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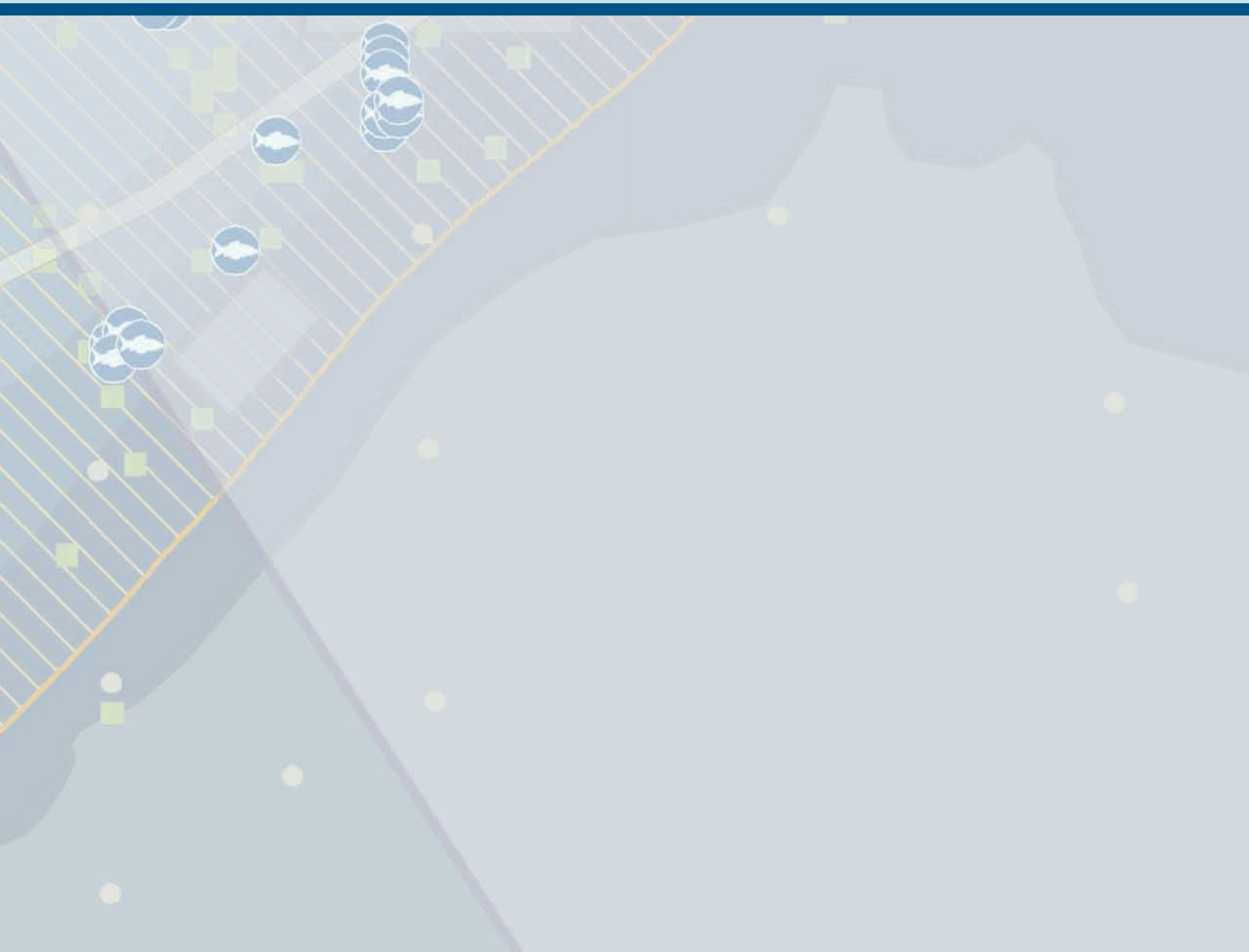
BEST PRACTICES FOR

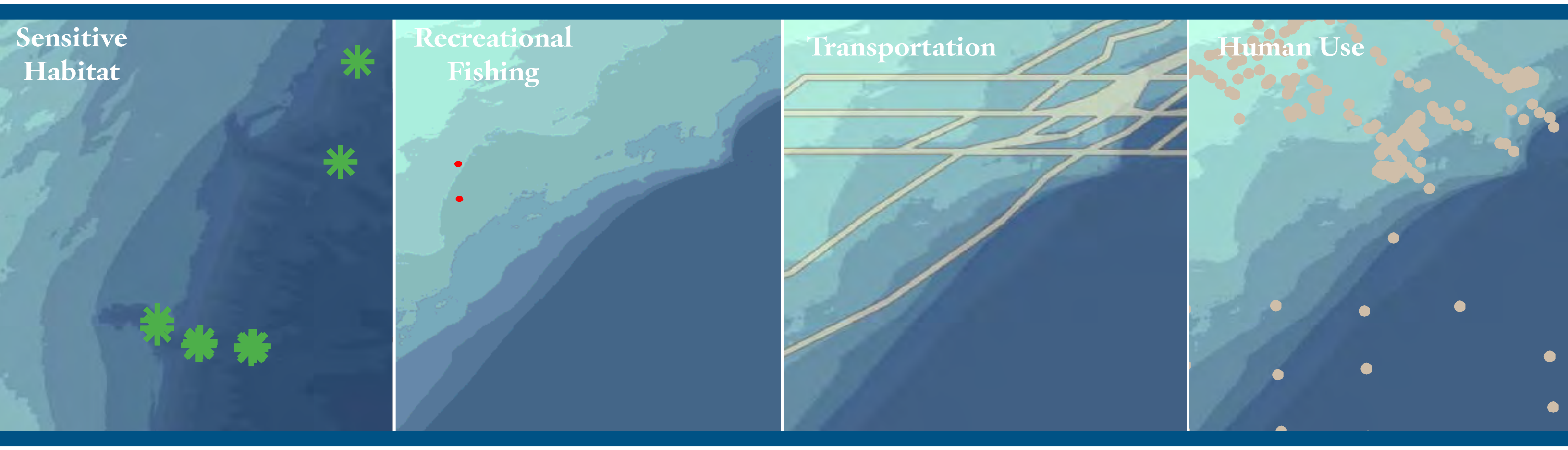
Marine Spatial Planning



BEST PRACTICES FOR

Marine Spatial Planning

EXECUTIVE SUMMARY



Marine spatial planning (MSP) is a process to develop a blueprint for area-based management that accounts for multiple management objectives. Many agencies are pursuing MSP to address the increasing human activities in the marine environment that are progressively more in conflict with one another and affecting the health of the ocean and the ecosystem services we depend on.

The Nature Conservancy's Global Marine Team convened a workshop in June 2009 to develop advice on best practices for MSP. Twenty practitioners with marine spatial planning experience in more than 20 regions of the United States, Canada, Costa Rica, Indonesia, Ecuador, Colombia, and Venezuela participated in the workshop. Our aim was to focus on key issues and critical points in the planning process to identify lessons learned and best practices from the extensive practical experience of the participants in the development of marine spatial plans. The aim was to provide best practices not a cookbook, and we recognize from experience that each individual piece of advice may not be relevant for every plan. The advice is summarized by section below.

1. BOUNDARIES OF THE PLANNING AREA

Fundamental to every MSP process is a decision about boundaries. It is most critical to be clear and consistent on the reasoning for the landward (coastal) boundary and somewhat less crucial for the alongshore and then seaward boundaries.

1.1 The coastal boundary should be the farthest extent of saltwater influence or head of tide.

1.2 The alongshore boundaries should weigh ecological, social, and jurisdictional considerations. These boundaries are less critical if adjoining plans are done consistently.

1.3 Consider using an existing jurisdictional boundary as the offshore edge of the planning area and adjusting if necessary for consistency in human uses and ecological features.

2. GEOGRAPHIC SCALE AND RESOLUTION OF PLANNING

Decisions about the geographic scope or scale (i.e., total size of the planning area is) and resolution (i.e., the size of planning units such as grid cells) are critical for effective planning.

2.1 Marine spatial plans should consider information at two scales and resolutions: (a) a ´state´ scale with relatively fine resolution and (b) a regional scale with coarser resolution.

2.2 Be aware of the scale and resolution of different data sets; maintain their utility by avoiding improperly scaling them up or down.

3. DATA COLLECTION AND MANAGEMENT

Most of the time and budget in a MSP effort is spent on gathering and managing existing data. The timely delivery of a plan is most affected by decisions on data collection and management.

3.1 Establish an independent panel of scientific experts to develop and approve MSP scientific practices and to adjudicate questions about data, methods, and findings.

3.2 Data collection is enhanced by the clear and early development of planning objectives and a list of data types needed for each objective.

3.3 Data can be used analytically or illustratively in planning; the recognition of these different uses increases utility of data and enhances stakeholder participation.

3.4 Establish firm criteria for accepting datasets for MSP analysis, such as minimum geographic coverage, and communicate these criteria consistently to stakeholders.

3.5 Peer-review the quality of all datasets—even large and commonly used datasets.

3.6 Data on the distribution of marine habitats should be the initial focus of collection for ecological objectives as they usually are the most comprehensive. These can be augmented with habitat models and expert/traditional knowledge.

3.7 Keep data in formats that can be easily transferred among tools and programs.

3.8 Authoritative databases are needed for certain data types.

3.9 New data collection can rarely be done within the time frame of a planning effort.

4. MULTI-OBJECTIVE PLANNING

The most important challenge for MSP is to explicitly consider multiple management objectives (e.g., energy production, environmental conservation, fishery production, transportation). Consideration of explicit trade-offs among objectives and examination of alternative scenarios for meeting them are the newest and most rapidly developing areas in planning.

4.1 A high-level government mandate is a necessary but not a sufficient requirement for successful development and implementation of MSP.

4.2. Facilitate local, bottom-up involvement of diverse stakeholders in MSP.

4.3 Ensure that the burden of proof about human impacts is distributed appropriately among groups with differing objectives.

4.4 Conduct formal, rigorous cost-benefit analyses for management alternatives.

4.5 Explicitly identify and quantify tradeoffs among objectives, while highlighting opportunities for reaching common ground among stakeholders.

4.6 Develop forward-looking scenarios to explore management alternatives.

4.7 Planning frameworks need to deliver certainty in the short term but reasonable flexibility in the long term to adapt to changing conditions and priorities.

4.8 Focus the planning effort on the few, overarching management objectives first and then on more detailed consideration of the many human uses of the ocean.

4.9 Develop an integrated plan that addresses multiple management objectives.

4.10 For plans that are intended to inform zoning, it helps to identify the likely types of and number of zones; fewer is better for planning.

5. Interactive Decision Support Systems (DSS)

The future of spatial planning for management is in interactive decision support systems (DSS), which provide transparency and engage a diverse array of people in the planning process. Interactive DSS can capture, share, and compare many people's ideas about planning options; help people understand the real-world implications of different management regimes and environmental conditions; and reveal tradeoffs among possible management scenarios.

