



A TOOLKIT FOR MARINE SPATIAL PLANNING

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NEED FOR MARINE SPATIAL PLANNING

The health of marine ecosystems is declining, and use conflicts in the marine environment are increasing, in part because of new needs for ocean space for emerging industries such as wind and wave energy and aquaculture. Marine Spatial Planning (MSP) is a process for analyzing and allocating the spatial and temporal distribution of human activities in marine areas to achieve ecological, economic, and social objectives (www.unesco-ioc-marinesp.be). Well-conducted MSP can:

- Reduce conflicts between users and increase regulatory efficiency
- Facilitate the development of emerging industries such as wind and wave energy and aquaculture
- Help maintain ecological processes and the ecosystem services they support (such as fishing, marine tourism and recreation, and cultural uses of the ocean).

STEPS IN THE MSP PROCESS

Many steps in an MSP process (Ehler and Douvère, 2009) require or are facilitated by the use of software tools or other well-defined spatially-explicit methodologies (collectively referred to as “tools”). The EBM Tools Network is an alliance to promote awareness, use, and development of tools that can help implement ecosystem-based management (EBM) in coastal and marine environments. The Network has created a knowledge base of tools for EBM. As MSP is a means of implementing EBM, virtually all of the EBM toolbox (see www.ebmtools.org) is relevant to MSP. EBM tools are particularly important for the steps in bold below.

Step 1: Identify Need and Establish Authority

Step 2: Obtain Financial Support

Step 3: Organize the Process through Pre-Planning

Step 4: Organize Stakeholder Participation

Step 5: Define and Analyze Existing Conditions

Steps 6 and 7: Define and Analyze Future Conditions and Prepare and Approve the Spatial Management Plan

Steps 8 and 9: Implement and Enforce the Spatial Management Plan and Monitor and Evaluate Performances

Step 10: Adapt the Spatial Management Process

A PRELIMINARY MSP TOOLKIT

Step 1: Identify Need and Establish Authority

Task: • Map ocean governance

Legislative Atlas (NOAA Coastal Services Center;
www.csc.noaa.gov/legislativeatlas)

- Displays spatial footprint of U.S. state and federal laws, policies, and regulations for ocean

Management Identifying the Needs of Ocean Ecosystems (MINOE) (Stanford University; <http://minoe.stanford.edu>)

- Identifies laws, regulations, and agencies relevant to management of specific ecosystems. Users construct or import an ecosystem model with elements and relationships. MINOE outputs laws and regulations containing the ecosystem elements and relationships and highlights relationships not explicitly addressed in laws or regulations

Step 3: Organize the Process through Pre-Planning

Task: • Define ecosystem boundaries



Don't reinvent the wheel! Use existing ecosystem maps if available. If they aren't, dynamic ecosystem models such as Ecopath with Ecosim and Ecospace (see Steps 6 & 7 below) are one way to define functional ecosystems.

Step 4: Organize Stakeholder Participation



Stakeholder participation is vital to many steps in the MSP process, including the development of social, economic, and ecological goals and objective; mapping current and future uses of marine ecosystems; and selecting preferred spatial use scenarios and zoning plans. There are numerous tools and techniques for gathering input from and sharing information with stakeholders and analyzing social networks. Given the rapidity with which this field is changing, we suggest using the EBM Tools Listserver (sign up at www.ebmtools.org/contact.html) to ask experts what might work best for your situation.

Audience Response/Keypad Polling Systems (Multiple providers)

- Integrated hardware-software systems that allow meeting facilitators to pose questions to participants and get and display feedback almost instantaneously. Recent advances allow synchronized keypad and on-line polling using computers and cell phones

Step 5: Define and Analyze Existing Conditions



*Don't reinvent the wheel! Important biological and ecological areas have been determined and mapped for many locations at many scales by local and regional management and conservation organizations. Use existing data and maps if available (see *The Nature Conservancy Ecoregional Assessments as an example* www.nature.org/initiatives/marine/strategies/assessments.html.) This is also an area for which there are numerous existing tools and techniques. Given the plethora of tools, we suggest using the EBM Tools Listserver (sign up at www.ebmtools.org/contact.html) to ask experts what might work best for your situation.*

Task: • Map important biological and ecological areas • Map oceanographic and other physical features

Habitat Digitizer Extension (NOAA Biogeography Team;
<http://ccma.nos.noaa.gov/products/biogeography/digitizer>)

- Helps create hierarchical classification schemes for habitats and delineate habitats from aerial photographs, satellite images, side scan sonar, and other georeferenced images

Marine Geospatial Ecology Tools (Duke University;
<http://code.env.duke.edu/projects/mget>)

- Includes a variety of useful tools useful for MSP including tools for modeling species habitat with environmental predictor variables and simulating marine connectivity through larval dispersal

Task: • Map current human uses

Open OceanMap (Ecotrust; www.ecotrust.org/ocean/OpenOceanMap.html)

- Process and tool for collecting local, spatially-explicit expert knowledge about human uses of an ecosystem

Task: • Determine cumulative impacts of human uses on ecosystem • Assess conflicts and compatibilities between human uses and ecosystem health

Cumulative Impacts Model (National Center for Ecological Assessment and Synthesis; www.nceas.ucsb.edu/GlobalMarine)

- Process for mapping human activities impact ecological communities, quantifying vulnerability of marine ecosystems to these activities, overlaying threat maps onto ecosystems, and using vulnerability scores to translate threats into ecological impacts
- Human activities can be included or excluded from consideration to determine what suite of activities can best meet objectives for a given zone

Task: • Manage project data

Multipurpose Marine Cadastre (NOAA Coastal Services Center and Minerals Management Service; www.csc.noaa.gov/mmc)

