

Biodiversity “Hotspots” Discovered for Large Ocean Predators; Can Serve as Basis for Open-Ocean MPAs, Say Researchers

Tunas, sharks, sea turtles, and other large oceanic predators concentrate in diversity “hotspots” much like those that exist on land, according to new research by a team of German and Canadian scientists. The distinct locations at which these hotspots occur — at intermediate latitudes close to habitat features like coral reefs, shelf breaks, and seamounts — could provide the basis for open-ocean marine reserves to protect threatened species, say the researchers.


Boris Worm and Heike Lotze of Kiel University (Germany) and Ransom Myers of Dalhousie University (Canada) published their findings in the August 19, 2003, issue of the *Proceedings of the National Academy of Sciences* (US). Their results, generated from scientific-observer records from pelagic longline fisheries in the Atlantic and Pacific Oceans, showed hotspots existing in national waters of Australia (off the Great Barrier Reef, Lord Howe Island, and the northwest coast) and the US (off the east coast of Florida, the Carolinas, and south of Hawaii). Computer-based models developed by the team predicted that large reserves around the hotspots would outperform non-hotspot closures in protecting large pelagic predators.

“The idea of oceanic reserves, and the concept of hotspots as an efficient way to site reserves, seems to make sense to everybody,” says Worm. He says existing reserves near some of the areas could be expanded to cover the hotspots. “The fact that these hotspots are found in national waters is very fortunate, because national action can take us a long way toward conserving threatened large predators.” There are very likely other predator-diversity hotspots in the world, he says, although finding them will require observer data equal in quality to those used in this study, which were collected by well-funded Australian and US observer programs.

Worm and his team found that most of the hotspots, though high in diversity, sustained relatively low longline catch rates of target species. Conversely, higher catch rates for target species occurred in areas of lower overall diversity. For reserve planners, this entails a decision: whether to site reserves for maximum protection of single species or groups of species. Reserve location, and the accompanying impact on fisheries, would depend on the decision.

Alain Fonteneau, a Seychelles-based tuna fisheries scientist with France’s Institute for Research and Development, says the concept of diversity hotspots in the pelagic ecosystem is very interesting, though not surprising. “All predators tend to concentrate their biomass where food is abundant, at least when the habitat is favorable to the species,” he says. However, although he favors the use of MPAs for future management of offshore pelagic resources, he is skeptical that the hotspots identified by Worm *et al.* would make the best MPA sites. “A fraction of the US and Australian longliners is really too small to allow an analysis of the management consequences of these potential MPAs,” he says. “The validity of this concept should be better explored at a worldwide level, using global tuna, billfish, shark, and turtle stocks/populations, and taking into account the global distribution of resources and all the major fisheries,” he says.

Callum Roberts of the University of York (UK) has advocated for years the use of marine reserves for protecting highly migratory species, and welcomes the findings of Worm *et al.* “What is especially intriguing is the juxtaposition of pelagic biodiversity hotspots with [previously identified] reef hotspots,” he says. “This adjacency provides us with an efficient means of targeting benthic and pelagic conservation priorities simultaneously.”

Although the research by Worm *et al.* focuses on presumably stationary hotspots, Roberts suggests pelagic predators could also be protected with mobile reserves. He cites the use of daily sea-surface temperature maps by the US east coast swordfish fleet to identify frontal areas of high productivity — somewhat like the frontal hotspots identified by Worm, but mobile. “That same technology could be harnessed for protection,” says Roberts. “Daily maps faxed to the fleet could include marine reserve areas that would change position with movement of the fronts.” 

Hotspots paper available online

The paper “Predator diversity hotspots in the blue ocean” by Worm *et al.* is available online in PDF format at http://www.dal.ca/~bworm/Boris_Worm.htm.

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The Mediterranean Sea is generally recognized more for its role as a cradle of Western civilization than as a role model for marine conservation. However, there are some innovative MPA-related initiatives underway in the region — initiatives that could provide useful examples for MPA practitioners elsewhere. This month, *MPA News* examines some of these efforts, their implementation so far, and the challenges they face.

