

Managing Water Quality in MPAs: How Practitioners Are Handling the Challenges

The quality of water in a marine protected area plays a major role in the health of that site's underwater ecosystems. MPAs near urban centers or agricultural lands can suffer from runoff of wastes, fertilizers, and other materials that degrade or otherwise alter natural systems. Floating garbage can accumulate in protected areas. Oil from drilling and transport carries the chronic problem of leakage and the threat of spills.

While the global MPA discussion often focuses on extractive activities and their management, threats to water quality can pose just as great a challenge for MPA practitioners. This month, MPA News examines the water quality-related challenges faced by four MPAs around the world, and how practitioners are handling them.

Great Barrier Reef: Setting targets for contaminant reductions

The Great Barrier Reef Marine Park stretches 2000 km along the northeast coast of Australia. Its reef system -- the largest in the world -- is fed by a watershed dominated by extensive agricultural production, tourism, shipping, and urban and industrial centers. These activities all contribute pollutant inputs to the park. Agricultural activity, which comprises more than 80% of the Great Barrier Reef catchments, accounts for the greatest share.

"The water quality threats to the Great Barrier Reef have long been regarded as elevated nutrient concentrations together with increasing sediment loads," said Sheriden Morris, director of the park's Water Quality and Coastal Development Issues Group. Nutrients -- such as fertilizers from agricultural runoff and livestock waste -- can cause blooms of algae on the reef, ordinarily a nutrient-poor environment. Sediment, created by intensive farming and then carried downstream, can bury coral and disrupt its recruitment. Researchers estimate that in the last 150 years, inputs to the reef of two nutrients -- nitrogen and phosphate -- have increased by up to 400% and 1500%, respectively, and sediment loads by as much as 900%.

The past decade saw significant expansion of the region's agricultural activity, particularly in the production of sugar cane. Sugar cultivation throughout the state of Queensland increased by nearly a third in the 1990s. Banana production also exhibited rapid growth. From 1990-1999, in the case of two rivers draining to the reef, the presence of dissolved nitrogen from fertilizers doubled.

The effects of these increases have been seen on the Great Barrier Reef, particularly in inshore areas. Rising nutrient concentrations have led to increased seagrass biomass and distribution at two sites, while similar nutrient elevations elsewhere have been linked to reductions in coral growth.

In June 2001, under the directive of the Australian environment minister, the Great Barrier Reef Marine Park Authority (GBRMPA) began work to develop a water quality action plan. The plan, now completed, reviews the data on pollutant runoff into the park, prioritizes catchments according to the risk they present to the reef, and recommends minimum targets for reducing the pollutant loads. Among the targets recommended: a 38% reduction in sediment; 39% reduction in nitrogen; and 47% reduction in phosphorus. Each target is to be met by 2011. (The action plan and supporting documents are available on the GBRMPA website, at <http://www.gbrmpa.gov.au>.)

The plan is a big step forward for the park. However, a significant obstacle remains. Under Queensland law, agricultural industries are not accountable for pollutants discharged into the state's catchments. In general, agriculture is exempt from Queensland environmental protection legislation and associated regulatory provisions. As a result, farmers on land that drains to the reef are under no pressure to reduce or otherwise manage their fertilizer inputs. Compliance with the action plan's targets is wholly voluntary.

GBRMPA says Queensland will have to change this. "It is anticipated that Queensland will have to utilize a range of management tools to bring about the changes in land use necessary to reduce current pollution loads," said Morris. "Queensland has already initiated some reform of both its water and vegetation management legislation. But the primary legislative instruments for environmental planning and management do not recognize agriculture as an environmentally relevant activity. Exploring a range of options for new instruments, or new provisions within existing instruments, is clearly

necessary."

If agriculture were a state-regulated activity, GBRMPA would wield some management control over it under the park authority's bylaws. The bylaws allow the park to regulate activities outside the protected area that are harmful to plants and animals inside. Interestingly, GBRMPA invoked this regulation in 1999 to reduce effluent discharge from land-based aquaculture facilities adjacent to the park. Aquaculture, unlike agriculture, is a regulated activity in the state of Queensland. Following pressure by GBRMPA, the facility operators are adopting technologies to treat their effluent before discharging it.

Monterey Bay: Working with farmers

Like the Great Barrier Reef Marine Park, the Monterey Bay National Marine Sanctuary -- in California, US -- is another large MPA into which multiple rivers drain. Stretching along 480 km of coast, the sanctuary directly fronts several urban areas. Farther inland, intensive agriculture sends nutrients and other materials downstream.

"There's a soup of contaminants that we're concerned about, both urban-based and agricultural," said Holly Price, resource protection coordinator for the sanctuary. "Street runoff, coliform bacteria, fertilizer, sediment, pesticides -- the mix of contaminants provides the greatest challenge. Solving the problem requires the involvement of everyone who lives and works in the area. That becomes a massive task."

