MARINE ECOSYSTEMS and Management

International news and analysis on marine ecosystem-based management

MEAM
www.MEAM.net
Vol. 2, No. 2
Dec. '08 - Feb. '09

Managing Ecosystems, Managing Fisheries: How Do EBM and EBFM Relate?

Fisheries management is an important component of broader marine management, no matter the circumstances of place or the scale of EBM undertaken. But what is the relationship between ecosystem-based management in general and ecosystem-based *fisheries* management (EBFM) in particular? Would it be better to think of EBFM as an entry point to EBM, or to consider EBM as a necessary prerequisite to effective EBFM?

Readers have queried MEAM in the past about the relationship between EBM and ecosystem-based fisheries management. MEAM devotes this issue to exploring distinctions between, and dependencies among, these approaches.

Role of EBFM in EBM

Many of the EBM practitioners that MEAM contacted on the relationship between EBM and EBFM felt that EBM represented the ultimate (though not always attainable) goal for marine resource managers. In some instances, EBFM represents a first step toward true EBM. Kevern Cochrane of FAO says that in most cases, an ecosystem approach to fisheries is a necessary but often not sufficient part of the sustainable use of aquatic ecosystems. "Managing the whole ecosystem is best, but managing individual parts can still be useful even when the whole cannot be achieved," he says.

For the purposes of this issue, MEAM generally considers "true" EBM to include EBFM as a component. However, there may be cases when EBFM is more than a subset of EBM – i.e., where the entry point to ecosystem–based management is unexpected. Take the case of managing parrotfish fisheries in the Caribbean region. Whereas coral reef managers have typically focused on direct impacts on reef ecology, reef ecologist Peter Mumby of the University of Exeter (U.K.) advocates using fisheries management in and beyond reef areas to manage reef ecosystems. Active management of these important grazing fishes not only contributes to their sustainable use (the goal of fisheries management), but also plays a key role in managing entire coral reef ecosystems. Mumby says grazing by parrotfishes has been shown to reduce the amount of seaweed on Caribbean reefs and help increase the rate of colonization of new corals. "This means that ensuring an adequate amount of fish grazing is at least one practical step toward improving the resilience of coral populations, and therefore the ecosystem services provided by reef habitats," says Mumby. "Carefully designed fisheries regulations for parrotfishes could have a great impact on the species themselves, but also on the biodiversity and functioning of the entire ecosystem."

Another way to look at the EBM-EBFM link is to think of EBM as the starting point for better fisheries management. A 1986 FAO publication by John Caddy and Gary Sharp introduced this way of looking at fisheries long before the terms EBM or ecosystem approach were in currency. (The publication, *An Ecological Framework for Marine Fishery Investigations*, is at www.fao.org/docrep/003/T0019E/T0019E00.htm). In effect this is Peter Mumby's point turned around. To achieve true EBFM, we need to re-orient ourselves toward EBM (see Caddy's essay on p. 7).

Cochrane agrees, saying that ecosystem-based management is an important complement to existing fisheries management approaches. When asked whether EBFM is possible without EBM, Cochrane suggests that the answer depends on the specifics of each case. "Most commonly, a number of sectors will be impacting on an ecosystem and real progress will be possible only if they are all addressed simultaneously within a broad EBM," he says. "However, there are almost certainly some instances where fisheries will be strongly dominant — for example in some cases on the high seas — and therefore big strides could be made through EBFM alone."

Embedding fisheries management

Jake Rice, Senior National Advisor – Ecosystem Sciences for Fisheries and Oceans Canada, says that the logical extension of attempting to balance "diverse societal objectives" must be that, as far as feasible, fisheries management should be embedded within a broader ecosystem approach. "The best approach is to start with societal objectives

continued on next page

Table of Contents

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— Jake Rice

(e.g., as reflected in relevant policies), and then to assess the greatest threats to achieving those objectives," says Rice. "With current management practices, fisheries will often emerge as being a source of important objectives and also the source of a number of different threats (over-exploitation of target species, impacts on conservation species, impacts on critical habitats, etc.). As long as those threats are not swamped by impacts from other sectors, they will be mitigated at least by taking action in the fisheries sector, with or without collaboration with other sectors."