5.1 Conduct a needs assessment to identify users and DSS requirements.

5.2 Enable users to develop potential alternative solutions themselves.

5.3 Ease of use and transferability of DSS technology are paramount.

5.4 Develop frameworks that can be used in data-rich and data-sparse areas.

5.5 Decision support systems should include the following features:

- intuitive user interface,
- concise description of the role of the DSS in the MSP process,
- easy comparison of management alternatives and tradeoffs,
- authoritative data with accepted standards endorsed by government,
- downloadable data that can be moved easily among different platforms,
- clear explanations of uncertainty, accuracy, and limitations in tools and data,
- user support, and
- capacity on the planning team to evaluate the evolving technology and to determine how the DSS can continue to meet user needs and stay relevant.

Contents

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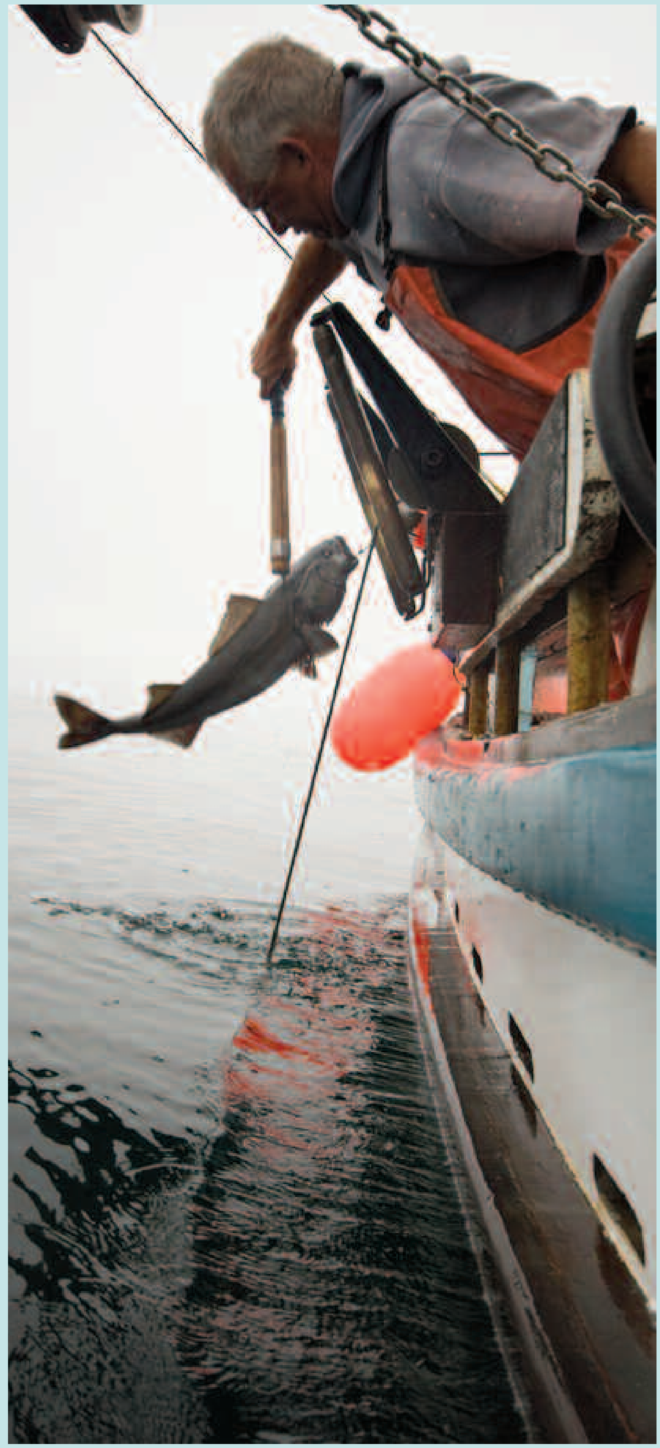


Introduction

The seas are no longer a wide-open frontier, and its spaces are broadly allocated and with extensive overlap by many management agencies. Many organizations and agencies are increasingly recognizing the need for proactive instead of piecemeal management of human activities that affect the health of the ocean. In the United States and around the world, now is a critical time to implement better management of ocean and coastal resources to meet multiple management objectives.

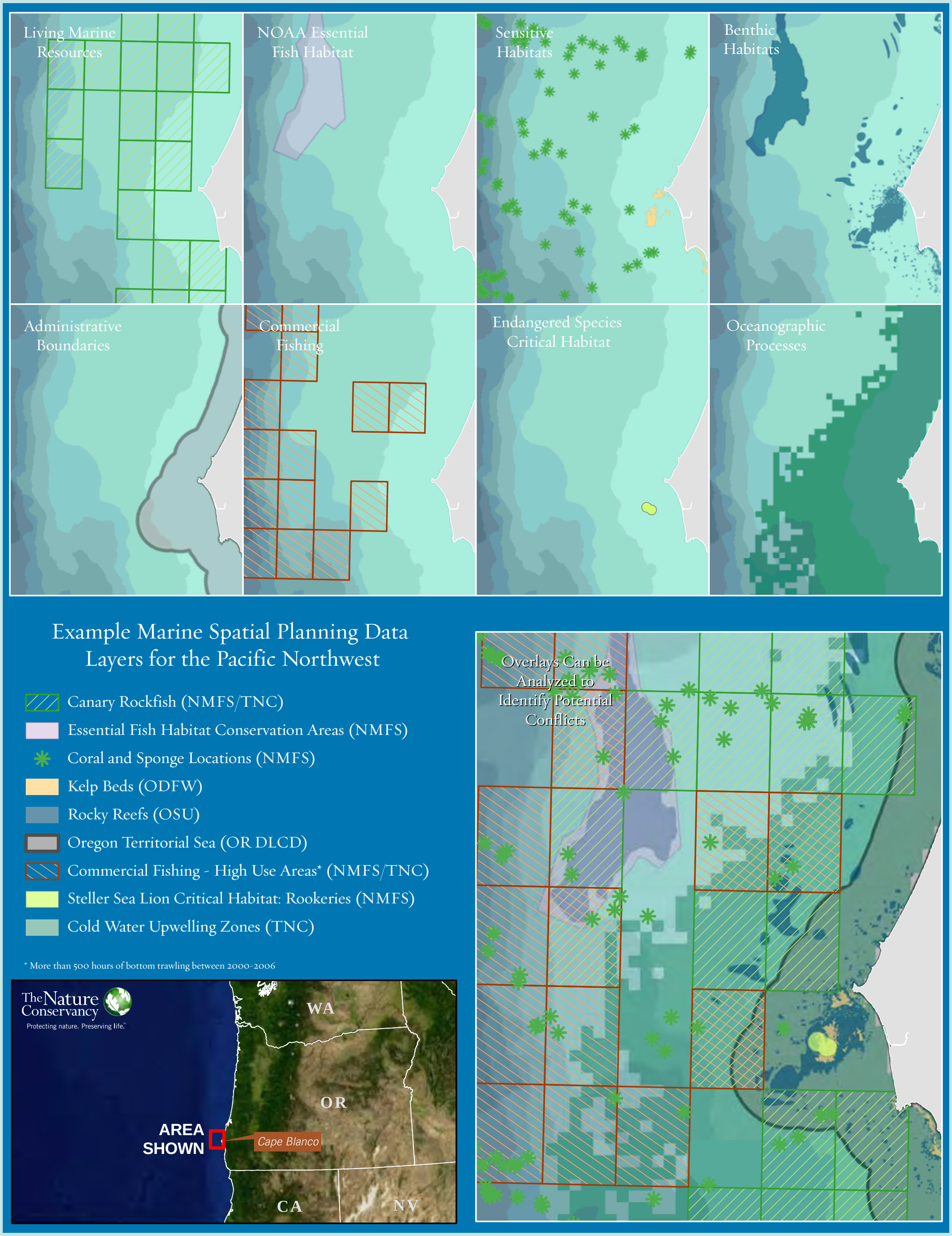
On June 18 and 19, 2009, the Global Marine Team of The Nature Conservancy convened a workshop on "Marine Spatial Planning in Practice: Lessons Learned and Best Practices" at the Center for Ocean Health at the University of California, Santa Cruz. Twenty practitioners with marine spatial planning experience in more than 20 regions of the United States, Canada, Costa Rica, Indonesia, Ecuador, Colombia and Venezuela participated in the workshop (Appendix A). The workshop was supported by the Gordon and Betty Moore Foundation and the Kabcenell Foundation.

The goal of the workshop and this report was to provide advice on best practices for marine spatial planning around key issues and inflection points in the planning process. The advice was based on the extensive, practical experience of the participants in the development of marine spatial plans. Our aim was to focus on critical points in the planning process; we did not aim to provide a comprehensive outline of steps involved in a planning process.

The advice on key issues is divided into sections on
1) Geographic Planning Boundaries
2) Planning Scale and Resolution
3) Data Collection and Management
4) Multi-objective Planning including Aims and Outcomes
5) Interactive Decision Support.

Both the Pew Oceans Commission and the U.S. Commission on Ocean Policy called for better ecosystem-based management (EBM) of marine systems. Marine spatial planning (MSP) is an important tool to achieve EBM. Marine spatial planning is a process to develop a blueprint for area-based management that accounts for multiple management objectives in the marine environment. For our purposes, MSP focuses on marine, spatial, and planning aspects to meet these multiple management objectives (e.g., energy production, environmental conservation, fishery production, transportation). It does not focus on the terrestrial, regulatory, or implementation issues, but recognizes that MSP is only part of what is needed for coastal and ocean management.

This report presents a summary of best practices for MSP identified at the workshop. The advice and guidelines in this report were developed with a focus on marine spatial planning in the United States; although much but not all of this advice will be relevant in other cultural and ecological settings.



Pacific Northwest Region

The above graphic highlights some of the multiple uses, resources and regulations that are currently present in the region's coastal and marine systems.

1. Boundaries of the Planning Area

Fundamental to every MSP process is a decision about boundaries: What is the exact geographic area in which plans will be developed and to which outcomes will apply? Geographic boundaries of marine plans have been and sometimes must be defined by political borders (e.g., state versus federal waters) and by the jurisdictional boundaries of government agencies (e.g., state departments of inland versus marine resources). These boundaries typically do not correspond to the geography of human uses or ecosystem processes. Because MSP is a tool for comprehensive management, we must consider jurisdictional, social, and ecological considerations in identifying boundaries. Based on extensive experience, workshop participants developed the following recommendations to assist in defining boundaries, recognizing that the best choice of boundaries is likely to vary with geography and planning objectives.

1.1 The coastal boundary should be the farthest extent of saltwater influence or head of tide.

In our experience, every MSP initiative includes lively debate about how far the plan should extend into coastlines and watersheds. For pragmatic reasons, we recommend that marine spatial plans focus on the estuarine and marine environment to the farthest extent of saltwater influence, which extends inland as far as intertidal saline habitats such as salt marshes and mangroves. In some places, the plan should extend to the head of tide to cover habitats such as tidal freshwater marshes.