Creating a Mediterranean-Wide MPA Network: The SPAMI System

In the early 1970s, marine pollution had become a major concern for Mediterranean scientists and government officials. Visible signs of a “sick” sea, including tar balls on beaches from tanker spills, led

Mediterranean states to seek a plan for identifying the extent of Mediterranean pollution, and for protecting the region’s marine environment in general. The resulting Mediterranean Action Plan was approved in 1975 by 16 nations and the European Community. One year later the Barcelona Convention, providing the legal framework for implementing the plan, was signed.

The Barcelona Convention remains the keystone of efforts to protect the Mediterranean Sea, including the designation and management of MPAs. Under a 1995 protocol to the convention, contracting parties agreed to create what will essentially be a Mediterranean-wide, representative MPA network — a system of sites known as Specially Protected Areas of Mediterranean Importance (SPAMI).

The SPAMI system, consisting of 12 sites so far, demonstrates the opportunities available for regional MPA management within an overarching legal framework.

Chedly Rais is scientific director of the Regional Activity Centre for Specially Protected Areas, which

serves as secretariat of the SPAMI system and is centered in Tunisia. “The main elements provided by the Barcelona Convention and relevant protocol are the legal basis and binding character of provisions,” says Rais. Not only are contracting parties made aware of the importance of the areas covered by SPAMIs, he says, but they are also forbidden from undertaking activities “contrary to the objectives” for which SPAMIs are established (i.e., protecting representative ecosystems, endangered and critical habitats, or other sites of particular importance). In addition, the Barcelona Convention and protocol provide a framework for cooperation and solidarity among Mediterranean countries, says Rais, which implies financial support, technical assistance, and exchanges of experienced personnel among parties in implementing the protected areas.

Proposals for inclusion of protected areas on the SPAMI list must indicate the management measures to be applied to an area as well as the means of implementation. The party or parties that propose inclusion of a site are responsible for its management.

Of the SPAMIs listed so far, there are seven in Spain, one in France, and three in Tunisia. Each is small or moderately sized and along a coast. The twelfth SPAMI — the Pelagos Sanctuary for Mediterranean Marine Mammals — stands in stark contrast. Spanning 87,500 km², it is much larger than the others and includes national waters of three contracting parties: France, Italy, and Monaco. Benefiting from the regional framework provided by the Barcelona Convention, the sanctuary is the first Mediterranean transboundary protected area. Additionally, a significant portion of the sanctuary lies outside of national marine jurisdictions, making it arguably the first high-seas MPA in the world (see box, opposite page). Parties to the protocol are bound by regulations set forth for each of the SPAMIs, whether inside or outside national waters.

The SPAMI system faces some obstacles to creating an effective, representative network of protected areas. At present, most of the listed SPAMIs lack management plans, despite the requirement that such plans exist before a site is listed. (The contracting parties included these areas on the list with the intent of “kick-starting” the SPAMI process; evaluations of each site are expected to conclude before the next meeting of the parties in November 2003.) The SPAMI list is also far from representing the full range of habitats in the Mediterranean.

In addition, though contracting parties are bound by the protocol, non-parties are not. Although this is not a major concern in national waters, where nations are free to enforce their protected area regulations, it becomes more complex on the Mediterranean high seas. “The SPAMI system needs to gain support from non-

The Mediterranean: A Semi-Enclosed Sea Rich in Biodiversity, Culture, and MPA Initiatives

“The Mediterranean Sea is a place of paradox and surprises. Despite many people’s image of the area as being vastly overpopulated, with built up shorelines, polluted waters, and over-exploited resources, the Mediterranean is in actuality a thriving, diverse ecosystem upon which people of many different cultures depend....”

Thus begins an essay by Tundi Agardy on the Mediterranean Sea and the promise it holds as a center for MPA-related conservation. Her essay is available on the *MPA News* website at <http://depts.washington.edu/mpanews/Agardy.htm>. As executive director of Sound Seas, a US-based NGO, Agardy is closely involved with an array of Mediterranean MPA initiatives, including ones described in the adjacent special feature.

The editorial board of *MPA News* is grateful to Tundi Agardy and to Giuseppe Notarbartolo di Sciara, marine conservation policy coordinator for the Tethys Research Institute (an Italian NGO) and IUCN WCPA Mediterranean coordinator, for their guidance and assistance in spearheading the research for the Mediterranean coverage in this issue.