However, small-scale or piecemeal attempts at practicing EBM will not necessarily result in desired outcomes. Jackie Alder, Director of the Marine and Coastal Branch of UNEP's Division of Environmental Policy Implementation, acknowledges that tools traditionally thought of as getting us closer to EBM are potentially powerful, such as large-scale, well-managed protected areas. But ignoring the EBFM component by not addressing fisheries management in the broader context, she says, can doom such initiatives to failure. "In the excitement to create effective MPAs, conservationists sometimes ignore the broader fisheries management issues, and do so at their peril," says Alder.

Cochrane suggests the best approach is not to differentiate between the two at the start. "Rather, identify the impacts on the ecosystem, prioritize them in terms of the risk they represent, and then address the higher priority issues," he says. "That will tell you whether it should be EBFM, or 'EB*CD*M' for coastal development, or 'EB*OG*M' for oil and gas, etc.," he says. He adds that combining two or more of these in an overarching EBM approach is also possible.

Practical steps to successful EAF or EBFM

Agreeing that a big-picture integrated approach to management is better than a narrow sectoral one is one thing. Creating management that mitigates negative impacts on ecosystems is another. The marine environment presents special challenges given both the scale of management and the information base upon which management must rest.

Defining terms

Ecosystem-Based Management (EBM):

Ecosystem-based management is "a management approach that considers all ecosystem components, including humans and the physical environment, rather than managing one issue or resource in isolation." **Source: NatureServe, a U.S.-based conservation NGO**

"Ecosystem-based management of coastal regions aims to restore and sustain the health, productivity, resilience, and biological diversity of coastal systems and promote a sustainable and enhanced quality of life for people who depend on them. Grounded in science, EBM seeks to foster management regimes that will be effective over ecological—rather than political—spans, and that address ecological, social, and economic goals...." **Source: Marine and Coastal Ecosystem-Based Management Initiative, David and Lucile Packard Foundation**

Ecosystem-Based Fisheries Management (EBFM) and Ecosystem Approach to Fisheries (EAF):

"Ecosystem based fisheries management (EBFM) considers the impact fisheries have on all components of the broader marine environment. This includes managing the impact of fishing on target species as well as byproduct species, bycatch species, threatened, endangered and protected species, habitats and communities." **Source: Australian Fisheries Management Authority, the Commonwealth statutory body for management of Australian fisheries**

"An Ecosystem Approach to Fisheries strives to balance diverse societal objectives, by taking account of the knowledge and uncertainties about biotic, abiotic and human components of ecosystems and their interactions and applying an integrated approach to fisheries within ecologically meaningful boundaries." **Source: United Nations Food and Agriculture Organization**

What is the difference between "ecosystem-based management" and an "ecosystem approach to management"? (Or, similarly, between ecosystem-based fisheries management [EBFM] and an ecosystem approach to fisheries management [EAFM]?)

The terms *ecosystem-based management* (EBM) and *ecosystem approaches to management* (EAM) are sometimes used interchangeably. However, some practitioners — particularly in the field of fisheries management — say the distinction between approaching management with ecosystems in mind as opposed to *basing* management on ecosystems is a subtle but important one. Essentially, they say, the difference lies in how heavily ecosystem considerations are weighted in decision-making.

Jake Rice, Senior National Advisor – Ecosystem Sciences for Fisheries and Oceans Canada, chooses to use EAM rather than EBM, and EAFM rather than EBFM. "All the agreements I know of have language where States agree 'to adopt an Ecosystem *Approach* to Management', whether of fisheries or of everything," he says. "They do not agree to *base* management on ecosystem considerations." In Rice's interpretation, an Ecosystem Approach to Fisheries is one that weighs ecosystem considerations along with all the other considerations in a decision, including socioeconomic concerns. This is broadly consistent with the UN Food and Agriculture Organization, which has also opted for the term ecosystem approach to fisheries (EAF) rather than EBFM.