We recommend focusing MSP efforts on the ocean and addressing land-based activities through other approaches. Land-based human activities and land-sea linkages, such as runoff of nutrients and pollutants, clearly affect marine ecosystems, but we have found it is not usually practical to address land-based activities as part of a marine-focused plan. When watersheds are added to the planning area, the number and complexity of stakeholders and managing agencies increases dramatically and tends to overwhelm and stall the planning process.

We recommend that marine spatial plans begin at the coast, not offshore. Marine spatial plans should include intertidal, estuarine, and shallow-water marine habitats, and the many important marine management issues near-shore.

1.2 The alongshore boundaries should weigh ecological, social, and jurisdictional considerations. These boundaries become less critical if adjoining plans are done consistently or seamlessly.

We recommend using biogeographic regions to capture both ecological and to a lesser degree social considerations in identifying boundaries. Along the coast, major transitions in flora and fauna mark the edges of biogeographic regions defined by ecological and oceanographic features. Such biogeographic boundaries are natural candidates for MSP boundaries.

We recognize that jurisdictional considerations for relevant managing agencies will take precedence in the development of alongshore boundaries for at least part of a planning effort. Of course within any area, even management boundaries vary among agencies. The best plans will be done so that databases, maps, and other information can be shared seamlessly across boundaries, providing flexibility based on the needs of the managing agencies.

1.3 Consider using an existing jurisdictional boundary as the offshore edge of the planning area, adjusting this boundary if necessary to cover the locations of human uses and ecological features.

When identifying the offshore boundary, we recommend starting with an existing jurisdictional boundary (e.g., EEZ). The boundary may be influenced by the extent of human uses such as fishing and energy production. The boundary may also be adjusted to reflect the locations of important species and habitats, including pelagic habitats such as areas of upwelling.

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2. Geographic Scale and Resolution of Planning

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Identifying the geographic scope or scale (i.e., how large the planning area is) and resolution (i.e., how finely the planning area is divided into planning units such as grid cells) are critical decisions in developing effective management plans that recognize ecological and social processes. In the ocean, important ecosystem processes and human activities span a tremendous range of geographic scales. For example, sea level is projected to rise on the scale of meters, dredging operations occur on the scale of kilometers, and fisheries encompass thousands of square kilometers.

Planning units are used by agencies to track their operations (e.g., the U.S. Minerals Management Service uses a spatial grid to track their oil and gas leases) and by non-governmental organizations to set priorities (e.g., proposed areas for conservation) and determine areas of conflict between human uses. A planning unit aggregates or bins disparate data into a common framework.

2.1 Marine spatial plans should consider information at two scales and resolutions: (a) a subregional or 'state' scale with relatively fine resolution and (b) a regional scale with coarser resolution.

2.1 (a) The subregional or 'state' scale should consider incorporating hundreds of kilometers of coastline at a resolution of planning units of 4 square kilometers or less.

The subregional or 'state' scale is often necessary for jurisdictional reasons and makes it feasible to use a resolution that approximates the largest scale at which people typically use and experience the ocean. We refer to this as the 'state' scale because it corresponds to many European Union countries, island nations, and American states. For larger states or nations with long coastlines, we find that it is often useful to identify planning regions within the state that correspond to just a few hundred km of coast. In California, for example, planning efforts under the California Marine Life Protection Act focused on sections of the state on the scale of hundreds of kilometers; boundaries of the sections reflected social and biogeographic features, in addition to jurisdictional considerations. For the 'state' planning scale, we recommend using a resolution of 4 square kilometers or less as the planning unit size. This resolution is important for stakeholder involvement in planning and management.

2.1 (b) The regional scale should consider thousands of kilometers of coastline and a resolution of 20 square kilometers or more.

Plans will often need to be done at a state scale, but it is critical to explicitly consider and plan at the regional scale (thousands of kilometers) for MSP. Processes at this larger scale are important drivers of marine ecosystem dynamics, which in turn affect many socio-economic considerations. Planning at the regional scale provides valuable context for prioritizing, coordinating, and evaluating smaller-scale efforts embedded in the region. A resolution of 20 square kilometers or more will be suitable for coarser-resolution datasets (i.e., map scales less than 1:250,000).

2.2 Be aware of the scale and resolution of data used in analyses, and maintain the integrity of analytical findings by not improperly scaling up or down.

When spatial data are collected, processed, displayed, and analyzed appropriately, they can provide powerful information for planning and management. However, MSP practitioners should be aware that using a spatial dataset at incorrect scales could result in faulty planning assumptions. For example, regional-scale oceanographic data may paint a very misleading view of how water circulates within a bay. This is an example of how downscaling a single regional dataset to a small-scale geography may be inappropriate. In other cases, regional datasets actually comprise a mosaic of data with different resolutions. This is often true with regional datasets for seafloor habitats, when fine-resolution data are available for only parts of the planning area and coarser resolution data are used in the remaining area. Based on the resolution of the original datasets and the methods used to integrate data, planners should determine whether and where downscaling is appropriate. The same factors should be considered when scaling up. A high-resolution dataset can bias an analysis when merged with larger-scale or lower-resolution data. Unless the high-resolution data are scaled-up appropriately by using generalization techniques to match the coarser data, they will cause intrinsic biases in subsequent analyses. If the data are not scaled-up appropriately, the data should be used for illustrative purposes only, not analysis (see 3.3).

3. Data Collection and Management

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In our experience, most of the time and budget in a MSP effort is spent on gathering and managing existing data and information. Thus the successful and timely delivery of a plan is highly affected by decisions on data collection and management. The effort required is typically underestimated. Project managers should focus on this commitment from the outset, and they should make clear and consistent decisions about what kinds of data will be needed and accepted. At national and larger levels, creating a system for storing, accessing, and managing data for MSP up front could dramatically improve efficiency, so that every MSP effort does not repeat these costs.

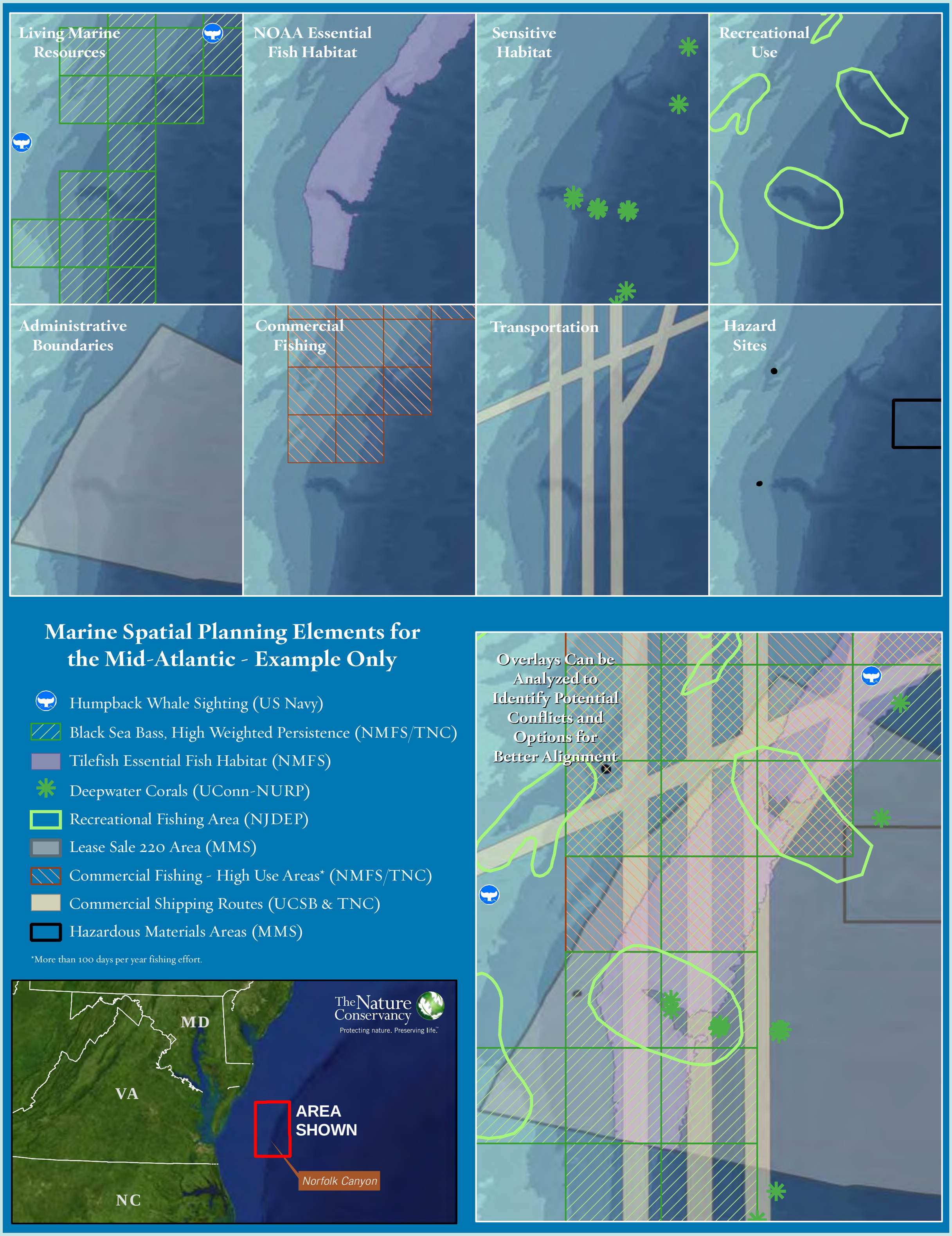
Workshop participants developed the following recommendations for data collection and management in marine spatial planning.

3.1 Establish an independent panel of scientific experts to develop and approve MSP scientific practices and to adjudicate questions about data, methods, and findings.

MSP requires complex analyses grounded in high-quality science. Throughout the planning process, many decisions must be made about scientific practices and findings. To speed decisions and ensure that planning outcomes are scientifically valid, credible, and unbiased, we recommend establishing an independent science advisory panel that informs the decision-makers on issues of data and science. In the California Marine Life Protection Act (MLPA) Initiative, for example, a Science Advisory Team sets scientific guidelines and reviews proposals for marine protected areas against these guidelines. In other efforts, informal advisory teams have been set up to review methods and results being produced by a planning team. For example, a science team in Venezuela examines proposals for marine conservation priority areas. These advisory groups, too, are valuable to establish, even without formal scientific guidelines, as long as the advisors are fully aware of the plan's aims and objectives, and have the necessary background to address them.

3.2 Data collection is enhanced by the clear and early development of planning objectives and a list of data types needed for each objective.