- Marine information system for state waters and outer continental shelf. Distributed data architecture lets federal, state, and local agencies manage their own data. Users can access and download data sets from numerous data providers

Steps 6 and 7: Define and Analyze Future Conditions and Prepare and Approve the Spatial Management Plan



In general, tools are not “all-sector” yet. Most spatial management tools have been developed for a specific purpose such as selecting marine protected areas, managing fisheries or watersheds, or planning land use. Some of the most promising tools for providing multi-sector scenario development and zoning plans are:

Tasks: • Create and visualize alternative spatial use scenarios and analyze tradeoffs between scenarios

- **Evaluate effectiveness of possible management measures (such as marine protected areas and fisheries management regulations)**
 - **Develop alternative zoning plans with appropriate permitting, usage rules, and monitoring for each zone**
 - **Evaluate the degree to which zoning plans meet objectives**

MarineMap (MarineMap Consortium; <http://marinemap.org>)

- Helps view maps of social and ecological attributes of marine areas, draw networks of prospective MPAs, develop alternative MPA plans with specific usage rules, and evaluate how well MPA plans meet objectives

Marxan with Zones (University of Queensland; www.uq.edu.au/marxan)

- Creates alternative zoning configurations that maximize achievement of social, economic, and ecological objectives while minimizing social, economic, and ecological cost. Planning units can be allocated to conservation zones with different protection levels and zones with non-conservation uses

NatureServe Vista (NatureServe; www.natureserve.org/Vista)

- Supports cumulative impacts assessment, creation of multiple use spatial plans, and evaluation of imported or created spatial use plans against stated objectives. Developed for terrestrial multiple use zoning and adaptable to MSP

In addition, dynamic ecosystem models that simulate ecosystems over time can be used to evaluate the effectiveness of possible management measures (such as marine protected areas and fishing gear regulations) and zoning plans at meeting objectives. Some leading models include:

- **Atlantis** (CSIRO; www.csiro.au/science/ps3i4.html#1)
- **Ecopath with Ecosim and Ecospace (EwE)** (University of British Columbia; www.ecopath.org)
- **InVitro** (CSIRO; www.cmar.csiro.au/research/mse/invitro.htm)

Steps 8 and 9: Implement and Enforce the Spatial Management Plan



In general, monitoring is one of the least developed areas for decision support tools. We will flesh out this section as we learn about new tools.

- Tasks:**
- **Monitor user compliance with spatial management plan**
 - **Develop monitoring indicators to determine spatial management plan success at meeting defined objectives**
 - **Develop monitoring system to track indicators**

Sampling Design Tool for ArcGIS (NOAA Biogeography Team; <http://ccma.nos.noaa.gov/products/biogeography/sampling>)

- Helps design sampling strategies in environments with limited data. Uses iterative sample design in which existing data informs new design decisions

HOW MUCH DO THEY COST AND HOW DO I FIND OUT MORE?

The cost of using a tool depends on a variety of factors including:

- initial purchase price of the tool (if any)
- cost of technical support/consulting and training
- people time to gather and format data, run the tool, and analyze results
- data you need to use the tool effectively.

A preliminary estimate of the purchase price and cost and effort to use the tools is below. In addition, the EBM Tools Network hosts free hour-long demonstrations of key EBM tools via webinar twice a month. These demonstrations provide an overview of how to use the tools and what resources are required to use the tools. Video recordings of demonstrations of most of the tools in the preliminary MSP toolkit are available (see table below for availability). Recordings can be downloaded from www.ebmtools.org/tools_training/presentations.html. [To attend future tool demonstrations, join the EBM Tools Network mailing list at www.ebmtools.org/contact.html.]

Tool	Purchase Price	Cost and Effort to Use	Demonstration Available
Legislative Atlas	Free	Low	Yes
MINOE	Free	Low-Moderate	Yes
Audience Response/Keypad Polling Systems	Variable	Low-Moderate	Yes
Habitat Digitizer Extension	Free	Moderate	-
Marine Geospatial Ecology Tools	Free	Moderate-High	Yes
Open OceanMap	Free	Moderate-High	Yes
Cumulative Impacts Model	Free	Moderate-High	Yes
Multipurpose Marine Cadastre	Free	Moderate	Yes
MarineMap	Free	Moderate-High	Yes
Marxan with Zones	Free	Moderate-High	Yes
NatureServe Vista	Free	Moderate-High	Yes
Atlantis	Free	High	Yes
Ecopath with Ecosim and Ecospace (EwE)	Free	Moderate-High	Yes
InVitro	Free	Moderate-High	Yes
Sampling Design Tool for ArcGIS	Free	Moderate	-

FUTURE WORK FOR THE MSP TOOLKIT

This toolkit is in its preliminary stages. We will continue to develop it by:

- Continuing to research the most appropriate and accessible tools for facilitating MSP tasks and updating the preliminary toolkit with new information
- Fleshing out information on tool functionality and resources needed to use tools
- Developing workflows to show how tools can be integrated into an MSP process and data and information can flow from one step to another
- Developing training on the toolkit.

ACKNOWLEDGEMENTS AND CITATIONS

- Participants in the EBM Tools Network Listserv
- Jason Roberts of Duke University
- Ehler, Charles, and Fanny Douvère. Marine Spatial Planning: a step-by-step approach toward ecosystem-based management. Intergovernmental Oceanographic Commission and Man and the Biosphere Programme. IOC Manual and Guides No. 53, ICAM Dossier No. 6 Paris: UNESCO, 2009. (Downloadable from www.unesco-ioc-marinesp.be).