A 1999 report from the U.S. National Marine Fisheries Service on ecosystem-based fisheries management described the problem of implementing EBFM and EBM in the face of uncertainty and incomplete knowledge:

> "We know that the traditional single-species approach of fisheries is tractable, but we also know that it may not be sufficient. We know that an ecosystem perspective is desirable, but it is complex and unpredictable." (www.nmfs.noaa.gov/sfa/EPAPrpt.pdf)

Boze Hancock of The Nature Conservancy (TNC) says the practical application of EBM and EBFM means that management must be "big and sensible", although what that means may be open to interpretation. Hancock prefers to call such approaches "multi-objective" as opposed to EBM. "We're forced to make the problems smaller in an effort to make them tractable," he says. "Practically, this means managers and planners tackle a few key interactions at a time." An example is TNC's work on restoring bays and estuaries through its Shellfish Restoration Network (www.nature.org/initiatives/marine/strategies/shellfish.html). The purpose is to restore the estuarine ecosystems back to coupled benthic/pelagic systems instead of predominantly pelagic ones. In practice this means increasing the number of shellfish, which play key roles in ecological processes crucial for the benthic ecosystems. "Achieving this increase involves addressing the multiple human (including fishery) and environmental influences that impact the shellfish populations and ultimately the estuarine ecosystems," says Hancock.

Depending on the circumstances, such ecosystem plans move from EBFM to true EBM. "Where there are important threats from other sectors, unless those are also addressed, the ecosystem will remain under pressure," says Rice. "If those threats impact fishery resources directly or indirectly, the full, potential, sustainable benefits from fisheries will not be attained."

Rice sums up the practical links between EBM and EBFM. "Different agencies and jurisdiction have very different appetites for integrated management, and different legal mandates to be responsive to different things," he says. "On a case-by-case basis the most amenable entry point will differ. There is very little to be lost and much to be gained by taking the entry point offered by the problem and the governance process and building from there. There is unquestionably a place for ecosystem approaches to fisheries management even if full EAM is not in place or even on the near horizon. The further away the governance processes are from the full suite of necessary steps, the more important it is to start on EAFM, because it will take everyone on a path that makes EAM more likely, and eventually certain."

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For links to additional publications on ecosystem-based fisheries management, go to http://depts.washington.edu/meam/EBFM.html.

EBFM in Practice: Benguela Current Large Marine Ecosystem

The Benguela Current Large Marine Ecosystem (BCLME) Programme is a multinational initiative conceived in 1995 and involving the southwest African governments of Angola, Namibia, and South Africa. It was designed to address the region's transboundary marine challenges. Such challenges include the management of valuable fish stocks across national boundaries, harmful algal blooms, alien invasive species, and pollutants transported by winds and currents from the waters of one country to another. One of the major goals of the BCLME was to establish a Benguela Current Commission (BCC) to enable the three countries to engage constructively and peacefully in resolving transboundary issues that threaten the integrity of their shared ecosystem.

"As the first regional institution of its type in the world based on a Large Marine Ecosystem approach to ocean governance, the formation of the Benguela Current Commission has been an African success story," says Mick O'Toole, a South African fisheries scientist and former regional coordinator of the BCLME programme. Through establishment of the BCC, ministers responsible for fisheries, environment, energy, mining, and tourism have worked to address issues such as the recovery of depleted fish stocks, restoration of degraded habitats, and reduction and control of coastal pollution.

Mike Sissenwine, a marine science consultant and former Director of Scientific Programs for the U.S. National Marine Fisheries Service, agrees that fisheries management in the LME represents a success for the region. "The Benguela LME is one of a few good examples of EBM that meets the challenges of cutting across scales," he says. (Sissenwine wrote on the issue of scaling in ecosystem-based management in MEAM 1:2.)

One of the key tools enabling this integration has been Transboundary Diagnostic Analysis – a tool developed by Laurence Mee of the University of Plymouth (U.K.). The TDA assesses transboundary threats then uses that information to develop a strategic action plan to address those threats. In the BCLME, the TDA was done with broad stakeholder involvement to ensure ownership of the process and outputs. (Information on the TDA is on the project website at www.bclme.org.)

continued on next page

BCLME map, funding

For a map of the Benguela Current Large Marine Ecosystem, go to www.eoearth.org/image/BenguelaCurrentLocation.jpg.

The BCLME Programme was launched with funding from UNDP/GEF under the International Waters Programme (www.undp.org/gef/05/portfolio/iw.html).

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Further development and implementation of EAF by the three Benguela countries will continue over the next five years, supported by the Benguela Current Commission. Notably, says O'Toole, the Commission is also set to extend its focus beyond just fisheries management. "The implementation of the EAF work will be done in a phased manner within the context of an overall ecosystem approach to ocean governance," he says.