Well-articulated objectives are critical for many aspects of marine spatial planning, but their importance is often overlooked with respect to streamlining data collection and management. Although initially it can take considerable



Mid-Atlantic Region

The above graphic highlights some of the multiple uses, resources and regulations that are currently present in the region's coastal and marine systems.

effort to develop clear objectives, this investment pays off later by reducing effort spent on obtaining and processing datasets that go unused. For example, an existing dataset created under a different set of objectives should not necessarily be incorporated into MSP, even if it covers the entire planning region. Before data collection begins, a science advisory panel can help determine the types of data needed to address each MSP objective. For example, conservation objectives may require data on distributions of habitats and species. Energy objectives may require data on depth, natural gas deposits, wind strength, wave height, and distance from offloading points (e.g., pipeline or grid). Tourism objectives may require data on water quality, public coastal access, and scenic quality. Searching for and acquiring only these data will make the process efficient and focused, and planning decisions will be informed by appropriate data. The science advisory panel should have a process in place to regularly reassess data needs, as well as a process to revise datasets based on new information or to remove data that are deemed unnecessary later.

3.3 Data can be used analytically or illustratively in planning; the recognition of these different uses increases utility of data and enhances stakeholder participation.

There are important differences in MSP for data used analytically and illustratively. Data are used analytically for example in algorithms to provide information about trade-offs and priorities. To be used in analysis, datasets must be consistently high in quality throughout their geographic coverage, and they must cover most of the planning region. Otherwise, analytic results may be biased towards areas with higher-quality or -resolution data (see 2.2). Setting clear criteria will save time, effort, and confusion when deciding among up to hundreds of datasets to accept for analyses. We have found that often only 10 to 50 datasets from a given region are used analytically to address planning objectives, even though the planning team might have amassed a hundred or more datasets during the planning project.

Importantly, however, we have found that some datasets not suitable for analysis are valuable for illustrative purposes. Illustrative data must still meet criteria for quality, relevance, and other factors, but where they can be used they add to information available and help enhance stakeholder engagement in the plan. In our experience, many stakeholders offer to provide datasets that focus on a particular geography, species, human use, or other facet of the planning area. The stakeholders may become offended and suspicious of the MSP process if their data are not used. We recommend establishing explicit criteria for inclusion of illustrative data and using the data for illustrative purposes whenever they meet these criteria.

For example, illustrative data can be very useful in discussions with stakeholders about important management outcomes. They may also be used for example for finer scale planning after large management areas have been identified based on regional data analysis. For example, a localized dataset on fishing activities may be useful to define the exact boundaries of a management area.

3.4 Establish firm criteria for accepting datasets for MSP analysis, such as minimum geographic coverage, and communicate these criteria consistently to stakeholders.

Not all datasets, even those of high quality, are useful for MSP analytical or illustrative purposes. For example, we have found that extent of geographic coverage is a critical criterion. We recommend that MSP datasets be required to cover a large percentage of the planning region (e.g., 66% or more of the region). Datasets covering only a small portion of the region may have little analytic utility for MSP, but they may have value for illustrative purposes. The level of effort to include datasets should be considered. For instance, existing datasets that are well documented, standardized to an accepted classification system, and regularly updated or considered foundational for a particular region are easier to justify using than newer datasets that may need their underlying methodologies to be reviewed and accepted. By establishing such criteria early and adhering to them consistently, MSP practitioners can streamline data-management and avoid ongoing questions about which datasets will be accepted.

3.5 Peer-review the quality of all datasets—even large and commonly used datasets—and accept only reliable data.

When a dataset is relevant to planning objectives and appears to meet criteria for acceptance, it should be peer-reviewed by the science advisory panel or other experts before it is incorporated into MSP. Peer review is essential regardless of a dataset's provenance. For example, in one regional planning effort in the northeast Pacific Ocean, a group of MSP practitioners originally intended to use a well-known dataset containing thousands of seabird sightings. Although the dataset was large and had been widely cited in other studies, scientific advisors recommended not using the data because the data-collection methodology was inconsistent over time and did not adequately represent true seabird distributions. Planners and scientific advisors should read all documentation and metadata accompanying a dataset in order to evaluate the data quality. They should evaluate the sampling method and the dataset's accuracies, limitations, and caveats for intended use.

3.6 To accomplish ecological objectives for MSP, focus primarily on obtaining explicit, observed habitat data. It may also be necessary to model habitat proxies and to augment with expert and/or traditional knowledge.

In some ocean regions, little ecological information is available, particularly after datasets are screened for quality and other criteria. Observations of habitat types and their locations should be a major focus of data collection and management. However, a backup option is to gather existing data on bathymetry, substrate, temperature, and other physical conditions and use them as habitat proxies. These data sets can be combined and modeled to represent explicit habitats. If this option is used, scientists and experts with traditional knowledge who are familiar with the area's habitats should review the modeled habitat data. This review will help the data to have credibility in the scientific and stakeholder communities. If expert or traditional knowledge is the basis or starting point for habitat data collection, we recommend it be used in conjunction with the other methods.

3.7 Keep data in formats that can be easily transferred among tools and programs.

Tools and technologies for data storage, analysis, and mapping are always changing, but the raw data itself does not change nearly as often and could be reused in numerous ways in the future. Keeping data in a format that is easily transferable among existing and future technologies should be a standard practice for MSP.

3.8 Authoritative databases are needed for certain data types.

Data on jurisdictional boundaries, other management boundaries, and human uses of the ocean are essential for MSP. Presently, data describing these features are often available from multiple sources, which are not always consistent. For example, datasets describing the jurisdictional boundaries within a region may not agree exactly on the locations of specific boundaries. An authoritative repository for these data is needed to avoid errors and confusion. In the United States, the National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center and the Minerals Management Service with partners are developing an online Multipurpose Marine Cadastre that will be an authoritative source of data on maritime zones, seabed and subsoil boundaries, and other marine boundaries (see Appendix A and www.csc.noaa.gov/mbwg/htm/cadastre.htm).

3.9 New data collection can rarely be accomplished within the time frame of a planning effort without substantial commitment.

In addition to using existing data, people involved in MSP often propose acquiring new data through field sampling and ground-truthing surveys. While this desire is laudable and the data may prove useful later, it is rare that data can be collected rapidly with enough geographic coverage to be valuable for planning efforts already in progress. Similarly, people often suggest the use of remote sensing to fill data gaps for regional-scale planning, but typically they underestimate the time, money, and skill required to produce an accurate and credible product. In general, acquiring new data is much more expensive than integrating existing data, and often the costs are high. We did note that there were a couple of exceptions, when it was possible to collect new data rapidly at reasonable cost within a planning effort.

4. Multi-Objective Planning

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Perhaps the most important challenge for MSP is to explicitly consider multiple management objectives (e.g., energy production, environmental conservation, fishery production, transportation). Consideration of explicit trade-offs among multiple objectives and examination of alternative scenarios for meeting them are the newest and most rapidly developing areas of MSP.

Closely tied to that challenge is the requirement for any plan that the aims are clear and stakeholders are engaged. Because MSP is new and addresses multiple management objectives, that clarity in aims and engagement is paramount. While aims and engagement are critical to any planning effort, we have explicitly included key advice in this section, because it is critical to multi-objective planning efforts.

4.1 A high-level government mandate is a necessary but not a sufficient requirement for successful development and implementation of MSP.

Based on their experience, workshop participants said that government engagement and leadership are essential for MSP to be successful. In particular, a high-level directive allows government agencies to pursue MSP as part of their mandate. Specifying clear goals for MSP increases efficiency and efficacy of the process. By providing complementary resources and skills, non-government organizations can collaborate with government agencies to advance MSP. We caution, however, that even with mandates in place, the challenge of successfully completing and implementing spatial plans should not be underestimated.

4.2. Facilitate local, bottom-up involvement of diverse stakeholders in MSP.

High-level government support is critical, but the success of MSP also hinges on engagement of local stakeholders. Their viewpoints, support, and knowledge of the place are necessary for a plan that reflects people's values, increases social wellbeing, and is tractable over the long term. Stakeholder engagement should include:

- developing agreement about how the planning process should operate;
- clearly communicating stakeholders' objectives;
- helping stakeholders to recognize common ground among their objectives; and
- establishing a process to identify and resolve conflicts among stakeholders.

4.3 Ensure that the burden of proof about human impacts is distributed appropriately among groups with differing objectives.

In many management contexts, it is common for one stakeholder group or government body to bear responsibility for showing that a proposed human activity would have significant negative impacts. If the evidence is uncertain, the proposal is approved. Often this burden of proof falls on people without funding or capacity to conduct the necessary research, monitoring, or analysis. In some cases, it would be more equitable to shift the burden of proof, so that the people making the proposal must show the activity would have only acceptable negative impacts. In other cases, it may be appropriate to share the burden of proof—with its attendant costs in time, money, and effort—among multiple stakeholder groups or government agencies. To increase the long-term success of MSP, we recommend that plans provide mechanisms that distribute the burden of proof equitably.

4.4 Conduct formal, rigorous cost-benefit analyses for management alternatives.

The field of natural resource economics offers a well-developed set of analytical methods that are appropriate for MSP. In particular, cost-benefit analysis (CBA) accommodates the full range of values, including non-market values not usually measured in dollars, such as the aesthetic value of coastal scenery or the existence value of whales. Cost-benefit analysis offers a framework for understanding the potential outcome (benefits minus costs) of management alternatives. A number of economic analysis methods are available for establishing non-market values. For instance, contingency valuation (basing the value of non-market goods and services on willingness to pay) can provide insight into the value of a coastal wetland as a natural system versus its highest economic use. This is just one of the valuation approaches that should be explored as part of cost-benefit analysis for MSP.

4.5 Explicitly identify and quantify tradeoffs among objectives, while highlighting opportunities for reaching common ground among stakeholders.

Resource management decisions inherently involve numerous tradeoffs. Usually these tradeoffs are not clearly identified and their magnitudes are not evaluated. In MSP, potential tradeoffs of proposed management actions should be explicitly identified and quantified, including market and non-market values. The analysis should emphasize opportunities to achieve common goals among stakeholders, rather than focusing solely on conflicts. Explicitly considering tradeoffs can lead to management outcomes with a greater net benefit for society. For example, when deciding where to allow construction of offshore wind turbines, valuation could be used to quantify positive and negative impacts on multiple sectors such as fishing, shipping, whale watching, recreational sailing, scenic views, and rare species. Including these values explicitly in the cost-benefit analysis may result in a different decision about turbine sites than if only the energy sector is considered—and society would experience a greater net benefit.

4.6 Develop forward-looking scenarios to explore management alternatives.

Workshop participants noted that many decision-makers and stakeholders find it very useful to consider alternative future scenarios, which may include written descriptions and visual depictions (static, animated, or interactive). Scenarios can show a range of future conditions based on possible management actions, including no action, and provide important insights when considering the best course of action. For example, Coastal Resilience Long Island is a project focused on conservation of key habitats and ecosystems as well as mitigation of coastal hazards through analysis of future sea level and storm surge scenarios (www.coastalresilience.org). It highlights that there are numerous scenarios where common goals can be achieved jointly in hazard and habitat management (see also 4.5).

