.

The percentage of ocean that should be set aside to protect fish stocks has long been debated in MPA science. Marine biologist Bill Ballantine of the University of Auckland's Leigh Marine Laboratory (New Zealand) has recommended that a figure of 10% should be the lowest moral obligation for the protection of his country's seas (see box, top of next page); managers in the Bahamas cited Ballantine and his work as their original inspiration for establishing reserves. Other scientists, including Sylvie Guénette of the University of British Columbia (Canada), have argued for reserves totaling 80% of

Scientific basis for 20% closure figure

In a draft of their forthcoming book, *Fully-Protected Marine Reserves: A Guide*, Callum Roberts and Julie Hawkins of the University of York (UK) detail the scientific arguments for setting aside 20% of the ocean as no-take zones. The following list summarizes these arguments:

Risk minimization: Calculations by some fisheries biologists have suggested that, on average, it is necessary to retain at least 20% of the level of an unexploited stock to keep fish stocks sustainable. That is, protecting a large proportion of the sea — 20% or more — will reduce risks of stock over-exploitation.

Catch enhancement: In examining reserves' effect on enhancing fish catches outside reserve limits, several modeling studies have concluded that protecting between 20% and 40% of fishing grounds will maximize catches. The models suggest that catches improve proportionately with the size of area protected, although a point will be reached at which the disadvantage of having an insufficiently large fishing area balances the advantage of protection.

Connectivity: As more of the sea is closed to fishing, the connectivity among reserves increases, thereby enabling greater interaction among protected stocks. The greatest gains in connectivity are made at the low end of the spectrum of protection, from 0%-30% of the sea.

Roberts and Hawkins write, "The main reasons for conservationists and scientists backing a target of 20% closure are: (1) this figure can be justified on the basis of the best biological information currently available; (2) such closures are expected to provide significant economic benefits to fisheries; and (3) it is a realistic figure to implement. However, we shouldn't look upon 20% as a fixed goal, but rather as an average, with some areas and habitats needing less protection and others needing more."

The book by Roberts and Hawkins is due to be published this year by the World Wildlife Fund and the University of York (UK).

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certain stocks' habitat, in situations where those reserves are unaccompanied by fisheries management regimes for the remaining habitat.

Published proponents of the 20% closure figure — including Bohnsack, zoologist Jane Lubchenco of Oregon State University (US), and senior scientist Gary Davis of Channel Islands National Park (California, US) — have helped spread the word to various workgroups of which they've been part, as well as to other countries. Bohnsack was active on the US Coral Reef Task Force; Lubchenco helped write the National Research Council report on sustainable fisheries; and Davis assisted the Galápagos Islands reserve-planning effort.

The 20% target has not yet spread to other areas of the world, where closures have more typically reflected particular political and environmental situations. Major reserve-planning efforts in Australia, for example, have not followed any one strategy for establishing closures. Although the Australian government announced plans last year to close nearly a third of the upcoming Macquarie Island Marine Park to fishing (1:1), an advisory council to the state of Victoria recommended a closure of 6% of that state's waters (1:4). In planning for the Lord Howe Island Marine Park (1:7), the Australian government has refrained from suggesting that any percentage of the MPA will be set aside as no-take, and is waiting instead to discuss management options with local stakeholders.

Usefulness in negotiations

When is it appropriate to pursue a closure target in negotiations for protected areas? According to the (US) National Research Council's report on sustainable fisheries, "Without a clear goal, it is impossible to generate the debate that expansion of MPAs requires or to begin designing and implementing protected areas before environmental damage makes that impossible."

The precautionary nature of such a target can be useful in resource planning, but it can also pose challenges to negotiations, particularly when stakeholders wary of no-take zones are involved. Last year, in negotiations on networking California's MPA system, representatives of fishing organizations opposed the setting of any percentage goals for the establishment of no-take zones. The negotiations' resulting legislation called simply for an "improved" no-take reserve component. Although fishermen admitted that this language would most likely still entail an increase in closed areas, they were satisfied that they had fended off the preconception that a certain percentage of waters had to be set aside. Environmentalists supported the fishermen on this point in order to achieve broad buy-in on the overall plan.

Stakeholder buy-in is crucial for consensus-based negotiations on marine reserves, according to Mike Eng, who has facilitated reserve-planning negotiations in the Florida Keys (1:1) and, currently, the Channel Islands in California. Eng feels that positional approaches, such as percentage targets, can tend to sidetrack negotiation participants away from addressing their potential common goals. As such, this positioning can be an obstacle to reaching a consensus-based agreement and can undermine community commitment to any solutions developed.

"There needs to be support from the community in order to ensure compliance with, and success of, the reserve," said Eng. He suggests using an interest-based approach, in which stakeholders work together to address commonly identified goals related to an MPA, such as healthy fish stocks, continued fishing, biodiversity protection, etc. By pursuing common goals, he said, stakeholders can find higher-quality solutions that can better address stakeholders' interests and protect the marine environment.

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Web site with argument for protecting 10% of seas

Bill Ballantine of the University of Auckland's Leigh Marine Laboratory suggests that the idea of setting aside 10% of New Zealand's marine environment provides a conservative, traditional, and easily remembered goal. To read his essay on this subject, "Why 10%?", go to

http://www.hmu.auckland.ac.nz:8001/sanctuary/index.html

For an online library of more of Ballantine's publications, go to

http://www.marine-reserves.org.nz

Your opinion on percentage targets?

MPA News would like to hear from readers with opinions on the 20% closure figure or other percentage closure targets. Pending space, we will print selected responses in coming issues. Please e-mail us, at mpanews@u.washington.edu.

Conference Calendar

6-7 July 2000 — Vancouver, British Columbia, Canada. "Economics of Marine Protected Areas." Hosted by the University of British Columbia Fisheries Centre. Web site: fisheries.com/Announce/econMPA.htm.

9-12 July 2000 — Portland, Oregon, US. "The Coastal Society 17th International Conference: Coasts at the Milennium." Organized by the Coastal Society. Web site: www.oce.orst.edu/mrm/tcs17/confhome.html.

23-27 October 2000 — Bali, Indonesia. "Ninth International Coral Reef Symposium." Co-sponsored by several organizations, including the International Society for Reef Studies. Web site: www.nova.edu/ocean/9icrs/9icrs.html.

20-25 May 2001 — Durban, South Africa. "Sixth Indo-Pacific Fish Conference." Organized by the Oceanographic Research Institute, Durban. Web site: www.seaworld.org.za/ippfc.asp.

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