Without that broader focus on the ecosystem in general, EBFM without EBM may not be possible over the long term, even in this success story. Andrew Bakun, a marine biologist at the University of Miami, has studied the dynamics of southwest Africa's marine ecology and suggests the ecosystem is changing in somewhat surprising ways. He has found that climate change in the region is causing wind patterns to change, which in turn produces a prolonged upwelling and a resultant surplus of phytoplankton. The phytoplankton are not consumed and ultimately sink to the seafloor, where they rot and contribute to hypoxia. "If fisheries ministers do not take such changes into consideration when setting their policies, a dead zone could form in the region, even with effective EBFM," says Bakun. Fisheries management must account for climate changes or else risk undermining the ecosystem, which is one of the world's most productive.

Editor's note: A 2007 report by the UN Food and Agriculture Organization, *Results and Conclusions of the Project "Ecosystem Approaches for Fisheries Management in the Benguela Current Large Marine Ecosystem"*, is at ftp://ftp.fao.org/docrep/fao/010/a1343e/a1343e.pdf.

Krill, the Antarctic Ecosystem, and CCAMLR

CCAMLR map
For a map of the CCAMLR Convention area and a description of its boundaries, go to www.ccamlr.org/Pu/e/conv/map.htm.

The multinational effort to protect the vast resources of the Antarctic marine environment is often cited as among the best working examples of marine EBM. This regional initiative is under the auspices of the Convention on the Conservation of Antarctic Marine Living Resources, which came into force in 1982 (www.ccamlr.org). Among other aspects, the treaty is notable for its embrace of the precautionary approach and the need to consider ecological links between species as part of management — the "ecosystem approach". Under the treaty, cooperative management is overseen by the Commission on the Conservation of Antarctic Marine Living Resources (CCAMLR), which includes representatives of 25 governments.

Original negotiations on the treaty arose from concerns that an increase in krill catches in Antarctic waters, back in the 1970s, could harm those populations of krill and the species that preyed on them, including birds, seals, and fish. A quarter-century later, as CCAMLR has made substantial progress in its management of Antarctic marine resources in general, the krill fishery continues to pose challenges. Although CCAMLR is revising its krill management to reflect ecological science, conservationists say that recommendations from the CCAMLR's Scientific Committee are being influenced by political and economic interests.

"CCAMLR has established krill catch limits for some areas of the Southern Ocean but these do not adequately account for the relationships between krill, predators, and the fishery, which occur at much smaller scales," says Rodolfo Werner, Science Advisor for the Antarctic Krill Conservation Project (www.krillcount.org), an international initiative supported by the Pew Environment Group. "Aware of this situation, CCAMLR has pledged to develop an adaptive management system based on small scale management units (SSMUs) — not only to account for these relationships but also to consider the effect of climate change. However, consensus has not been reached on the approach for an initial establishment of krill catch limits at the SSMU level, despite the substantive ongoing work of CCAMLR's technical bodies." In addition, says Werner, CCAMLR should increase its efforts to implement comprehensive monitoring of krill-dependent predator colonies on land, using the predators as indicator species to distinguish the effects of fishing from the effects of climate change.

A main obstacle to managing the krill fishery has been disagreement among CCAMLR members on whether to require full scientific observer coverage on krill fishing vessels. Virginia Gascón, Policy Advisor for the Antarctic Krill Conservation Project, says such a measure would provide CCAMLR's Scientific Committee with the information it needs to help develop the SSMU-based catch limits. At a recent CCAMLR meeting, nations active in the krill fishery, including Japan and South Korea, opposed the requirement for observers.

"We understand that implementing ecosystem-based management is a long process, and CCAMLR is doing substantive work in the right direction," says Gascón. "This process will suffer, though, if the scientific work of the organization is politicized. Scientific advice should be independent from political or economic interests. Without this, true EBM or EBFM will be impossible to implement."

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EBM Opinion: On Marine Ecosystems, Fisheries Management, and Semantics

By Daniel Pauly

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In the 1970s, when I was a student of fisheries biology in Kiel, Germany, we were taught from textbooks, by Beverton & Holt, Ricker, Gulland and others, which did not mention more than casually the ecosystems within which the exploited species in question are embedded. In fact, these species were presented as having mainly internal dynamics, upon which the "outside", i.e., the ecosystem, could impact only via natural mortality, which was represented by a constant. It was the same in other countries, and there were reasons for that, perhaps good reasons, but they are no good any more.

