

Using Computer Software to Design Marine Reserve Networks: Planners Discuss Their Use of MARXAN

The process of designing a network of marine reserves can involve an extraordinary amount of labor and data. This is particularly the case when planners seek an “optimal” network design — one that provides the best balance of biodiversity and socioeconomic considerations. Such a design requires accounting for multiple species, habitats, oceanographic factors, and resource uses across a wide geographic area. The data and computations involved can overwhelm planners without the aid of computers and special software to handle the challenge.

MARXAN, a software program to help design optimal reserve networks, is gaining fans in the MPA-planning community, thanks to its flexibility and capacity for processing large amounts of information. It was instrumental, for example, in designing the new zoning plan for the Great Barrier Reef Marine Park, which resulted in the world’s largest marine reserve network (*MPA News* 5:10). This week, *MPA News* examines MARXAN, its strengths and weaknesses, and how reserve planners are using it around the world.

How the software works

MARXAN supports decision-making on reserve design. It is not meant to replace decision-making. By incorporating data on species, habitats, and other biodiversity features, the software can identify networks of reserve sites that would meet biodiversity targets while minimizing costs to resource users, such as fishermen. It is then up to planners to decide which of the possible networks would be preferable, or to modify the networks by addressing specific stakeholder concerns or incorporating other data.

MARXAN works by performing an algorithm — or series of computations — called “simulated annealing”. This technique finds optimal combinations of sites that best satisfy the planning objective, subject to various constraints. (Simulated annealing has several other real-world applications, including the arrangement of telephone networks.) Although other software programs provide similar services for reserve design, MARXAN is generally considered to be the most powerful. It accommodates the most datasets and offers the greatest flexibility for entering a variety of decision-making factors.

Applying simulated annealing tools to marine systems is different than applying them to terrestrial ones, says Hugh Possingham, an ecologist at the University of Queensland, Australia, who helped develop the underlying basis for MARXAN in 1998. (The software design comprised the Ph.D. thesis of graduate student Ian Ball.) The main difference, Possingham suggests, is that on land, private land ownership and irreversible habitat change are more common factors than in the sea. When terrestrial sites targeted for protection are privately owned, it takes time for the government to procure them for the network; conversely, any delays in designation increase the likelihood those habitats will experience irreversible change. As a result, computer-generated plans for terrestrial networks can fall out of date rapidly, even within a year, due to changes in habitat. The resulting networks, if still based on the original plan, are less than optimal. Possingham describes this phenomenon in a paper he co-authored in the journal *Ecology Letters* in July 2004 (7:615-622), available online at <http://www.nceas.ucsb.edu/collab/2135/docs/ele6241.pdf>.

“The *Ecology Letters* paper is not so relevant to marine systems,” says Possingham. “It is primarily relevant to systems where sites are being destroyed and where sites only become available at the whim of the owner. In many marine systems, sites are not being irreversibly destroyed, aside from perhaps in some areas with dynamite fishing, for example. And with government control of most waters, planners do not have to wait for sites to become available. In the case of the Great Barrier Reef Marine Park, for example, the government was able to implement its re-zoning plan in one fell swoop.”

Applications of MARXAN

Three cases in which MARXAN was used to plan marine reserve networks are discussed below:

- **Great Barrier Reef Marine Park, Australia.** Leanne Fernandes, who managed the program to design a re-zoning plan for the Great Barrier Reef Marine Park, needed a tool that would be powerful enough to compute 16,000 planning units (each ranging in size from 10-30 km²) and 20 or more datasets. “We wanted a system that would optimize for a solution, but

continued on next page

Website about MARXAN

For more information on MARXAN, including a web-based demonstration of the tool, visit the MARXAN website at <http://www.ecology.uq.edu.au/marxan.htm>. The site also allows visitors to download MARXAN software for free.

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given that we calculated there might be 10¹⁵ or so options, a normal optimization program wasn't going to do it," she says. Planners also wanted a tool that would account for "representativeness" as a target — not just biodiversity hotspots or irreplaceable areas with unique species — and would account for the cost of designating particular sites.

At the time, no systems available met all of GBRMPA's needs, including an early version of MARXAN. So, with the help of Possingham and Ball, GBRMPA revised the MARXAN software, making it more appropriate for use in the marine environment and the Great Barrier Reef in particular. Using the software requires expertise, says Fernandes. "In my opinion, you need to be highly competent in GIS analysis and preferably programming with an idea about optimization algorithms," she says. "We had the technical expertise in-house and — with the forbearance of Dr. Ball, who had to revise the code of the program on occasion for us to overcome glitches — we were able to make it work for us."