In recognition that water quality in Monterey Bay was critical for ensuring protection for all sanctuary resources, a group of eight federal, state, and local government agencies agreed in 1992 to work together to create a Water Quality Protection Program for the sanctuary, newly designated at the time. Today, 26 agencies and other organizations have teamed up to implement it.

The program is based on the concept of integrated coastal management, a process that begins with the direct participation of a region's managers, scientists, businesses, landowners, and other public stakeholders. One primary focus of the program has been to improve integration among the large number of existing water quality management and monitoring programs.

"In 1994-1995, when we started looking at what was being done on water quality, we realized there were already several poorly funded government programs involved, as well as a number of volunteer groups," said Price. Dozens of water quality management programs at all government levels were already in existence, in fact, but acting independently of one another. The sanctuary pulled these efforts together for training, coordinating and strengthening efforts, and planning to fill critical gaps.

"We started out by identifying other private or public groups in the area that were already active in water quality, then made them our allies," she said. "An MPA can be the catalyst for bringing these groups together, as well as a galvanizing influence on the public to protect water quality." One hallmark of the sanctuary's work has been the involvement of more than 100 volunteers trained to monitor water quality. The volunteers test local water samples for nutrients, bacteria, and other contaminants, and report back to the sanctuary.

The Water Quality Protection Program is divided into four action plans: urban runoff, marinas and boating activities, regional monitoring and data sharing, and agricultural and rural lands. The implementing agencies first addressed urban runoff, with which they thought they might have the most immediate influence. The cities were quick to raise funds and help build community awareness. One year later, monitoring of detergent levels in stormwater runoff -- an indicator of urban contamination -- showed a decline.

Reducing agricultural runoff has been a longer-term process, says Price. "It takes time to get the agricultural community involved," she said. "It may be contentious at first, but it's worth the effort. Farmers want to be good stewards of the land but they don't want to be told what to do. They also don't want a one-size-fits-all solution. We've been able to set up a framework whereby they can make adjustments that work for them."

The key has been the involvement of farm bureaus -- local cooperative organizations of farmers. The farm bureau community has taken a leadership role in organizing its members on the subject of runoff, says Price. As a result, the message is being distributed peer-to-peer in the agricultural community, rather than from agency to farmer. The farm bureaus are able to work with farmers on an individual level -- discussing solutions pertinent to specific crops, for example -- in a way the sanctuary would not have been able to offer.

"We still have a long way to go," said Price. She estimates it may take 10 years or more for contaminant levels to be reduced to where the sanctuary would like them to be. "It's an ongoing commitment."

Flower Garden Banks: Surrounded by oil industry

The Flower Garden Banks National Marine Sanctuary, off the coast of the states of Texas and Louisiana in the US, is named for the colorful "gardens" of corals and sponges found 20 to 30 meters below the surface. Located more than 700 km from the next nearest tropical coral reefs, the Flower Gardens provide a regional oasis for shallow-water Caribbean reef species.

What makes the sanctuary doubly-unique is its man-made resident: an offshore gas-production platform. In addition, two-dozen more platforms stand within kilometers of the sanctuary's bounds, drilling for oil and natural gas in the muddy, petroleum-laden bottom. (The platform within the sanctuary predates the latter's 1992 designation.)

"The good news is that the water quality is excellent at this time," said Sanctuary Manager G.P. Schmahl, noting that the sanctuary's remote location -- roughly 100 nautical miles (185 km) from land -- protects it from terrestrial runoff. "The not-so-good news is that there are lots of threats around."

The biggest threat, of course, is a spill, either from one of the platforms or from a seabed pipeline that transports the oil and gas to shore. The US government has gone so far as to draw a "30% oil spill probability zone" around the sanctuary. That is, if a spill were to occur from an identified platform within that zone, given an average of surface currents, there would be at least a 30% probability that the spilled oil would enter the sanctuary. There are 27 platforms within the zone.

In the case of such an incident, the sanctuary would defer response duties to the US Coast Guard, which has the assets to contain, clean up, or otherwise manage the spill. "The sanctuary's main role in a spill would be to make sure that we could document and quantify impacts," said Schmahl. In order to do that, the sanctuary is working now to measure baselines for a range of physical and biological factors. The sanctuary and the US Minerals Management Service (the federal agency that oversees offshore oil drilling) support an annual contract to conduct water quality analysis and benthic monitoring, including video transects and coral growth stations.

In recent years, the sanctuary has deployed devices to detect the presence of bioaccumulative compounds in the water, such as DDT, PCBs, and heavy metals. Later this year, two permanent stations to measure current through the water column will go online in the 30% oil spill probability zone. In the case of a spill, these stations -- paid for by the oil industry -- will provide the Coast Guard with clues to which direction the spill is likely to head.