Two related developments led to this extreme reductionism being gradually overcome. One was the inordinate number of exploited stocks that crashed in the 1980s and 1990s, the most famous of those crashes being that of Northern cod off Eastern Canada, which was supposedly well-managed and whose collapse hugely impacted on the credibility of fisheries science. The other development was the collateral damage of fisheries, in the form of marine mammals, seabirds and turtles drowned and in form of habitat destruction, both of which became big public issues in that period.

I don't know who first coined the term "ecosystem-based fisheries management" (EBFM), which was proposed as the solution to these ills. But the term was extremely successful, as attested by its acceptance by the NGO community and the public and by various governments, often before their fisheries management agencies could adapt. In fact, the quick acceptance of the term preceded serious scientific discussion of its implications. (It also preceded any consensus on its meaning and feasibility, but this is not a problem as "consensus" is never achieved on this Earth).

Fisheries scientists and marine ecologists thus had to scramble to give the term some operational definition. Most settled on a list of essentials, including: a place (for the ecosystem to be in), which is zoned (for different uses), whose integrity (e.g., the sea floor communities) is to be protected from, for example, trawling (at least in part; we are realists), and whose key forage species (e.g., krill, or small fishes) are to be shared between humans and other predators, such as marine mammals and seabirds. Also, social scientists have joined in the fray, informing us of such things as "people are part of the ecosystem." (The quotation marks are a hint that this seemingly platitudinous phrase is anything but, given that it prevents us from conceiving of ecosystems that we would deliberately leave alone.)

Out of this scramble came the realization that once an ecosystem becomes the focus of concern, there is no reason to privilege the fisheries, and thus ecosystem-based management (EBM) was born. However, this term hides more than it clarifies. Here is how a major environmental NGO defines "the Principles of EBM" in one of its brochures:

> "Ecosystem-based management has objectives and targets that:
> • Focus on maintaining the natural structure and function of ecosystems and their productivity;
> • Incorporate human use and values of ecosystems in managing the resource;
> • Recognize that ecosystems are dynamic and constantly changing;
> • Are based on a shared vision of all stakeholders;
> • Are based on scientific knowledge, adapted by continual learning and monitoring."

In other words, EBM as defined here means everything and nothing, i.e., the term has devolved toward vacuity. This is similar to "sustainability", which could be taken to mean things being done such that they could remain more or less the way they are forever (or at least for a long time). Sustainability then devolved to "sustainable growth", which is an oxymoron, because something that grows (e.g., an economy, or fisheries catches) cannot continue to do so forever, or even for a long time. This is in fact neatly illustrated by the unraveling of the various Ponzi schemes of which Wall Street was so fond.

And while we are agonizing about EBM vs. EBFM, and whether humans should be considered in or out, fisheries go on their merry fuel- and subsidy-guzzling ways, smashing deep coral and driving iconic and other species toward extinction. And when fisheries will run out of things to smash and of oil to burn, ocean warming and acidification will complete the job. The difference between EBM and EBFM is not relevant to anything real. What is important is what happens on the ground. We have lots of work to do.

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— Daniel Pauly

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Marine Ecosystems and Management is published quarterly by Marine Affairs Research and Education (MARE), a 501(c)(3) not-for-profit corporation, in association with the School of Marine Affairs, University of Washington. Financial support is provided in part by a grant from the David and Lucile Packard Foundation.

All content has been written by the MEAM editorial staff unless otherwise attributed. The views expressed herein are those of the author(s).

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EBFM Opinion: Furthering Fisheries Management, Hopefully Toward EBM

By Mike Beck

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Many countries are moving toward more ecosystem-based management of fisheries. These programs vary somewhat in name and approach, but I will refer to them broadly as EBFM for this essay. These EBFM programs are beginning to lead to advances in the way that the fisheries sector is managed and studied and could be an important step toward the more multi-sector management that is at the heart of ecosystem-based management (EBM).