Fernandes says MARXAN was helpful in delivering a solid beginning point — a network of reserves within the marine park — from which to launch the process of rezoning the park. "But the tool did more than that," she says. "It highlighted data gaps and inadequacies, displayed the extreme importance of a good reporting tool, and ensured a structured approach to setting objectives, using data, understanding data limitations, etc."

Nonetheless, she adds, MARXAN was only a beginning point. "Prior to release of the draft zoning plan, much information was added that was not amenable to application in the software, such as information about important uses and values that were in people's heads, not in databases," she says, citing areas of importance to recreational fishers as an example. "This information was integrated prior to finalization of the draft zoning plan. Then GIS, as well as roundtable planning teams and a database of analyses of public submissions, were all tapped to revise the draft plan based on the next round of submissions. The textual information often contained spatial references that were relatively easily interpreted by the planning teams working with the submissions database and GIS, but more difficult to transform into a format usable in MARXAN."

• **New Zealand.** In 2002, New Zealand's Department of Conservation (DOC) and National Institute of Water and Atmospheric Research (NIWA) used MARXAN on a trial basis. They tested its possible future application for designing a network of MPAs throughout the nation's 3.8 million-km² Exclusive Economic Zone (EEZ). Kathy Walls, senior marine conservation officer for the Department of Conservation, and scientist Mark Weatherhead of NIWA worked together on the project. "This EEZ-wide approach presented some exciting opportunities to test the application of MARXAN over a large marine area," says Walls.

Weatherhead says the greatest challenge was the volume of input data, which led to very long run times for the computer — over 40 hours on a powerful computer. "Because the computation time was too long, we coarsened the data for the purposes of the trial by stepping up to 100-km² planning units from 1-km² units, which reduced the computation time substan-

tially," he says. He and Walls concluded that the 100-km² dataset was adequate for investigating different management options at the EEZ-wide scale, and that the 1-km² dataset should be used to produce final outputs. They decided MARXAN was a promising tool to assist with selection of MPAs, and now hope to continue development of it with possible application at a finer scale in the nearshore.

Walls and Weatherhead say the outputs of MARXAN are only as good as the data that go in. "So we need to know the data limitations," says Walls. "We also need to be aware of the gaps in our knowledge that may be of importance. For data that have a high degree of temporal or spatial variability, you would probably want to look at them a little more abstractly, or look at long-term average conditions." Ultimately, setting up MPAs is a sociopolitical decision, she says. "MARXAN is just one of many sources of information feeding into that decision-making process."

• **British Columbia, Canada.** The Living Oceans Society, a Canadian NGO, has used MARXAN to design a potential network of marine reserves in the waters of British Columbia, along the Pacific coast of Canada. Jeff Ardron, who managed the process for the organization, says MARXAN is not perfect. "I have found it finicky to run correctly, and although it was designed for large amounts of data and large areas, certain functions can grind the program almost to a full halt," he says. "But then again, we were looking at about 32,000 different planning units and 93 layers of data. This is far beyond the abilities of any other program, and certainly not something a planner can intuit. Having said that, when MARXAN is running smoothly, it is a thing of beauty."

Notably, the Living Oceans Society was not interested in the "best solutions" that MARXAN produced, in light of unknown factors or assumptions that could potentially render such solutions infeasible, says Ardron. "Rather, we were interested in emergent patterns over the course of hundreds or thousands of runs under a variety of modeled reserve sizes and fragmentations," he says. "From these aggregated runs, we identified areas as having high 'conservation utility'. That is, under a variety of conditions, certain areas appeared again and again as being useful, perhaps even essential, in reserve design. These we viewed as the logical place to begin marine reserve planning."

Since 2000, the Living Oceans Society has provided its findings to the provincial and federal governments, but despite several false starts, integrated marine planning has yet to begin. "Am I happy with MARXAN? Generally, yes," says Ardron. "Am I happy with marine planning in BC? No comment." Reports on his organization's MARXAN work are available online at <http://www.livingoceans.org/library/index.shtml>. 

For more information

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MPA News Poll: What Qualities Make a Good MPA Manager?