Sanctuary personnel take part in regular oil spill drills conducted by the Minerals Management Service and the Coast Guard. In the drills, says Schmahl, companies that operate nearby platforms are notified that a spill has occurred, and are instructed to respond accordingly. The sanctuary provides realistic information such as might be relevant in a spill -- i.e., how the spill has affected a particular reef.

As further precaution, the federal government requires any pipeline that experiences a certain percentage decrease in pressure, such as might occur in a leak, to shut down automatically. For pipelines within four nautical miles of the sanctuary, the percentage decrease allowed is even stricter.

Thankfully, no major spills have occurred in the area since the sanctuary's designation. "Much of the oil and gas industry has gone out of its way to work with the sanctuary," said Schmahl. "I would never say that it is a good thing to have all this drilling around an MPA. But if you look objectively at the information, I think you have to conclude that it might not be as bad as others make it."

Bunaken: Floating garbage and the threat of mercury pollution

Bunaken National Park is one of six marine national parks in Indonesia. Designated in 1991, it covers 900 km² of diverse reefs and some of the largest mangrove stands in the northern hemisphere. With the capital city of North Sulawesi province, Manado, located just 10 kilometers from the park by boat, one might conclude that the main water-quality concern for the park would be urban runoff, namely human waste. In fact, it is not.

"Two major rivers empty into Manado Bay in the vicinity of Manado, and these two rivers are heavily polluted," said Mark Erdmann, marine protected areas advisor for the park. The rivers contain raw sewage, among other materials. "However, Manado Bay drops off quite steeply to 300-500 meters, and the maximum depth between Bunaken Island and Manado is 800-900 meters. Between the depth and the strong currents that flush the bay, the result seems to be that most particulate matter never makes it to Bunaken."

Nonetheless, any material that floats -- i.e., plastic garbage, including bags and food packaging -- travels straight to the park. This is the principal water-quality problem the park currently faces. "The floating plastic garbage is a major eyesore for tourists," said Erdmann, adding that at times there appear to be more bits of plastic garbage in the water than fish. "Moreover, the shape of Bunaken Island is more or less a crescent, and floating plastic is often entrained in the bay, ending up on the main tourist beach." On the ecological side, the area is a major cetacean thoroughfare and at least three species of sea turtle are common, so the potential for plastic ingestion is real, though not witnessed so far.

The park is working to reduce the flow of plastics. "Stopping the major source of plastic garbage from Manado is the obvious long-term goal, and park management and the tourism community have made this abundantly clear to the local government," said Erdmann. "But this effort is majorly hampered because Manado's dump has been technically 'full' for three years, and the government has been unable to find an acceptable new site." He says the World Bank and the US Agency for International Development have expressed interest in helping Manado manage its waste problem, but these efforts are very preliminary. In the meantime, the park's multistakeholder Management Advisory Board has made local management of plastic garbage a

priority for the board's second year of operation, and has begun a program of weekly beach cleanups funded by the park entrance fee. Dive operators have taken the step of reducing their use of disposable plastics, and have financed a video aimed at locals and tourists to encourage an end to plastic dumping.

Another potential problem for Bunaken has been that of petroleum hydrocarbon damage to some reefs. The vast majority of dive boats visiting the islands use relatively inefficient, two-stroke outboard engines that expel a certain amount of unused fuel oil into surface waters. There has been noticeable damage -- including disease, bleaching, and partial death -- to the shallow coral colonies that many divers come to see, and park managers suspect this could be a result of damage from fuel oil. "The local dive association has made a verbal commitment to begin switching the fleet over to cleaner-burning four-stroke engines as soon as they become available for sale in Indonesia, hopefully in the next year," said Erdmann.

What may pose the greatest future threat to the park, he says, is mercury contamination from illegal gold-mining in the mountainous watershed that drains to Manado Bay. The mining -- a widespread practice -- uses a mercury-based extraction process. The mercury enters the watershed and flows downstream. Aquatic organisms in the watershed and some marine animals in the estuarine zone are now showing elevated levels of mercury in their tissues. As yet, corals and fish from Bunaken have tested clean.

"It is possible that the deep water and strong flushing will yet again prevent major problems for the park itself," said Erdmann. "But the potential to destroy the tourism industry from negative publicity, as well as the province's valuable export fisheries, has spurred the park's Management Advisory Board to apply pressure to the provincial government to do something to stop the contamination." The government, led by environmental agencies that sit on the advisory board, has now initiated a campaign to begin licensing all small-scale miners, who will be required to use a non-mercury extraction process. The tourism industry has also initiated articles in the local newspaper on the dangers of mercury to the general public, building public support for an end to mercury use.

Erdmann says it would be misleading to portray the park management as having its water-quality problems under control. But it is moving forward. "With each of these problems, some successes have been scored and bigger plans are underway," he said.

For more information

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