Fishery managers should be encouraged in their moves toward EBFM while also being clear that this represents potential reforms in only one sector or objective, fishery management ("FM"). Two of the main issues that have motivated fishery managers to think more broadly (in an ecosystem-based, or "EB", way) are (i) the increasing recognition of the connections between different fish species and stocks, which have been managed individually (and usually in decline) and (ii) the impacts to fisheries from decisions made in other management sectors.

The first issue can be addressed directly by fishery managers. The addition of EB to FM is leading toward real shifts away from just single-species or stock management to multi-species management including the trophic interactions among species. These improvements in fisheries management should benefit fisheries and could create greater flexibility for the joint management of resources in other sectors.

Improvements in management in individual sectors are necessary but often not sufficient to address current governance shortcomings.

— Mike Beck

The second issue — multi-sector impacts and opportunities — is more difficult and can only be addressed indirectly by fishery managers because the decisions are primarily outside of their authority. EBFM is about fisheries management and it is led by agencies and managers whose primary (and usually sole) mandate has been to sustain or increase the catch of fish. Under EBFM, fishery management decisions can be influenced by examination of their impacts on other sectors or resources. This consideration of other sectors by fishery managers is an important step toward future opportunities to jointly manage these issues across sectors. But the converse of influencing management decisions in other sectors (e.g., agriculture, conservation, and energy) based on their impacts to fisheries is much more challenging to fishery managers, because they do not have authority over these other sectors.

This second issue is exactly where EBFM, single-sector management, falls short of EBM, multi-sector management. A driving force for the development of EBM has been the recognition that there are now many overlapping and conflicting uses in the marine environment. Sector-specific management has led to fractured governance systems that are insufficient to meet these challenges. This fractured marine governance was a core problem identified for the U.S. by the recent Commission on Ocean Policy (www.oceancommission.gov), and it is a common problem in most countries (finding working examples of marine multi-sector management are the oddities). Improvements in management in individual sectors are necessary but often not sufficient to address current governance shortcomings.

The improvements and shortcomings of EBFM are being mirrored in other management sectors, including conservation. For example, many conservation programs (public and private) are doing a better job of understanding fishery management objectives in their planning and implementation. This involvement runs the gamut from certification programs to working directly with fishermen on new approaches to harvesting. But these programs fall short of explicitly and jointly meeting fishery management objectives, because such management is outside their purview. There are some real advances being made in cooperation across sectors toward jointly meeting objectives (as well as some hyperbole about relatively minor advances in communication across sectors). In the U.S., for example, fishery management plans are increasingly being developed with real input from conservation scientists, although there is still room for improvement. In the south Pacific, the Secretariat of the Pacific Community is developing an ecosystem approach to fisheries management with conservation groups at the table.

The painful truth is that managing for multiple objectives, even just two, is difficult and in the marine environment we have less direct experience with it than in the terrestrial environment. Nonetheless, we are making real progress in getting toward the ideals of EBM: full and joint consideration of multiple management objectives in a common framework.

EBM Opinion: EBM Is About More than Just Managing Fisheries

By John F. Caddy

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I see EBFM (Ecosystem-Based Fisheries Management) as a subset of EBM (Ecosystem-Based Management). Any kind of fisheries management that separates itself from changes in the ecosystem, the habitat, and the environment, is in danger of neglecting dangerous changes. We expressed that opinion over twenty years ago (see Caddy and Sharp 1986*), and I see no reason to change my opinion now.

When describing what now seems to be my minority view, I have to query the majority view, namely that ecosystem issues must be addressed through trophic analysis. Over-promoting the axiom that ecosystems are maintained by the flow of carbon through a food web, however true, casts a shadow over other important issues in marine ecology. Wherever EBM is discussed you will see trophic models offering pre-digested solutions to your ecosystem modelling needs. I appreciate the utility of these and other models used in EBFM, but have a bone to pick with scientists who use any model without considering its assumptions, or advocates of ecosystem conservation who adopt any explanation that proves their point of view.

When we discuss that mysterious procedure referred to as EBFM — or any other science-based endeavour for that matter — progress will be made only if we avoid paradigm fixation, and compare different hypotheses for ecosystem change. In the 1970s-1990s we were perhaps over-fixated on size frequency analysis, but it seems illogical to abandon size-based methods now in favor of a classification by trophic levels. Size, scale, and spatial dimensions are critical to understanding trophic interactions at different life history stages, but are also needed to understand size-related interactions of fauna to their marine habitat. And habitats often show fractal characteristics of size that add complexity to understanding ecosystems.