The job of the MPA manager is a challenging one. Despite shortages of funds and personnel in many cases, the manager is expected to administer a site effectively, including managing resource threats and juggling stakeholder interests. To do the job well requires people with special skills, backgrounds, or personalities.

For insights on finding such people, *MPA News* consulted a range of practitioners and other experts in the MPA field. Each was asked a single question: What quality or qualities make a good MPA manager? Below are their answers, in their words:

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Nirmal Jivan Shah Chief executive, Nature Seychelles (NGO), Seychelles. Shah was the first director of the Conservation and National Parks Service of the Seychelles.

The qualities of a good MPA manager are having the foresight of a prophet, the patience of a saint, and the understanding of a psychiatrist.

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Sue Wells Private consultant, UK. Wells is former coordinator of the Marine and Coastal Programme of the IUCN Eastern Africa Regional Office, and remains active with it. She has helped create a training course and toolkit for MPA managers in the Western Indian Ocean (*MPA News* 5:4).

A good MPA manager has the qualities that define good managers of any organization or business. I think that conservationists and scientists often forget that protected areas are essentially businesses and that many of the best practices for good business management need to be applied to the running of an MPA. Technical expertise in marine issues is important, but in terms of making an MPA effective, general managerial skills may be even more essential.

In our work in the Western Indian Ocean, we have recommended that managers consult websites on good business management. An online article titled "What Makes a Great Manager", for example, is available at <http://www.ee.ed.ac.uk/~gerard/Management>. It points out that "common sense" is the first key requirement of any good manager, which I would strongly endorse.

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Kalli De Meyer Executive director, Coral Resource Management, Bonaire. De Meyer is former director of the Bonaire National Marine Park.

Some of the most successful tropical marine park managers I have come across have come out of the dive industry or have a background including time spent in the tourism sector. I think this is because, while we kid ourselves that we are "resource managers", we are in fact

managing people. Those who have worked successfully in dive tourism are good communicators. They are also personable, can organize themselves and others, may already have management experience, understand basic accounting, know about marketing and public relations, and are not easily daunted.

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Richard Kenchington Visiting professor, Maritime Policy Centre, University of Wollongong, Australia. Kenchington is chair of the board of the International Coral Reef Action Network and a former executive director of the Great Barrier Reef Marine Park Authority.

Acceptance that managing environments is managing people is a fundamental quality that should enlighten all levels of MPA management. The core objectives of MPAs generally relate to maintenance of biodiversity and ecosystem processes. However, the threats, cause of the problems, and means of management relate to human behaviors. Achieving the objectives often involves time to achieve major changes in the substance and balance of human behaviors, values, attitudes, and dependencies.

So the key qualities of a manager are:

- Capability, capacity, courage, and persistence to work with and through people whose lives and values are linked with the MPA;
- Capacity to identify, prioritize, and address internal and external impacts, threats, and opportunities, recognizing the relevant scales of space, time, societal values, and development needs; and
- Intolerance of paper parks and a commitment to reasonably enforceable and enforced MPAs.

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Tomas Camarena Policy expert, Environmental Defense (NGO), USA. Camarena is former director of the Banco Chichorro Biosphere Reserve and other MPAs in Mexico.

Administrative skills are essential. These include areas as diverse as:

- Short-, medium- and long-term planning;
- Making efficient use of personnel, money, and equipment;
- Hiring personnel with adequate profiles;
- Fundraising, which may sometimes be the primary task of the MPA manager; and
- Conflict resolution, both for social conflicts in the field and administrative conflicts within the MPA or with local, regional, and national agencies.

Marine skills, such as seamanship, scuba diving, knowledge in mechanics (outboards, compressors, generators, diesel, etc.) can also help a lot in being accepted in the confined world of fishers, and are very helpful in the best use of limited resources.

Management integrity

In an essay in our February 2001 issue (*MPA News* 2:7), Graeme Kelleher, a senior advisor to the IUCN World Commission on Protected Areas, described lessons learned from the successful management of MPAs. Kelleher offered the following lesson for managers:

"The most important attribute of an MPA manager is integrity. Many managers have made the mistake of believing that they can fool some of the people some (or even all) of the time. The consequence of this is that the manager appears to win a series of battles, but he or she loses the war because of the accumulation of loss of trust. This eventually leads to failure."

MPA News

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Thank you.