Mediterranean states and persuade them to comply with the measures applicable to the SPAMIs,” says Rais. One goal, he says, is to involve the International Maritime Organization (IMO) in the SPAMI system, potentially through recognizing the SPAMIs as Particularly Sensitive Sea Areas, an IMO designation. “In that case, all IMO member states would recognize the importance of the sites, and ships flying their flags would be required to comply with SPAMI regulations,” he says.

Despite these challenges, the SPAMI system offers a valuable template for regional conservation, says Giuseppe Notarbartolo di Sciara, Mediterranean coordinator for the IUCN World Commission on Protected Areas. “The legal and operational framework of the SPAMIs provides an extraordinary opportunity for creating a real network of Mediterranean MPAs, which should not be missed,” he says.

Sistema Afrodite: Coordinating the Monitoring of MPAs Throughout Italy

In recent years Italy has designated 16 marine protected areas, and nearly 20 more are in the pipeline. Italian MPAs are multiple-use protected areas, typically including one or more core “A” zones (i.e., no-entry, no-take reserves); buffer “B” zones where limited human activities are permitted; and general reserve “C” zones having a lesser degree of protection. At present, each MPA functions as a separate entity, facing its own set of institutional, administrative, and management challenges.

Sistema Afrodite is an attempt to unite Italian MPAs into a cohesive network. Developed and led by the Italian government’s Central Institute for Applied Marine Research (ICRAM), *Afrodite* is focusing on the science of these MPAs, standardizing and synchronizing the research carried out at each site. By standardizing the knowledge gained, *Afrodite* intends to allow scientists to assess effectiveness of the core zones, detect environmental trends, identify gaps in MPA coverage, and ultimately provide information to improve management. It is among the first attempts in the world to synchronously monitor a set of parameters across a wide protected area system using standardized methods. Data collection is coordinated to the day and hour.

Now in its first three-year phase (2001-2004), the program has coordinated a number of research activities, primarily conducted in the highly protected “A” zones of the MPAs. These activities include:

- Detailed cartography, including bathymetry and geomorphology;
- Monitoring of the water column, phyto- and zooplankton, and sediments;
- Habitat and species inventories, using standardized data-entry forms;
- Fish visual census, with data collected from A and C zones;

“The First High-Seas MPA”: The Pelagos Sanctuary for Mediterranean Marine Mammals

The most noteworthy of the Specially Protected Areas of Mediterranean Importance (SPAMIs) is the one that best demonstrates the unique capacities for MPA designation afforded by the Barcelona Convention.


The 87,500-km² Pelagos Sanctuary for Mediterranean Marine Mammals, more than half of which lies in international waters, has been argued to be the first high-seas MPA in the world. Although whale sanctuaries in the Indian Ocean and Southern Ocean have been in place for several years under the auspices of the International Whaling Commission, their regulations are largely limited to a prohibition on commercial whaling. In contrast the Mediterranean sanctuary, which entered into force in 2002, requires contracting parties to protect the area’s marine mammals and habitats from all direct or indirect negative effects, including pollution and dangerous fishing gears.

Contracting parties under the Barcelona Convention are required to abide by the regulations of protected areas on the convention’s SPAMI list, whether the SPAMIs lie inside or outside national waters. This is what makes the high-seas portion of the Mediterranean sanctuary possible.

The sanctuary contains internal maritime waters and territorial waters of France, Italy, and Monaco, as well as the adjacent high seas, which comprise 53% of the total area. Note that no exclusive economic zones, or EEZs, are included. The reason: Mediterranean coastal states have so far been reluctant to establish 200-nautical mile EEZs, although afforded the right to do so by international law. (France and Spain have declared EEZs for their non-Mediterranean waters.) Therefore the Mediterranean high seas begin beyond the 12-nm limit of each nation’s territorial sea.