Fishing is not the only cause of ecosystem change

From an EBM perspective, in most coastal seas anthropogenic effects start within estuarine systems and wetlands: these are highly vulnerable ecosystems and are under threat. Progressive nutrient enrichment affects demersal food chains through seasonal and then permanent hypoxia, and results in "unnatural" and often toxic algal blooms. Hence I cannot accept the dominance of the "Fishing Down The Food Web" (FDTFW) hypothesis in all cases. It singles out the impact of the fishing industry on the upper trophic levels as the predominant cause of ecosystem change, and absolves the rest of humanity from responsibility for its "footprint" on coastal seas. Urban humans also cause bottom-up effects: we are responsible for pollutant runoff for example, as well as the water shortages our needs can cause. We also create the market demand that the fishing industry tries to satisfy.

Effectively, semi-enclosed and coastal seas act like large estuaries, and human actions within catchment areas can seriously impact adjacent marine ecosystems by reducing freshwater runoff and increasing nutrient and sediment outflows. Should we exclude these effects from the models we use? How can we avoid incorporating habitat and environmental change into our working hypotheses? While all ecosystem stresses can cause consequences similar to those described in the FDTFW hypothesis, the assumptions of a predominantly top-down effect, and of fixed trophic level components within a static food web, are not always compatible with reality.

An incident at the ICES/SCOR Symposium on the Ecosystem Effects of Fishing in 1999 emphasizes how poorly my point of view has been received. I had been asked to talk about fishing effects in semi-enclosed seas. This posed a problem, since in addition to effects of trawling such as those on seagrass beds in the Mediterranean and other semi-enclosed seas (e.g., Caddy 1993**), ecosystem components were disappearing in areas with high turbidity and eutrophication. In the Black and Baltic Seas, resulting problems of hypoxia make bottom trawling a high risk activity. Other anthropogenic influences that I classified as "Marine Catchment Basin effects" have shown dramatic impacts on Black Sea fisheries, and bottom-up factors appeared to be responsible for an apparent increase in productivity in other Mediterranean areas. Therefore in my talk I chose to compare two sources of ecosystem stress: fishing and eutrophication. My presentation was interrupted by one organizer who came on stage to claim that this conference was on the effects of fishing and not on environmental change!

Although trophic models provide useful background information, ecosystem change is primarily what we have to document at this time, and we need to identify the causes of it, which may not be simply a consequence of trophic imbalances.

I do not discount the overcapacity of fishing fleets as a major factor damaging marine ecosystems, or that predator decline may affect lower trophic levels – this has been evident for decades. What I have warned against is choosing a single explanation for the deterioration of marine ecosystems, not to mention the dangers of adopting a canned software approach without considering the evidence and assumptions of the model (which is, of course, the responsibility of the user).

There are several other potential causes for stock declines and ecosystem change, such as the degradation of habitats by fishing and eutrophication, declines in spawning stock size, the loss of spawning or nursery habitats, cover and connectivity, the conversion of sources of recruitment within a metapopulation into sinks, changes in environmental temperatures, or the introduction of harmful exotics. Unless you can identify the single (or more usually, the several) key problems that apply locally, working toward a solution through EBFM or EBM will be difficult.

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* *An Ecological Framework for Marine Fishery Investigations*, by J.F. Caddy and G.D. Sharp. 1986, United Nations Food and Agriculture Organization. www.fao.org/docrep/003/T0019E/T0019E00.htm

** "Towards a comparative evaluation of human impacts on fishery ecosystems of enclosed and semi-enclosed seas", by J.F. Caddy. 1993, *Reviews in Fisheries Science* 1(1): p 57-95.

Marine Habitat and Cover, by J.F. Caddy. 2007, UNESCO. http://publishing.unesco.org/details.aspx?Code_Livre=4538

The EBM Toolbox — Tools for ecosystem-based fisheries management

Editor's note: The goal of The EBM Toolbox is to promote awareness of software tools for facilitating EBM processes, and to provide advice on using those tools effectively. It is brought to you by the EBM Tools Network (www.ebmtools.org), a voluntary alliance of leading tool users, developers, and training providers.