Tundi Agardy Executive director, Sound Seas (NGO), USA.
Agardy has worked for more than 20 years on coastal conservation
and sustainable resource use issues worldwide. She serves on a US
federal advisory committee on implementation of MPAs.

The power of the individual in determining the success
of an MPA cannot be overstated. We spend an awful
lot of time and resources discussing optimal MPA
design, perfect processes, and best practices. But when
it comes down to it, having a committed individual
driving the whole thing is key, and we usually just shrug
off this fact of life.

Second, a capacity for empathy is important. Aside
from having this sort of personality, empathy can be
gained through previous work in one of the sectors
being managed (fishing, for example) or one of the
management activities (law enforcement, for example).

Third, the best MPA managers know how to delegate
authority, manage staffs well, and maintain a sense of
humor — crucial in these difficult times!

Marjaana Kokkonen and Steven Ripley UNESCO World
Heritage Centre, France. Kokkonen is a natural heritage specialist,
while Ripley advises managers of World Heritage sites.

A good manager should be enthusiastic about the job
and have a firm belief in the objective of conservation of
the site. A manager who views his position as simply a
“9-to-5” job is more likely to look for other employ-
ment as soon as funding for the site runs into any
difficulties. In addition, in cases where this person leads
a team, the manager who demonstrates total commit-
ment to the site is better able to lead by example and
motivate his team.

Bill Ballantine Marine biologist, Leigh Marine Laboratory, New
Zealand. Ballantine has been instrumental in the designation of
several no-take marine reserves in New Zealand waters, although he
has not been an MPA manager. He notes that his response is in the
context of marine reserves, not multi-use MPAs.

Most managers of marine reserves know that their three
most important tasks are enforcement of the rules,
education of the general public, and monitoring of
marine life. Some managers treat these as separate
matters, but good managers know they are inextricably
linked. Effective enforcement, for example, depends on
the active interest of the general public. Such support
depends on the provision of interesting information
about the marine life. Suitable information can only be
obtained by monitoring.

Professional rangers, trained educators, and research
scientists are expensive. The official budget is never
adequate, and reducing activity to fit these is simply
admitting defeat. Good managers realize that they can
use the public and special interest groups to do much of

the work. Such people do not require payment but they
do need active support and encouragement. Poaching
and other illegal acts are unlikely in the presence of
schoolchildren, trainee divers, fish watchers, research
students, amateur photographers, snorkeling tourists,
etc., and such groups will report any infringements.
They can be encouraged to make maps and species lists,
design posters and pamphlets, and record all kinds of
useful and interesting information. Where such groups
do not yet exist, good managers help create them.

Nancy Dahl-Tacconi Ph.D. candidate, University of Queensland,
Australia. Dahl-Tacconi is conducting research on management
effectiveness of MPAs in Indonesia.

Good managers are receptive. They are open to a range
of different kinds of information, options, and ideas,
and recognize the importance and power of broad
understanding. So they seek out this range of input to
improve their own management capacity. By inspiring
transparent and fluid communications based on mutual
respect and trust, they encourage a pragmatic apprecia-
tion of complexity and uncertainty among their staff
and stakeholders.

Good managers are also sagacious. They are perceptive,
discerning, and tactful in the way they develop strategies
and partnerships, resolve conflicts, and facilitate
negotiations. They base their decisions on the fruits of
their receptiveness and they adapt their approaches in a
sensible and rational way, based on an understanding of
priorities and an analysis of a variety of alternatives.

Doug Yurick Chief, Marine Program Unit, Parks Canada. Yurick
coordinates work to establish new national marine conservation areas
for Parks Canada as well as other activities in support of the program.

Management of an MPA should focus clearly on
achieving stated goals and objectives. The successful
MPA manager recognizes that to achieve this result, a
foremost requirement is to maintain open dialogue with
partner agencies and stakeholders in order to obtain
consensus on the wide array of management and
planning issues that will affect his or her ability to
achieve success. Accordingly, strong interpersonal,
communication, and negotiating skills are of fundamen-
tal importance.

As well, the successful manager should possess a
comprehensive understanding of MPA management
principles and issues — including those ecological,
socioeconomic and cultural considerations relevant to
his or her site, with most of these extending beyond the
MPA into adjacent waters, lands, and communities.
Such awareness must not be static but adaptable to
changing circumstances, as must be the MPA manage-
ment that it will inform. 