The format used for sharing alternative future scenarios with decision-makers and stakeholders should vary depending on the intended audience of the planning effort. Generally, information has the biggest impact when it is communicated using multiple formats and channels. Before investing money and resources in a specific tool or format, MSP practitioners should carefully consider the target audience and the most effective ways to communicate with them.

4.7 Planning frameworks need to deliver certainty in the short term but reasonable flexibility in the long term to adapt to changing conditions and priorities.

One major benefit of MSP is its potential to provide short- to medium-term certainty in the management regime. This certainty may enable stakeholders to proceed with investments in ocean uses, such as building offshore wind facilities. There is concern that MSP would create permanent lines in the ocean dictating where particular human uses can or cannot occur and would not provide long-term flexibility that stakeholders and managers need. Future advances in technology, for example, might enable previously incompatible or environmentally harmful activities to coexist in the same area without damaging the environment. We should expect some plan recommendations to be revisited and revised. Because flexibility would be curtailed, we recommend that not every part of the planning area be assigned use(s) initially.

4.8 Focus the planning effort on the few, overarching management objectives first and then on more detailed consideration of the many human uses of the ocean.

A multitude of human activities may occur in the planning region. Planners and stakeholders can easily become overwhelmed by the many and varied human uses, associated datasets, and numerous tradeoffs among human uses. To be clear, this complex information needs to be part of the MSP process. However, the core aim of a plan should be on using the data to help decision-makers to meet their overarching management objectives, which are usually few in number, cover these uses and are defined fairly well in legislation and policy. Management objectives address fishery production, energy production, environmental conservation, and coastal access among others. Maintaining a focus on the management objectives can keep the planning process from becoming overwhelmingly complex.

4.9 Develop an integrated plan that addresses *multiple* management objectives.

It can be tempting and initially easier to develop a plan that addresses only two management objectives, such as energy extraction and environmental conservation or fishery production and sand extraction. Data collection and the analysis of tradeoffs, for example, are greatly simplified if only one or a couple of objectives are addressed. We caution against this approach. It is better to plan now for all major management objectives than to plan serially for each pair or group of objectives. Although the complexity of the planning process increases considerably by taking a multi-objective approach, an integrative plan has less total cost and greater net societal benefits, as tradeoffs are considered more holistically. The resulting plan will differ substantially from a plan developed using only one or two objectives.

4.10 For plans that are intended to inform zoning, it helps to identify the likely types of and number of zones; fewer is better for planning.

Zoning is not necessarily a goal of MSP. While MSP is intended to inform some of the area-based management within a marine region, it rarely attempts to do so comprehensively. If zoning is an intended outcome, this must be clear from the start and it will help to identify if plans should consider a few or many different types of zones. Conceivably, many types of zones could be established with each addressing a discrete human use, environmental condition, or other factor. However, planning will certainly be simplified and likely management and compliance too, if fewer types of zones are identified. The same advice holds even if the intention of a plan is only to identify some management areas in a region; fewer types is better. These types might include for example areas that meet objectives associated with fisheries, conservation, military, shipping, ports and emergent structures (e.g., energy and aquaculture). Within these broad types, some of the management decisions should be addressed through future regulations.

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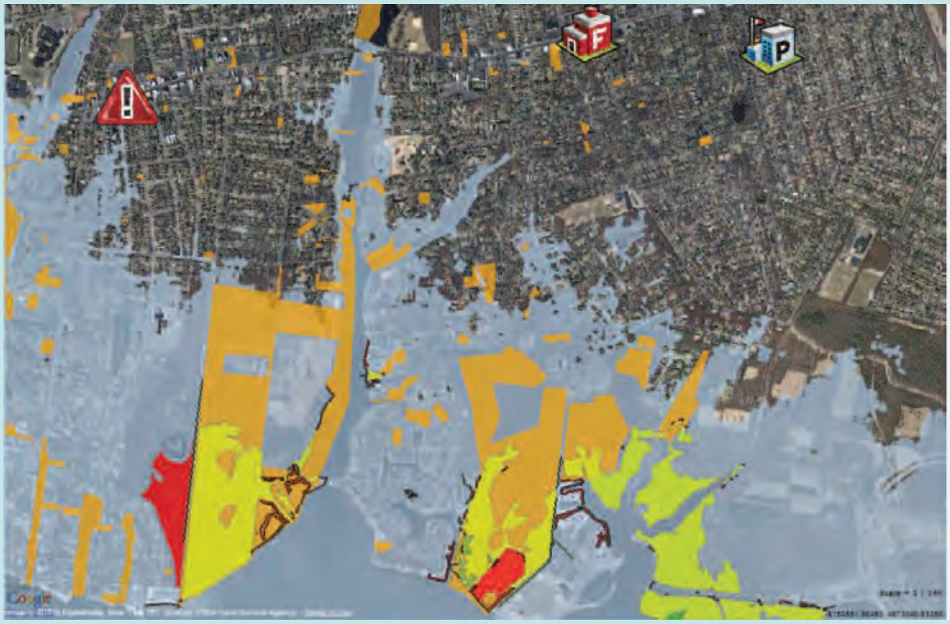
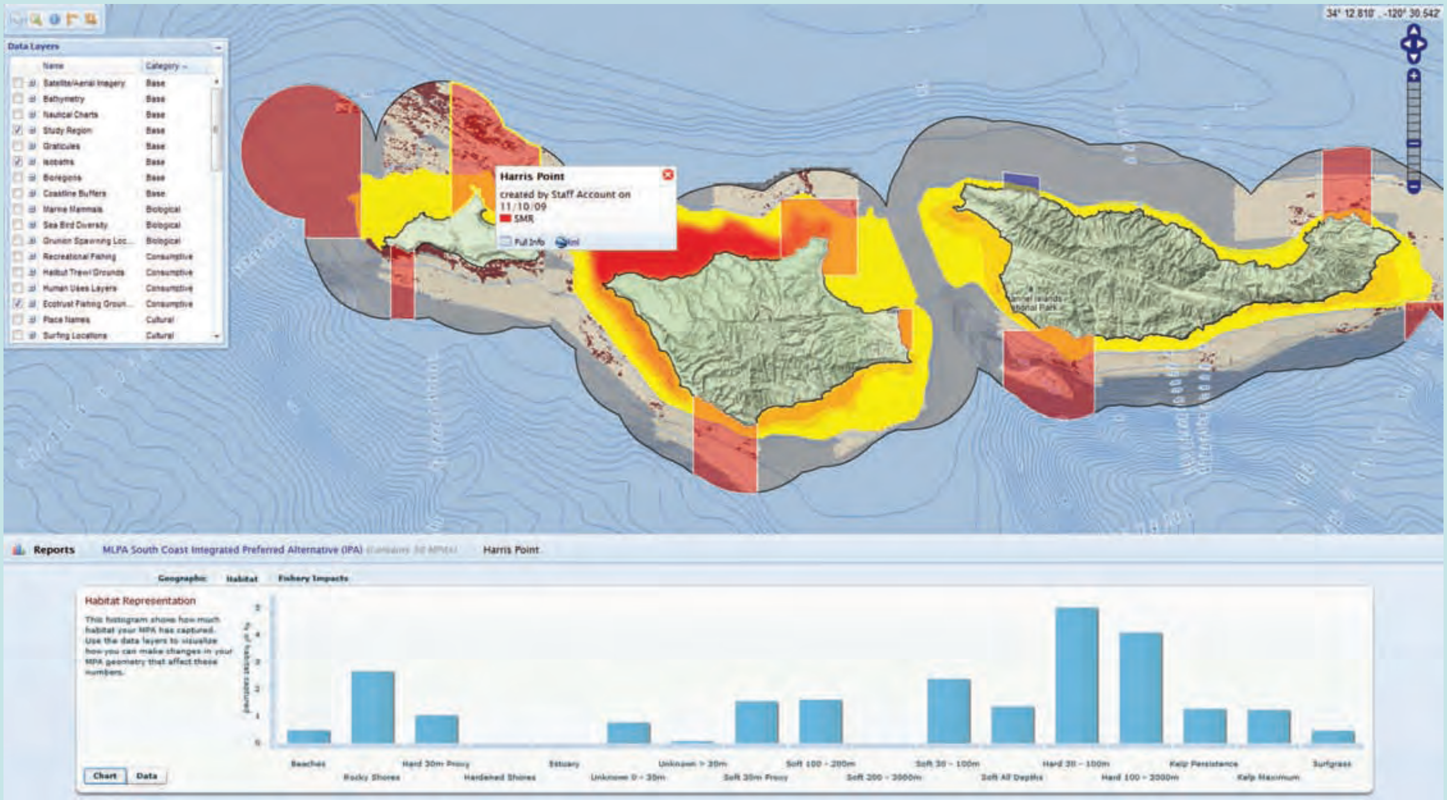
Two Examples of Interactive Decision Support Systems



The Coastal Resilience decision support system (DSS) at ***www.coastalresilience.org***. The DSS allows users to examine reasonable future flooding scenarios from sea level rise and storms; to examine the ecological, social, and economical vulnerability; and to identify solutions. The image is an example screen shot from the online, interactive, future scenarios mapper. The map is zoomed in to a portion of the existing project area on the southern shores of Long Island. The map illustrates the flooding and inundation from a moderate emissions scenario (IPCC A2 projection) coupled with a flooding event with a 20% likelihood annually. A few of the ecological and socio-economic data layers are activated to show some of the information that decision makers can access.



The MarineMap Decision Support System (DSS) located at ***www.marinemap.org***. MarineMap is a web-based application that allows non-technical users to (a) view geospatial data layers in and around the ocean, (b) draw prospective MPAs, (d) assemble MPAs into groups or prospective networks, (e) view reports on potential socioeconomic impacts, habitat representation and replication, (f) share prospective MPAs and networks with other users, and (g) export shapes and analytical results to third party applications. This map overlays lobster fishing hotspots, bathymetry and substrate data. The graph at the bottom shows the relative amount of key habitats captured within the MPA selected at the center of the map. Similar reports may be generated for an entire network of MPAs.

5. Interactive Decision Support Systems

The future of spatial planning for management is in interactive decision support systems (DSS), which provide transparency and engage a diverse array of people in the planning process. Interactive DSS can capture, share, and compare many people's ideas about planning options; help people understand the real-world implications of different management regimes and environmental conditions; and reveal tradeoffs among possible management scenarios. DSS helps to create a forum around which decision makers and some of the stakeholders they represent can see shared information and examine alternatives in real time. The key benefits of good DSS are in the ability to centralize and handle spatial data, the speed of processing those data, and the ease of use and clarity for users. It is extremely useful and sometimes critical to have the DSS available on line to reach stakeholders and increase transparency.