If coastal states were to establish EEZs in the region, the sanctuary would lie completely within national waters of France, Italy, and Monaco — the three states that jointly proposed its designation. Under the designation agreement, these nations claim the right to enforce the sanctuary’s regulations on the high seas even with respect to ships flying the flag of third states (presumably including non-Mediterranean nations), within the limits established by the rules of international law. No formal prosecution of a high-seas violation in the sanctuary has tested the fitness of this arrangement.

Responsibility for managing the sanctuary also rests with the three nations, which have initiated efforts to draft a management plan and address such issues as the management of whale watching, traffic and collisions, military exercises, and the illegal use of driftnets in the area. NGOs, which played an active role in the sanctuary’s planning, are expected to continue their involvement.

Ecologically, the sanctuary is characterized by high levels of offshore primary productivity, caused by the conjunction of oceanography, climate and other factors. The sanctuary contains habitat suitable for the breeding and feeding needs of all eight cetacean species regularly found in the Mediterranean Sea, from fin and sperm whales to four species of dolphins. 

- Benthic sampling; and
- Pollution monitoring, using sand samples and biomarker studies in fish.

Measurements are taken on a range of schedules, varying by activity: the water column is measured fortnightly, for

continued on next page

example, while fish are sampled every six months. All data collected are entered into a single database designed to meet the needs of different users, including academics, managers, teachers, and the general public.


Such extensive monitoring has required a substantial research team. To carry out the array of measurements,

ICRAM has secured the cooperation of several partners within the National Research Council (CNR) and the National Consortium of Marine Science Institutes (CoNISMa) of the Italian university system. In addition, a special committee of international experts in the field of MPA science has provided advice on research standardization for the program.

Marine biologist Fiorenza Micheli of Stanford University (US) is a member of the interna-

tional advisory committee. She says the large scale of the program and involvement of so many researchers required an extensive preparatory phase, involving workshops and meetings where potential approaches were presented and roles of research units were defined. "This was, and is, an unprecedented and extremely important effort in a research environment that has lacked large-scale, coordinated research," says Micheli.

If one viewed an MPA network as a systematic sampling scheme, then MPA-based research would yield information not only about individual sites but also about large marine ecosystems as a whole. Standardized research in MPA systems would be able to provide information on whole water bodies such as the Mediterranean Sea, including distribution and abundance of species, status of habitats, predictions on future status, and efficacy of management.

Although *Afrodite* is still early in its implementation, its organizers are optimistic of its future, including the potential for expanding it to other MPA systems within the Mediterranean region or beyond. "*Afrodite* represents a model that could be followed everywhere," says Felicia Coleman of Florida State University, another member of the international advisory committee. "It sets Italy squarely in the forefront as the most progressive country in MPA assessment." 

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MPAs a key part of draft regional marine plan for SE Australia


Marine protected areas will play a key role in the coming regional marine plan for southeastern Australia, currently available in draft form and open for public comment until October 17, 2003. The plan, whose final version is scheduled for release this December, provides a broad framework for managing all ocean uses in a marine area of more than 2 million km². It is the first step in a national effort to develop integrated management plans for each of Australia's marine regions.

The draft plan features several objectives in support of ongoing efforts to develop a representative MPA system in SE Australia and around the nation (*MPA News* 3:4). Although the draft stops short of naming specific MPA site options, the final version will likely include some, according to Peter Taylor, director of marine protected areas for Parks Australia, within the federal Department of Environment and Heritage (DOEH). "DOEH has a strong and clear expectation of rolling out a representative system of MPAs as each regional marine plan is undertaken," he says.

DOEH will host a series of stakeholder workshops over the coming months to facilitate a design process for potential MPAs in SE Australia, including consideration

of socioeconomic interests. "Of special interest is the fact that the fishing industry is recognizing it has significant additional information about habitats, water column, species, etc., that could add value to the design process," says Taylor. Notably, over the past six months, DOEH has provided funds to the fishing industry in SE Australia to facilitate its input to MPA design processes. The funds are part of an 18-month project aimed at helping the Australian Seafood Industry Council (ASIC), the peak commercial fishing organization in Australia, to build coalitions with the diverse and fragmented fishing associations of the southeast region and establish these associations' buy-in to the design effort.