New Book Takes Comprehensive Look at Marine Reserves

A new book aims to summarize the “state of the art” on no-take marine reserves, providing an overview of current expertise on reserve science, planning, and management. Targeting a broad audience — including non-expert scientists, students, managers, decision-makers, conservationists, and other stakeholders — the book provides analysis on all aspects of reserves, as well as detailed case studies from around the world.

Marine Reserves: A Guide to Science, Design, and Use, by Jack Sobel of The Ocean Conservancy (a US-based NGO) and Craig Dahlgren of the Caribbean Marine Research Center, will fill a vacant niche on the MPA bookshelf, says Sobel. “The lack of an existing, easily accessible overview and synthesis of marine reserves was a primary motivation for writing this book,” he says. “Readers interested in exploring the primary literature more fully should find a strong base here for such exploration.”

The 383-page book has chapters on such topics as the impacts of fishing, reserve design, social dimensions, and research priorities. A chapter titled “What Marine Reserves Can Accomplish” reviews the latest research on reserves, and addresses the often-contentious issue of the potential benefits of reserves for fisheries. Acknowledging that evidence of reserve benefits is “not always ironclad”, due to sources of uncertainty and basic

challenges involved in conducting ocean research, Sobel and Dahlgren challenge whether any other fisheries management tool has been proven to have been directly responsible for improving long-term fishery yields.

“Compared to other management tools, extensive scientific support backs marine reserves as an effective conservation and fishery-management tool,” they write.

“Scientifically, we already know more than enough to plan, design, develop, and create highly effective marine reserves, and should greatly expand their use,” Sobel told *MPA News*. The primary challenges are all socio-political, he says, such as lack of wide public knowledge of the efficacy of reserves and the influence that extractive industry can have on policymaking. He says planners can face these challenges by using improved and extensive public outreach to all public constituencies and allowing for vigorous debate on the merits of reserves. “Consensus is neither always possible nor necessary,” he says.

More information on the book, including instructions on ordering it, is available on the website of the publisher, Island Press, at <http://www.islandpress.org>. On the homepage, enter “marine reserves” in the search engine and click “Search”. The book costs US\$35 for the paperback version and US\$70 for the hardcover version. 

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Funding available for coral reef conservation

Projects to reduce or prevent degradation of coral reefs and associated habitats may be eligible for funding from the (US) National Fish and Wildlife Foundation, or NFWF, in partnership with the (US) National Oceanic and Atmospheric Administration Coral Reef Conservation Program. Grants between US\$10,000 and \$50,000 will be available, with priority given to projects that either (a) provide hands-on, measurable watershed approaches to reduce land-based pollution and sedimentation to adjacent reefs and associated habitats, or (b) involve efforts to measure and improve management effectiveness of coral reef protected areas. Pre-proposals are due 31 January 2005. Applications will be accepted from US or international NGOs, academic institutions, and government agencies, although priority will be given to projects that focus on US domestic, US insular, Freely Associated States, Caribbean, or Mesoamerican coral reef ecosystems. In 2004, the program provided 26 grants for coral reef conservation projects, totaling US\$2.4 million. For more information, visit the program website at <http://www.nfwf.org/programs/coral.htm>.

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Report provides technical advice for national MPA networks

A report with guidelines for establishing and managing MPAs and MPA networks was released earlier this year by the Secretariat of the UN Convention on Biological Diversity (CBD). Produced over two years by a group of technical experts, including fisheries managers and marine biologists from 15 nations, the report provides a concise overview of MPA planning and management, from design principles, to enforcement, to financing, and more. The report also points out the benefits of no-take marine reserves and the need for such areas.

“The task was to provide advice on the prevailing wisdom on marine and coastal protected areas in a format that could give direct advice to the Parties to the Convention on how to make MPAs functional at the national level,” says Murray Hosking, who chaired the technical expert group. Hosking is a special advisor to the New Zealand Department of Conservation (DOC) on marine reserves.

“The key advice from the report is fairly simple,” says Hosking. “Above all, start somewhere. Gain experience

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from one MPA and build on it. Develop processes and think about networks. Let local communities into the process, and develop good management and compliance procedures.”

The 43-page report *Technical Advice on the Establishment and Management of a National System of Marine and Coastal Protected Areas* is available online in PDF format at <http://www.biodiv.org/doc/publications/cbd-ts-13.pdf>.