Governing bodies must still make difficult decisions among alternative solutions, but these alternatives can be established and understood more quickly and holistically. Decision support systems represent an important shift away from 'black box' software programs, closed-door committees, and other decision-making methods that often lack the transparency and stakeholder inclusiveness required for successful implementation. Establishing an online, interactive decision support framework that can accommodate multiple objectives should focus primarily on analyzing and providing data, and not on establishing 'priorities' for any one objective. In MSP, the need for DSS tend to increase with the number of planning objectives and tradeoffs; in turn, the amount of data, technical challenges, and cost of tool implementation also increase.

5.1 Conduct a needs assessment to identify users and DSS requirements. Keep these needs at the forefront throughout DSS development.

Prior to investing time and money in technology development, it is essential to determine what type of decision support system will be most useful for users. Key questions to consider are who will be using the DSS and what role will it play within the MSP decision-making process? Will users be staff members at government agencies involved in decision-making, stakeholders at a workshop, or stakeholders logging in from their home computers? Based on information from the needs assessment, detailed technical specifications should be developed and used as the blueprint for building the DSS. Note that it may be necessary to modify the DSS as user needs evolve. A good blueprint provides the starting point, but it should not be so restrictive as to hamper "adaptive development".

5.2 Enable users to develop potential solutions themselves.

There are two general approaches to decision support for MSP: (1) the DSS presents a pre-defined set of alternative solutions for users to consider, or (2) the DSS enables users to explore management scenarios and develop their own solutions. In our experience, the latter is preferable because it increases the transparency of the process and helps build ownership for the decision among stakeholders. In addition, it allows for multiple stakeholders to review a large amount of information collaboratively and to discover relationships and proposed solutions together. One example of the user-driven approach is MarineMap (http://marinemap.org/marinemap), an interactive mapping system that allows stakeholders to view data layers, design proposed networks of marine protected areas, and obtain analytical reports on how the design meets requirements of California's Marine Life Protection Act.

5.3 Ease of use and transferability of DSS technology are paramount.

Stakeholders and partners usually have very limited time available for participating in MSP, and it is important that they do not encounter barriers such as difficult-to-use decision support systems. Similarly, government agencies need DSS that integrate easily with their existing databases and technological formats, do not require technical expertise to use, and need little maintenance. To produce easy-to-use, effective decision support, the MSP team and its collaborators must have the capacity to keep aware of, evaluate, and adopt rapidly evolving technology.

5.4 Develop frameworks that can be used in data-rich and data-sparse areas.

In some planning areas, large amounts of data are available, while other planning areas have extremely sparse data with little possibility of collecting new data quickly enough for a planning effort. Decision support systems should be developed and tested in data-rich and -poor regions to ensure that they work in both settings. Some analytical methods that might be incorporated into DSS are only appropriate for data-rich settings and would be impractical or would produce invalid results in data-poor settings. Following this advice is especially worthwhile in large-scale, national MSP efforts that seek to use consistent planning methods in multiple regions. In the United States, for example, many datasets relevant to MSP are available for the Gulf of Maine, while very few are available for the Beaufort and Chukchi Seas, and it would be preferable to have DSS that work in both regions. A DSS used in one of these regions should be transferable to the other region with common functionality and baseline information intact, while providing flexibility to incorporate customized functions and structure as needed in the new region.

5.5 Decision support systems should include the following features.

- An intuitive user interface.
- A concise description of the role of the DSS in the MSP process.
- Easy comparison of management alternatives and tradeoffs.
- Authoritative data with accepted standards endorsed by government.
- Downloadable data that can be moved easily among different platforms.
- A straightforward, understandable explanation of uncertainty, accuracy, and limitations associated with the tool and underlying information.
- Technologists who are available throughout the MSP process to provide user support and to refine the DSS as needed to meet planning goals.
- Capacity on the planning team to evaluate the evolving technology for online, interactive decision support and to determine how the DSS can continue to meet user needs and stay relevant.

Appendix A: Case Studies

This selection of case studies is not meant to be comprehensive or to include the many past efforts on which the experience of the practitioners was based. We asked them to consider and provide insights from current activities and to be very brief.

Conservation Planning in the Atlantic Sea Front of Venezuela in the Context of a Major Coastal and Offshore Oil and Gas Exploitation Program

By Juan José Cárdenas (The Nature Conservancy)

Location: Venezuela

Objective: Aiming to establish a set of conservation strategies related to the presence of oil industry, we are employing an ecoregional planning methodology to identify not only where but why and how much it is necessary to protect in order to ensure the natural system's viability and its capacity to provide environmental services.

Problem: The Venezuelan Atlantic Front is a diverse set of marine and coastal ecosystems (mangrove and palm forests, sand barriers, estuaries, muddy/sandy marine bottoms) in a relatively limited area (35,000 square kilometers), all of them with a general high health status and all of them providing several types of resources for the local Creole and indigenous communities. Because of the Venezuelan government's political and economic strategies, the national oil industry has implemented a large-scale project for offshore and nearshore gas exploitation, affecting more than 25% of the territorial sea and EEZ. This economic and social development strategy could represent a major threat to marine biodiversity in a pristine region and to the traditional livelihoods of local people.

Process: In addition to applying The Nature Conservancy's protocol for ecoregional planning, we wanted to design a set of strategies (best practices) mainly addressed to the oil and gas industry (e.g., exploratory drilling and seismic, development and production activities, platform setting, pipeline delivery of products). This set of strategies is being adapted to the specific natural attributes of each proposed conservation area to account for features with high social and culture significance.

Outcomes and Products: Our results, still under preparation, are presented as a set of products:

- A portfolio of priority areas for the Venezuelan Atlantic Front to complement an existing portfolio for Venezuela's Caribbean waters.
- A record card for each priority area.
- A visualization system connecting oil and gas activity with its expression on the environment, impacts for each expression, and strategies to abate or minimize impacts.

Key Lessons: Considering the relevance of oil and gas industry in Venezuelan economics, and therefore the ongoing huge exploitation programs, we believe that it is critical to anticipate potential impacts. To do so, we are proposing a model to reconcile industrial development with a healthy ecoregion. We hope that this proposal becomes a reference concerning legal environmental rules in the country. Beside that, we would like to highlight the importance of taking into account social and cultural considerations, as they are key for structuring human communities and preserving traditions.

More Information: A website for this project is under construction. Information about a similar previous effort in the Caribbean is available at http://bdb2.intecmar.usb.ve.

Working Toward a Multipurpose Marine Cadastre

By David Stein (NOAA) and Christine Taylor (MMS)

Location: All federal waters of the United States

Objective: The Multipurpose Marine Cadastre is being developed to support renewable energy planning and siting, and larger marine spatial planning efforts in U.S. waters.

Problem: There is no single location to access and visualize authoritative marine jurisdictions and other key ocean related data. The Multipurpose Marine Cadastre Project (MMC) is a multi-agency effort to build a GIS-based marine information system for U.S. waters that provides geospatial data and supporting information to inform decision making on a range of issues, including the demand for alternative energy. The project was initiated from the Energy Policy Act of 2005 (P.L. 109-58) – *Sec. 388 – Alternative Energy-Related Uses on the Outer Continental Shelf*, which directs the Secretary of the Interior, in cooperation with the Secretary of Commerce, the Commandant of the Coast Guard, and the Secretary of Defense, to establish an Outer Continental Shelf (OCS) Mapping Initiative to assist in decision making related to alternative energy uses on the OCS. At its core, the MMC contains marine cadastral data, which encompasses the spatial extent, usage, rights, restrictions, and responsibilities of marine areas. It also contains other regionally specific data needed to support planning, management, and conservation of submerged lands and marine spaces. The combination of marine cadastral and other regionally specific data provides users with the spatial context needed to address issues such as alternative energy siting, aquaculture, submerged lands leasing, marine conservation, and comprehensive marine planning.

Process: The NOAA Coastal Services Center and MMS are working collaboratively to organize, integrate, and visualize underlying framework data and form key partnerships with data providers and stakeholder groups. There are three major components of the MMC project: spatial data, decision-support tools, and partnerships. Future plans include adding additional data on a case-by-case basis to support multiple offshore uses and develop regional demonstration projects. A data management plan and spatial data policy are currently being developed.

Outcomes and Products: The data can be visualized through ArcIMS, ArcReader, and Google Earth applications. To service more advanced GIS analysis, a data download capability (via a data Portal) is provided to allow users to select from all available data sets. The MMC is currently being used by MMS and its partners for renewable energy project siting and by the National Marine Fisheries Service for permit review.

Key Lessons:
- Technology always changes. Data should be the primary focus of any spatial planning activity.
- Scale is an issue that should be addressed early in a project (e.g., Are you developing a national, regional, or a local viewer, or some combination of all?)
- Spend time and resources up front to define user groups and their needs, it is money well spent.

More Information: www.csc.noaa.gov/mmc

MarineMap: A Decision-Support Tool for Marine Spatial Planning for the California Marine Life Protection Act Initiative

By Matt Merrifield (The Nature Conservancy), Will McClintock (University of California, Santa Barbara), Mary Gleason (The Nature Conservancy), and Charles Steinback (Ecotrust)

Location: Southern California

Objective: The MarineMap decision-support tool facilitates participatory marine spatial planning for the California Marine Life Protection Act Initiative (MLPAI). By designing this tool using free and open-source software, we intend to encourage its use by other teams engaged in similar marine protected area (MPA) planning efforts.

Problem: The Marine Life Protection Act of 1999 mandates the state of California to implement a network of marine protected areas (MPAs) based on the best readily available science. These MPA networks are designed to meet multiple objectives, including (1) protecting marine life, habitat, ecosystems, and natural heritage, (2) improving recreational, educational, and research opportunities provided by marine ecosystems, and (3) minimizing the economic impact to local commercial and recreational fisheries and coastal communities. The MLPAI is intentionally designed as a participatory process that requires representative stakeholders of various user groups to design prospective MPA networks. This requires stakeholders have access to large amounts of spatial information and delineate boundaries that are ultimately evaluated against the scientific guidelines provided by the California MPA Master Plan, i.e., size, distance to other MPAs, amounts of habitat represented(CDF&G 2008).

Process: The primary goal was to develop a sophisticated decision-support system for stakeholders tasked with designing MPAs in a participatory setting. MarineMap was developed and supported by scientists and technologists at the University of California Santa Barbara, Ecotrust, and The Nature Conservancy. The system functions similarly to a traditional GIS but also incorporates spatial logic and workflow necessary to design MPAs consistent with scientific guidelines of the MLPAI. The first step was to aggregate and publish a comprehensive spatial database of all relevant information. The second step involved building a web-based tool that relied on the same information and allowed users to contribute MPA shapes that could be aggregated into networks and shared with other stakeholder members. Since December 2008, MarineMap has served as the tool by which stakeholders explore and propose prospective MPAs, and the primary mechanism by which scientists and planning staff evaluate alternative MPA proposals

Outcomes and Products: MarineMap is a web-mapping application that allows users to (a) visualize over 60 vetted geospatial data layers, (b) draw prospective MPA boundaries with attributed information, (c) assemble prospective MPA boundaries into arrays, (d) share MPA boundaries and arrays with other users, (e) generate graphs and statistics to evaluate MPAs based on science-based guidelines, and (f) share results with users in a place-based discussion forum. Based entirely on open-source technologies, we have developed MarineMap to be freely distributable and easily adopted by MPA planning processes worldwide. Furthermore, we have designed MarineMap to be extensible and modular so that it can be modified easily for MPA monitoring once MPAs have been established.

