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."

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.

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 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.

For more information:

Mark Monaco, National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS), N/SCI1, SSMC4, 1305 East-West Highway, Silver Spring, MD 20910, USA. Tel: +1 301 713 3028 x160; E-mail: mark.monaco@noaa.gov.

Eric Treml, National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS), EASC, NX32, 2234 South Hobson Ave., Charleston, SC 29405-2413, USA. Tel: +1 843 740 1288; E-mail: eric.treml@noaa.gov; Web: www.csc.noaa.gov/opis/index.htm.

Also for OPIS: Cindy Fowler, NOAA Coastal Services Center, Charleston, SC, USA. Tel: +1 843 740 1249; E-mail: Cindy.Fowler@noaa.gov.

Robert Wright, Centre for Remote Sensing and Mapping Science, Department of Geography, University of Aberdeen, Elphinstone Road, Aberdeen AB24 3UF, Scotland, UK. Tel: +44 1224 272333; E-mail: r.wright@abdn.ac.uk.

Marc Pakenham, Department of Fisheries and Oceans, Nanaimo, BC, Canada. Tel: +1 250 m213 8762; E-mail: pakenhamm@pac.dfo-mpo.gc.ca.

Brian Crawford, Coastal Resources Center, University of Rhode Island, Narragansett Bay Campus, Narragansett, RI 02882, USA. Tel: +1 401 874 6225; E-mail: crawford@gso.uri.edu.

Alan White, Coastal Resources Management Project, 5th Floor, CIFC Towers, North Reclamation Area, Cebu, Philippines. Tel: +63 32 232 1821; Fax: +62 32 232 1825; E-mail: awhite@mozcom.com.

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).

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.