For more information: Marjo Vierros, Secretariat of the Convention on Biological Diversity, Montreal, Canada. Tel: +1 514 288 2220; E-mail: secretariat@biodiv.org

MPA Spotlight: Vanuatu MPA offers turtle, crab sponsorships to raise funds

The Nguna-Pele Marine Protected Area in the South Pacific nation of Vanuatu is offering sponsorships of sea turtles and coconut crabs as a way to raise funds for the MPA. Each sponsorship costs US\$50 and provides the donor with biological data on the individual creature being sponsored.

The turtles and crabs have been tagged and released by MPA staff as part of programs to monitor and protect these species. Sponsors may give their turtles or crabs a name, which is entered in the MPA's monitoring database. Because the turtle-tagging effort is part of an international initiative (the South Pacific Regional Action Plan), turtle sponsors may also receive updates on where their creatures have been spotted throughout the region. Since June 2004, more than 30 turtles have been sponsored, along with seven crabs, reports Chris Bartlett, a biologist for the MPA.

The MPA also sells T-shirts and MPA memberships to raise funds, in addition to the sponsorships. “These projects have brought financial sustainability to an organization with no other revenue-generating activities,” says Bartlett. Funds from sponsorships have been used to purchase new underwater torch lights for turtle catching, lifejackets for boat safety, and a VHF marine radio for contact with shore. Funds have also been used to provide stipends for local volunteer staff.

The MPA is a collaborative effort among eight local villages on the two islands of Nguna and Pele. To become involved in the MPA, each village must select one or two small areas of its reefs to protect permanently, with no fishing allowed. In total, the MPA protects about 3000 hectares of coral reef, rocky volcanic coastline, and seagrass habitat. For more information on the Nguna-Pele Marine Protected Area and its tagging and sponsorships programs, visit <http://www.marineprotectedarea.com.vu>.

Report: Measures needed to protect cold-water coral reefs

MPAs should be used along with several other policy tools to protect cold-water coral reefs, which are threatened by bottom fishing, oil exploration, and other human activities, according to a new report published by the UN Environment Programme's World Conservation Monitoring Centre.

“Cold-water coral ecosystems are biodiversity hotspots and resources which may be as important as their counterparts in tropical, warm waters,” write the authors. “Their conservation, protection, and sustainable management requires a concerted, dedicated approach, and an increase in national and international efforts and commitments.” The report recommends a “toolbox” of options to be considered for the reefs' effective conservation, and suggests that stakeholders implement the ones most appropriate to their means. Researchers have only recently begun to appreciate the scale of cold-water coral reef communities and their potential significance to

fish and biodiversity (*MPA News* 3:5). Also called deepwater coral reefs, they are usually found at depths between 200 and 1000 meters; new findings have shown that they exist off the coasts of more than 40 countries. The 84-page *Cold-Water Coral Reefs: Out of Sight – No Longer Out of Mind* is available online in PDF format at http://www.unep-wcmc.org/press/cold_water_coral_reefs/report.htm.

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Report: Nearly half of Caribbean MPAs managed inadequately

Nearly half (48%) of Caribbean MPAs suffer from inadequate management while the management status of another one-third (33%) is unknown, according to a new publication from the US-based World Resources Institute (WRI). The report, titled *Reefs at Risk in the Caribbean*, adds that only 5% of the region's coral reefs are within MPAs with fully or partially adequate management. The authors suggest that management effectiveness be strengthened through capacity-building efforts, funding, and political support from governments, donors, NGOs, and the private sector. Management effectiveness was measured according to four criteria: existence of management activity, existence of a management plan, availability of resources, and extent of enforcement.

The MPA data comprise one section of the report, which provides a regional view of reef degradation based on several factors, including coastal development, sedimentation, and overfishing. The report provides the first regionally consistent, detailed mapping of these threats, and concludes that nearly two-thirds (64%) of Caribbean coral reefs are threatened by human activities. The 80-page report is available online at <http://reefsatrisk.wri.org>.

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Education journal publishes issue on MPAs

Current: The Journal of Marine Education, published by the (US) National Marine Educators Association, has released an issue devoted to the subject of marine protected areas in the US. The issue explores challenges facing MPA managers, and provides classroom activities that teachers can use to introduce students to concepts discussed in the articles. The issue, Vol. 20, No. 3, was sponsored by the National Marine Protected Areas Center. To order a copy, e-mail Phyllis Dermer, education coordinator of the National Marine Protected Areas Center, at phyllis.dermer@noaa.gov.

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