Key Lessons:

- Having a well-defined planning process and regulatory framework made it easier to translate needs into functional requirements for the MarineMap application. There was no ″mission drift,″ and no time was wasted because of not knowing exactly what was needed.
- A collaborative team developed this application. Instead of just "throwing money over a wall" and getting a tool back from a contractor, we intentionally designed a team that collaborated on the development of this application and thus increased the mind share and ability to support it into the future.

More Information: www.marinemap.org/marinemap, www.twitter.com/marinemap, CDF&G (2008) Master Plan for Marine Protected Areas http://www.dfg.ca.gov/mlpa/masterplan.asp.

Implementation of Spatial Conservation Planning within the Eastern Scotian Shelf Integrated Management Area (ESSIM) Initiative

By Jennifer Smith (WWF-Canada, Atlantic Region) and Hussein Alidina (WWF-Canada, Pacific Region)

Location: Atlantic Canada

Objective: Since 2002, WWF-Canada has sought the protection of a key set of priority areas through a government-led planning process for Integrated Management Planning in the Eastern Scotian Shelf.

Problem: The marine ecosystems of the Gulf of Maine, Georges Bank, and the Scotian Shelf are legendary for their productivity, and marine life has played an important role throughout this region's history. However, due to the depletion of populations of many fishes, whales, turtles, and seabirds, and due to habitat loss and water pollution, these once-plentiful waters are in peril. Scientific research points not only to dwindling populations of marine life, but also to fundamental changes in the characteristics of populations and complex ecological systems. To date, the stewardship of the region's marine ecosystems has been inadequate, and further losses in terms of biodiversity and the valuable goods and services provided by healthy ecosystems are to be expected. Failed fisheries and unemployment testify to these problems and mark the changing face of coastal communities throughout our region. A host of scientific, conservation, and governmental bodies have recognized that effective marine ecosystem conservation must include carefully designed networks of marine protected areas that are representative of habitat types and the full spectrum of marine life.

Process: In 2001, WWF-Canada with U.S.-based partners The Conservation Law Foundation (CLF) embarked on an analysis grounded in principles and tools of systematic conservation planning to identify key priority areas for protection in the cross-boundary waters in the region of New England and Maritime Canada. After several peer reviews, this analysis was published in 2005. In 1998, the government of Canada announced the Eastern Scotian Shelf Integrated Management (ESSIM) initiative, one of five Large Ocean Management Planning Pilot areas in Canada. This process was publicly launched in 2002 and presented an opportunity for WWF-Canada to provide input and analysis in a planning process that would potentially apply a spatial planning approach and confer protection and result in the designation of a network of marine protected areas. However, given that the ESSIM was the first of its kind in Canada, the next few years were spent engaging in a multi-stakeholder process for Integrated Management Planning. Expectations that this process would result in a spatial plan and deliver area-based protection have yet to be realized. WWF-Canada continued to be engaged in this process and sat on the Stakeholder Advisory Committee (SAC). In 2006, the SAC endorsed a draft plan with 3 overarching goals related to collaborative governance, integrated management, and sustainable use and healthy ecosystems. The plan did not identify specific actions to be pursued under each strategy, leaving those for the post-plan stage. The multi-year process did, however, establish a structure and plan through which multi-sector issues could be deliberated.

Outputs and Products: Since 2006, there has been a spatial conservation planning action plan stewarded and put forward through the SAC that WWF-Canada has had an influential role in informing and developing. We expect outcomes of this action plan to include identifying and building agreement on areas of conservation priority and making recommendations for action.

Key Lessons:

- There is no legislative requirement for spatial planning in Canada and the integrated management process is currently the only vehicle through which comprehensive integrated management and spatial planning may be pursued, and it is very slow.
- Influencing the process to deliver spatial outcomes has required a long-term commitment and engagement in the process, including building relationships and new structures.
- Robust, peer-reviewed analysis completed earlier by WWF served as a proof of concept for conservation planning, and elements of that analysis are now reflected in the spatial action conservation plan.
- The time and money spent on developing multi-sector share objectives was an important investment, as the objectives guide any followup action plans that may develop from the process.

More Information:

- Identifying Priority Areas: http://assets.wwf.ca/downloads/wwf_northwestatlantic_marineecosystemconservation2006.pdf
- ESSIM Spatial Conservation Action Plan: http://ecologyaction.ca/ESSIM/background.html

Marine Spatial Planning in the Birds Head Seascape, Indonesia

By Vera Agostini (The Nature Conservancy)

Location: Birds Head Seascape, Indonesia

Objective: The Birds Head Seascape project is executing marine spatial planning to support the current zoning efforts for a MPA network and to initiate a process for zoning at a larger seascape scale.

Problem: Located on the northwest coast of West Papua (Eastern Indonesia), Birds Head Seascape is the center of the Coral Triangle, the most biodiverse marine region in the world. A system of MPAs has been established to protect this biodiversity. The area is also increasingly becoming the target for development in a wide variety of economic sectors (e.g., fisheries, energy extraction, tourism). As a result, local governments in this region are facing difficult decisions in their attempt to balance sustainable development of an incredibly rich array of marine resources with conservation of globally significant marine diversity. They have turned to zoning as a potential strategy to manage multiple activities taking place across the seascape.

Process: The Birds Head project was designed to provide tools to support decision makers jointly addressing multiple objectives. This project is helping to meet that goal by providing a suite of potential zoning schemes for (a) the MPA network currently in place, and (b) the overall Birds Head Seascape. Traditionally, conservation planning has focused on how to efficiently conserve patterns of biodiversity, such as benthic habitats and relatively sedentary species. It has also conventionally focused on using one approach, predominantly marine reserves, where most extractive activities are excluded. To advance the science of conservation planning and to meet the increasing need to zone existing MPAs as well as larger seascapes, we are testing approaches that systematically plan multiple actions or zones and consider the whole ecosystem, including ecological processes and different human uses, rather than managing each issue in isolation. We are using a GIS database to integrate a wide range of information on biodiversity, human uses such as fisheries and tourism, and future threats such as climate change impacts. These data and other information products are made accessible on the Internet. The planning tool Marxan with Zones will be used to produce a suite of zoning scenarios.

Outcomes and Products:
The project is producing a spatial database and decision-support system for jointly meeting multiple objectives (e.g. biodiversity and fisheries) in the Birds Head ecosystem.

Key Lessons: Truly facilitating processes that attempt to address multiple objectives will require a shift in how we think about, prioritize collection of, synthesize, communicate, and make information accessible to stakeholders and decision makers. Great attention needs to be devoted towards ensuring that a balance between objectives informs every step of the way.

Collaborators: The Nature Conservancy Indonesia program (Jo Wilson, Sangeeta Manghubai), University of Queensland (Hedley Grantham, Hugh Possingham), Conservation International (Mark Erdmann)

Prioritization of Marine Conservation Sites in Florida

By Laura Geselbracht (The Nature Conservancy)

Location: Florida

Objective: The Florida Marine Site Prioritization project identified a spatially efficient portfolio of priority sites based on distribution of marine habitats and species to inform state and regional marine conservation and management activities.

Problem: Florida is rich in marine and estuarine resources, but not all areas are equally important. Where then, in the face of limited funding for conservation and management, should resources be applied first or with the highest priority? Until recently, Florida lacked a framework for prioritizing one marine/estuarine area over another based solely on natural resources.

Process: Marxan software and existing geospatial data sets of marine and estuarine resources were used to develop several potential conservation portfolios for the marine and estuarine areas surrounding Florida. To accomplish this, we identified planning-area boundaries and subregions, conservation targets, appropriate target distribution and socio-economic use data sets, and alternative approaches for setting representation goals. We also created an index for spatially representing socio-economic activities likely to have an irreversible adverse impact on biodiversity and/or resource viability. We evaluated a number of alternative portfolios based on their efficiency in terms of spatial representation and attainment of conservation target goals. We held expert review workshops throughout the priority site identification process and used the experts' comments to help select a preferred alternative. This project was completed as a supplement to the Florida Comprehensive Wildlife Conservation Strategy.

Outcomes and Products: The results of this analysis are being used to direct where The Nature Conservancy and its partners focus conservation attention. For example, The Nature Conservancy and the Florida Fish and Wildlife Conservation Commission are collaborating on evaluations of how sea level rise will impact coastal wetlands in Florida estuarine systems. The estuarine systems selected for analysis were identified through the site prioritization project.

Key Lessons: Without a legislative mandate to create marine protected areas or a marine spatial plan, agency stakeholders are reluctant to commit to any particular plan or priority areas. Directives in the form of legislation and/or executive order are essential for accomplishing something concrete and lasting.

More Information:
http://floridaconservation.org/WILDLIFEHABITATS/Legacy_strategy.htm

Classification of Offshore Habitats in the Gulf of Mexico

By Rafael Calderon (The Nature Conservancy)

Location: Gulf of Mexico

Objective: Although coastal habitats in the Gulf of Mexico have been studied and classified for many years, this is not the case for the Gulf's offshore ecosystems and environments. In this project, The Nature Conservancy will work with NatureServe to apply the Geoform Component of the Coastal and Marine Ecological Classification Standard (CMECS) in a portion of the Gulf. We anticipate studying habitats from the Texas coast to the abyssal plain, or the limits of U.S. waters.

Problem: The Gulf of Mexico is a rich and heavily used ecosystem. Energy production (offshore drilling), offshore commercial fishing, deep-sea mining, offshore aquaculture, and most recently offshore wind energy are among the human uses of this body of water. Although the Minerals Management Service (MMS) has traditionally requested specific and detailed studies of the leased and project areas, the studies have been done piecemeal with no holistic view. Therefore, there is a need to better understand the Gulf's habitats to facilitate planning and to improve communication of potential impacts. In the past, scientists and managers have lacked a consistent and unified classification scheme that could subsume the marine habitat nomenclature all across the country. This project will serve as a real-world test of the recently developed Coastal and Marine Ecosystem Classification Scheme (CMECS).

Process: This project will focus on gathering, processing, and analyzing the physical data that exists for the Gulf of Mexico (GOM), including bathymetry, sediment type, and seabed forms (aspect and rugosity). The Nature Conservancy will analyze these 3 physical characteristics and determine the different "clusters" that ultimately represent the variability of the factors. This information, in turn, will help in developing habitat proxies for the offshore environment in lieu of consistent and well-distributed biological data. After the proxies have been generated, the team will use existing biological data to associate species with physical characteristics of the seafloor. These analyses will provide an initial estimation of habitat types that should be represented in the Geoforms Component of CMECS.