"DOEH has been very explicit in recognizing the importance we place on building the trust and confidence of industry," says Taylor. "We are also quite clear that we are talking about MPAs that have no-take components and multiple-use when necessary. To date, this project has exceeded expectations in the interest and commitment shown by the fishing industry."

The SE Australian marine region includes the waters off Victoria, Tasmania, eastern South Australia and southern New South Wales, as well as the sub-Antarctic Macquarie Island. The draft regional marine plan is available online in PDF format at http://www.oceans.gov.au/se_draft_plan.jsp. 

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MPA Perspective The Diminishing Returns of MPA Science

By Jake Rice, Department of Fisheries and Oceans, Canada

There is a common belief that good science, combined with enough consultation, will provide universal support for MPAs. Based on my experience linking science to policy in marine conservation and management, particularly in fisheries, I think this belief is naïve. I am prompted to share two observations on the appropriate relationship of science and MPAs.

First, science is crucial to selection of good sites for MPAs and determining what provisions of management plans are necessary for each MPA to achieve its objectives. However, such science has diminishing returns. We don't need enough science to design the perfect MPA, however desirable perfection may be. The time and research support necessary to have all the answers is excessive.

If the justification for establishing an MPA is the protection of a unique feature, the feature should be unique enough to stand without long-term, intensive research. If not, a science-based justification of "uniqueness" won't be convincing to opponents anyway. If the ecological goals of an MPA are more generally to protect representative ecosystem structure and function, the cost of research to demonstrate conclusively that an area is "representative" and to quantify all important structural and functional properties is prohibitive.


With realistic amounts of science, I suspect that all that could really be shown on a case-specific basis is what we already know: we need such MPAs to be large and we need them soon. The inescapable opportunity for "more research" should not be an excuse to delay action once the properties of candidate areas are known well enough for informed discussion of the likely consequences of protection.

Second, and more importantly, there is no scientific finding out there, waiting to be discovered, that will make opposition to MPAs melt away. Where people currently (or plan to) pursue economic activities such as fishing in a proposed MPA, some of them will feel they will lose at least part of their economic or cultural basis of living when their activities are prohibited or restricted. Perhaps enough science can be done to demonstrate to the satisfaction of objective third parties that in the medium term there will be more benefits than losses from setting up the MPA, or that the economic activity is doomed in the medium term anyway due to resource overexploitation. That won't convert all of those stakeholders who are focused on their immediate losses (whether only short-term or enduring) into supporters of the MPA.

If local opinion were formed primarily by objective and relevant information, participants in fisheries long ago would have embraced reduced effort, capacity, and catches. After all, existing fisheries models clearly demonstrate how much more yield could be taken from stocks were they allowed to rebuild.

Experience is very different: opponents of fishery reductions can acknowledge all the potential benefits yet can oppose the reductions for at least two reasons. They cannot address the immediate costs that they would incur personally, whatever the potential future benefits might be. And there is no guarantee that when the benefits started to accrue, those who bore the costs would be the ones to accrue the benefits. Both of these factors play strongly in stakeholder discussions on fisheries, where the models predicting the future benefits, though flawed in many ways, are better than any quantitative ecosystem models available, and where the future benefits are necessarily in the currency most relevant to the fishers (i.e., catches). In contrast, when discussions are about short-term sacrifice of fisheries to allow MPA establishment, the future benefits will be more uncertain in timing and magnitude, and many of the greatest benefits will be in currencies of less direct relevance to fishers.

The messages are that science is important — we all support it — but even the best science is no "magic bullet" that neutralizes opposition and ensures MPAs will be the perfect tools for recovering healthy ecosystems. We certainly need to use all the science we have when planning and managing MPAs, and to consult widely with affected stakeholders, building as strong a base of support as possible. However, we also need to be prepared to act without full information and full consensus when the decision system is receptive, and to make some mistakes due to incomplete knowledge. What matters then is that we admit the mistakes later when more information becomes available, and do our best to correct them.

Above all, we need to keep our use of science consistent with the reasons why science has such a privileged place in decision-making. Science is not the selective use of information for advocacy purposes. It is the use of all available information, however great or inadequate, to allow an informed and common factual basis, from which advocates from all perspectives can find as much common ground as possible. 