By Sarah Carr

In ecosystem-based fisheries management (EBFM), tools are needed to help assess and plan for the impact of fisheries on natural and human systems. Such tools may include:

- Models of ecosystem structure and function;
- Simulations of how fisheries management actions would affect ecosystem structure and function; and
- Simulations of how changes in ecosystem structure and function would affect ecosystem services and human communities.

Tools to perform these functions have been developed for a variety of intended users. Some commonly used tools include:

Coastal Transects Analysis Model (http://fishbase.sinica.edu.tw/report/t/home.htm) — A free, on-line visualization and decision-support tool for describing and analyzing interactions between natural and human systems, with an emphasis on fisheries and aquatic resources. It is available in two forms: a basic model that utilizes descriptive information about a coastal area and is appropriate for data-poor areas, and an advanced model for users with detailed information about their coastal area.

Ecopath with Ecosim (www.ecopath.org) — A free suite of ecosystem modeling tools that can be used to evaluate the ecosystem effects of fishing and explore management policy options. It is one of the most user-friendly and least data-intensive of the whole-ecosystem models (models that represent all trophic levels) but still requires data that may be difficult to obtain in data-poor areas (e.g., species abundance estimates).

Atlantis (www.csiro.au/science/ps3i4.html) — A free whole-ecosystem model intended for use in management strategy evaluation. It incorporates sub-models for the marine environment (physical and biological components), industry (including pollution, climate change, and fishing fleet dynamics), and management actions (including gear restrictions, days at sea, spatial and temporal zoning, discard restrictions, size limits, and bycatch mitigation). Calibration and use of Atlantis can be time- and data-intensive, and it is generally not suitable for data-poor areas.

To learn more about marine ecosystem models and their applicability to EBFM, we suggest "Models for an ecosystem approach to fisheries" published by FAO (www.fao.org/docrep/010/a1149e/a1149e00.htm).

(Sarah Carr is coordinator for the EBM Tools Network. Learn more about EBM tools and the EBM Tools Network at www.ebmtools.org. Sign up for Network updates and contact Sarah at www.ebmtools.org/contact.html.)

In our next issue: MPAs and EBM

The upcoming issue of MEAM will examine the role of marine protected areas in ecosystem-based management. If you have thoughts on this topic or examples of where MPAs are working effectively to promote EBM, please let us know about them. E-mail us at editor@meam.net. Thank you — we look forward to hearing from you.

Notes & News

Proposals wanted for EBM working groups

Proposals have been requested for working groups to develop and apply scientific knowledge to ecosystem-based management of coastal and marine ecosystems. The request for proposals is from the National Center for Ecological Analysis and Synthesis (NCEAS), a research center of the University of California, Santa Barbara. Applications are due 2 March 2009, and may come from anywhere in the world.

The request for proposals suggests several topics that applicants may address with their prospective working groups. Among these are methods for analyzing the costs and benefits of management scenarios; methods for estimating the market and non-market value of resources; tools for communicating science to policymakers and the public; methods to help local managers access and manage data; and more. The request for proposals — including the full list of potential working group topics, proposal guidelines, working group characteristics, background on NCEAS, and a submission form — is at www.nceas.ucsb.edu/files/news/NCEAS_EBM_RFP_January2009.pdf.

Global webinar on EBM & EBFM — 16 Mar. 2009

MEAM and the EBM Tools Network will co-host a live Web-based seminar (or "webinar") on Monday, 16 March 2009, to explore the relationship between ecosystem-based management and ecosystem-based fisheries management. Speakers include:

- Jake Rice, Fisheries and Oceans Canada;
- Kevern Cochrane, UN Food and Agriculture Organization; and
- David Fluharty, NOAA Science Advisory Board

The webinar will begin at 1:30 p.m. EDT (5:30 p.m. GMT) with brief presentations by the speakers and will last for 90 minutes. Webinar participants can use their computer microphone *or* a telephone conference call for audio for the webinar. Participants will be able to ask questions to the speakers, using either their computer microphone or keyboard. The event will be free of charge to participants.

You may register for the webinar at www1.gotomeeting.com/register/474287875. Upon registering, you will receive instructions on how to join the webinar. After the webinar, a recording of it will be available at www.ebmtools.org/about_ebm/meam.html. If you have any questions, please contact Sarah Carr at sarah_carr@natureserve.org.