Outcomes and Products: The major outcome of this work will be an example of the use of the CMECS Geoform Component in the Gulf of Mexico, which could guide other processes in the region for characterization of offshore habitats. Products will include a map of Geoforms for a section of the Texas coast; a map identifying and naming benthic habitats; a database of bathymetry, substrate type, seabed forms, and habitats; and a report describing the process and detailed methods used to arrive at the products listed above.

Key Lessons: This process is only in the beginning stages, so lessons are yet to be captured.

More Information:
www.natureserve.org/getData/CMECS/metadata_intro.htm

The Coastal Resilience Project: A Decision-Support Tool for Understanding Impacts of Sea-Level Rise

By Zach Ferdaña, Mike Beck, and Vera Agostini (The Nature Conservancy)

Location: South Shore of Long Island, New York

Objective: The Coastal Resilience project is executing marine spatial planning to support decisions that address coastal losses for both natural and human communities.

Problem: The shores of Long Island, New York, have highly developed lands in the coastal zone. Much of this private property is only inches above sea level, placing millions of dollars in public and private funds at risk. This also puts at risk coastal wetlands and other ecosystems that provide habitat, natural buffers to storms, and additional services. Despite a growing awareness of global climate change, local decision makers—the primary regulatory authorities on coastal development—still lack the tools to examine concurrently different management objectives such as coastal hazards and conservation. Long Island stakeholders have indicated a need to visualize and understand how they can make informed decisions about marine conservation, land protection, and coastal development.

Process: The Coastal Resilience project was designed to provide tools and information to better inform decision-making. A primary goal of the project is to help meet that need by designing, building, and discussing alternative future scenarios that address sea level rise, storm surge, community vulnerability, and conservation priorities. A number of decision-support tools are being used in the process. SLOSH model outputs provide flooding scenarios for coastal storms. Future potential inundation scenarios consider coastal storms in conjunction with Long Island sea-level-rise scenarios developed to account for local influences. The Coastal Services Center's CVAT methodology aids in analyzing community exposure and vulnerability to these hazards. FEMA's loss estimation tool, HAZUS, helps to estimate the flood damage impacts for each scenario. The project uses GIS to combine hazard information with ecological data to identify potential conservation areas that can both enhance biodiversity and reduce hazards exposure.

Outcomes and Products: Analytical results are presented in an interactive, online mapping tool that provides local and state decision makers with a new tool for their planning, zoning, acquisition, and permitting decisions. Viewed with contextual information on viable land-use policy options, the web tool will help decision makers keep the environment and public safety in mind as they consider conservation and development in the face of rising seas and coastal storms.

Key Lesson: We believe that focusing more on interactive decision support and less on identifying priority areas is key to the success of priority setting and marine spatial planning.
More Information: www.coastalresilience.org

Northwest Atlantic Marine Assessment and Mid-Atlantic Seascape Conservation Action Plan

By Jay Odell (The Nature Conservancy)

Objective: Two coordinated teams are (a) developing comprehensive regional-scale spatial data and tools to support effective marine biodiversity conservation within the Virginian and Acadian Ecoregions and (b) catalyzing the creation of a new regional ocean governance institution capable of implementing ecosystem-based marine conservation approaches to meet multiple objectives, with biodiversity conservation goals explicitly addressed.

Problem: Progress in achieving effective marine conservation for North America's east coast continental shelf ecosystems and their linked estuaries has been stalled due to three broad factors. (1) Although state and federal government agencies have high-quality data, the data have not been integrated and decision-support tools are lacking. (2) Ocean governance is fragmented into single sector "silos", without overarching policy and goals to provide structure and a process for collaboration. (3) State agencies have only recently begun to think about ocean policy development beyond fisheries management and therefore lack the resources and capacity needed for multiple-objective management.

Process: The Nature Conservancy's human and financial resources across eleven states (NC, VA, MD, DE, NJ, NY, CT, RI, MA, NH, ME) are coordinated to establish and communicate a clear set of regional marine conservation priorities (places and strategies). The project team is building from a solid foundation of prior terrestrial and marine ecoregional assessments by The Nature Conservancy and its partners. The Northwest Atlantic Marine Ecoregional Assessment (NAM-ERA) project team has been working for the last two years to create an information baseline to inform and support effective regional-scale conservation strategies. In the second phase of the project, these data are being integrated to create a "portfolio" of conservation priority areas that include (a) areas selected for representative biodiversity and (b) areas identified or modeled as critical locations for habitats, species, and ecological processes. This base portfolio is not designed as a blueprint for a fully protected MPA network but rather to provide the ability for selection of subsets of priority conservation areas that are most suitable for (or most in need of) specific types of protection or management measures. Protective measures (place- and non-place-based) will necessarily be developed in specific governance contexts, ideally to simultaneously meet multiple stakeholder objectives.

Beginning three years ago, a multi-disciplinary team developed a conservation action plan for the 20-million-acre Mid-Atlantic Seascape (North Carolina to New York). In recognition that the marine conservation actions we sought would need to be implemented by government, we sought to catalyze creation of a regional-scale ocean governance institution. Shuttle diplomacy and a series of small meetings culminated in a two-day mid-Atlantic ocean forum for regional policy leaders. A new institution, the Mid-Atlantic Regional Ocean Council (MARCO), was subsequently launched by governors of the five states. Our ongoing engagement is focused on helping to build conservation capacity within states and promoting biodiversity conservation as a foundation and high priority for the new ocean council.

Outcomes and Products: Ecoregional assessment: (1) baseline database, (2) conservation portfolio, and (3) decision-support tools. Mid-Atlantic Seascape Team: (1) MARCO established, (2) marine spatial data, including NAM-ERA portfolio elements, used to inform MARCO actions to protect Mid-Atlantic marine biodiversity (grant funded work to commence Fall 2009).

Key Lessons:

- Make sure that government gets the credit it deserves when doing the right thing.
- There is high value in simply compiling diverse marine spatial data sets and displaying the data in an aesthetically pleasing manner—pictures drive policy.
- In many cases, our government partners do not have the marine conservation resources they want and need, and there are relatively inexpensive ways we can help.
- Clarity of communication regarding MSP is difficult and essential; perception is reality.

More Information: NAM-ERA Fact Sheet, www.midatlanticocean.org

Polar Marine (Beaufort and Chukchi Seas) Ecoregional Assessment

By Steve MacLean and Laura Chartier (The Nature Conservancy)

Location: North Slope of Alaska

Objective: The Polar Marine program plans to use marine spatial planning to identify and protect important biological and cultural areas in the Polar Marine ecoregion. The program will identify ecologically important places, subsistence areas, and potential development (energy and shipping) areas in the Beaufort and Chukchi Seas.

Problem: The Beaufort and Chukchi Seas are under increasing development pressure as changes due to a warming Arctic make these waters seasonally accessible. Warming waters also bring challenges to Arctic biodiversity as warmer-water species move north. Despite these challenges, there is no coordinated development plan for the region, and regulatory agencies lack the data or tools to predict areas of greatest change. Data to describe the biological resources of the area are 20 to 30 years old and likely no longer describe the current environment. Recent lease sales in the Chukchi Sea have generated nearly $3 billion in revenue, although exploration plans in the Beaufort and Chukchi have been halted due to inadequate environmental assessments for the exploration plans. Native groups and environmental organizations have challenged the speed with which development decisions are made, and they are increasingly seeing the need for a coordinated development plan that identifies and protects important biological and cultural areas.

Process: The Polar Marine Ecoregional Assessment will identify the present state of knowledge in the region by analyzing data gaps and quality of data sets. It will seek ways to use alternative data (e.g., local and traditional knowledge) to fill gaps. The primary goal of the project is to provide a mechanism by which these data can be used to develop conservation and development plans for the region that include subsistence needs of the Inupiat residents. A few data syntheses have been completed (Hopcroft et al. 2008), and Audubon Alaska and Oceana are preparing a biological hotspot atlas. The Alaska Ocean Observing System is designing a comprehensive data portal for the region.

Outcomes and Products: We anticipate that results will be presented in an interactive web-mapping tool to provide local, state, and federal resource managers with a new tool for lease sales, shipping designation, and other planning and permitting decisions. Our hope is for ecological and cultural data to be available and used in all state and federal planning processes.

Key Lessons: Data are scarce in the polar marine system, and identifying ways to fill data gaps until new data are available is critical. This project will rely on the willingness of partner agencies to share data and on the use of non-traditional data sources.

State of Oregon Territorial Sea Plan: An Example of Marine Spatial Planning

By Dick Vander Schaaf (The Nature Conservancy)

Background: The State of Oregon Territorial Sea Plan (1994) was an outgrowth of the Oregon Ocean Plan (1990) that was developed by the Oregon Department of Land Conservation and Development (DLCD) in response to several statewide planning goals that addressed marine and coastal resources. Statewide planning began with legislation in 1973, and the coastal goals were added in 1976. The coastal goals focus on Estuarine Resources (Goal 16), Coastal Shorelands (Goal 17), Beaches and Dunes (Goal 18), and Ocean Resources (Goal 19). The Ocean Resources Goal was developed amid national concerns about federal offshore oil and gas drilling as well as regional concerns about foreign fishing fleets and overfishing on or near the U.S. continental shelf. Accordingly, the Ocean Resources Goal established a priority for renewable resources, emphasized optimum-yield management for fisheries, and established a decision-making process that required adequate inventory information and the assessment of impacts from development actions.

Plan Summary: The Territorial Sea Plan initially consisted of three parts: (1) ocean management framework, (2) directions for making resource-use decisions, and (3) rocky shores management strategy. The mandatory policies that decision-makers must follow are outlined in Part 2: Making Resource Use Decisions, and they mostly consist of doing a comprehensive review of effects of proposed actions. The plan has had a fourth section added to address the laying of submarine cables on the seafloor. In 2009, the plan is being amended again to address the development of alternative energy in the nearshore ocean. The amendment outlines a process that is to be followed in any proposals for energy development, but there is no real explicit spatial component to the process.

Relation to Marine Spatial Planning: The Plan was not developed with spatial attributes and has not been fully brought up to date in terms of the making it a truly spatial document. However, many of the designated conservation areas that are identified in Part Three (Rocky Shores Management Strategy) have been digitized. DLCD maintains the online Oregon Coastal Atlas that contains most of these features. There is a known need to update the Plan, strengthening it in terms of conservation issues (Marine Reserves and MPAs) as well as making it a document that can utilize the GIS tools that are now readily available. The Plan also needs more links to other regulatory aspects of the marine environment such as fisheries and environmental quality, as these concerns are managed by other agencies in state government. Currently, these agencies are somewhat reluctant to share their management responsibilities—a dilemma that is faced in many marine spatial planning cases.

More Information:

- Territorial Sea Plan: www.oregon.gov/LCD/OCMP/Ocean_TSP.shtml
- Oregon Ocean Plan (1990): www.oregon.gov/LCD/OCMP/Ocean_Policies.shtml
- Oregon Coastal Atlas: www.coastalatlas.net

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Advice from a workshop organized by
The Nature Conservancy's Global Marine Team
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