Editor's note

Jake Rice is director of the Canadian Science Advisory Secretariat for the Department of Fisheries and Oceans. He manages the peer review and application of marine and fisheries science to policy formation and management decision making. In this perspective piece, he expands on remarks he made at the May 2003 meeting of the Science and Management of Protected Areas Association (SAMPAA), held in Victoria, British Columbia, Canada.

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Views on Adjustment Programs for Displaced Canadian Fishermen

Last month, *MPA News* reported on the development of alternative livelihoods for fishermen, particularly those displaced by closure of fishing grounds, either for fisheries management or as part of an MPA. We cited a CDN\$4-billion (US\$2.8-billion) effort by the Canadian government since 1992 to help communities in Atlantic Canada adjust to cod fishery closures, through a license buyout, early retirement, skills training, and other programs. The case focused on insights from the government agencies that provided these programs.

Afterward, we spoke with other members of the community. Earle McCurdy, president of the Fish, Food and Allied Workers' Union, the leading fishing union in Atlantic Canada, says some aspects of the adjustment programs were useful. "The license buyout [for fishermen] and the early retirement programs [for processing plant workers and crew members] were quite helpful, generally speaking," says McCurdy. "They helped some of the older people get out of the industry with dignity, while allowing younger workers to avoid being laid off."

Job retraining, though, was less effective, he says. Some fishermen were able to retrain to work on offshore oil platforms, lay deep-sea cable, or work as long-haul truck drivers, but the transition for the remainder, particularly older workers, proved difficult. "The economy doesn't want older people," he says. "You bring in someone who is 53 years old to discuss his career prospects, and he doesn't have any. No one will hire him." Although the government programs helped some find a niche in the changing economy, says McCurdy, "For the others, it was just money thrown at a problem. If anything, the government should have put more of the money into the license buyout and early retirement."

Debbie MacKenzie, an independent fisheries scientist in the coastal province of Nova Scotia, worked as a public health nurse in Atlantic Canadian fishing communities in the 1990s. "Except for the cases where exploitation of now-depleted fish species has been shifted to still-abundant crustaceans, successful retraining and new endeavors have been relatively few at both the individual and community levels in Atlantic Canada," she says. "A hitch with retraining in rural communities founded on fishing is that there is very little that one can realistically be retrained for. Attracting new manufacturing industries to these locations is very difficult, due to added transportation costs resulting from the remoteness."

MacKenzie recalls one government program, known by its acronym "TAGS", that provided income support to displaced fishermen in the mid-1990s. It was intended to help community members until the cod stocks rebounded to sustainable levels, but that rebound has not occurred. "The TAGS payments seem to have functioned only as a stopgap measure, delaying the inevitable," she says. "TAGS would have worked just fine if the scientific projections [of stock recovery] had been correct, but the predictions were dead wrong." Although federal fisheries managers are determined not to let the crustacean fisheries go the way of the cod, MacKenzie says she worries the shrimp and crab are another stopgap "until the crustaceans bottom out, too." 

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Notes & News

Report available on training managers for modern fisheries challenges

Today's fisheries managers often must account for a complex array of factors in their decisionmaking, including stakeholder involvement, ecosystem management, sustainable fisheries, international policy, litigation, and scientific uncertainty, among other considerations. A new report lays out a vision for future fisheries management and how the skills and knowledge of managers worldwide may be developed to implement it. *Training Managers for 21st Century Fisheries*, the report of a similarly named international workshop held in Queenstown, New Zealand in December 2001, provides a blueprint for building the capacity of

problem solvers, innovators, and leaders in the management field. The workshop was sponsored by the New Zealand Seafood Industry Council, the (US) National Marine Fisheries Service, and the Coastal Oregon Marine Experiment Station of Oregon State University (US). The report is available in PDF format on the website of the "Training Managers for 21st Century Fisheries" initiative, an ongoing project, at <http://oregonstate.edu/dept/trainfishmgr>. You may also join the project listserv. For more information: Laurie Jodice, Parks, Recreation & Tourism Management, Clemson University, 263 Lehotsky Hall, Box 340735, Clemson, SC 29634-0735, USA. Tel: +1 864 656 2209; E-mail: jodice@yaho.com.

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