Strategic Advice on Designing and Implementing Coastal and Marine Spatial Plans

Report to the NOAA Science Advisory Board From the Ecosystem Science and Management Working Group

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EXECUTIVE SUMMARY

Marine spatial planning is developing rapidly in many regions and countries in response to increases in ocean uses and user conflicts, growing environmental degradation and loss of ecosystem services, and awareness of the shortcomings of single-sector management. Marine spatial planning attempts to reduce spatial use conflicts and environmental stressors by comprehensively planning for multiple uses and objectives in an ecosystem- and place-based manner (Beck et al. 2009, CEQ 2010).

In July 2010 President Obama issued an executive order adopting the recommendations of the U.S. Interagency Ocean Policy Task Force; Coastal and Marine Spatial Planning (CMSP) is a priority objective (CEQ 2010). In response to the Interagency Ocean Policy Task Force's final recommendations, NOAA has created a CMSP program. The NOAA CSMP program will develop regional and national workshops, establish nine regional planning bodies to facilitate regional plans, and develop a strategic action plan.

To advise NOAA in the development of CMSP, a working group of NOAAs Science Advisory Board formed a CMSP-focused subcommittee to review and assess a representative set of 17 MSP examples from around the world (including plans and national frameworks). Our aim was to offer findings and recommendations from these efforts to assist NOAA (and the NOC) in the development of CMSP regionally and nationally. We developed a survey for these planning efforts and evaluated them based on published literature, interviews with plan leaders, and experiences from our direct involvement in planning efforts. We also examined the broader body of published works on MSP in the evaluation of evidence, findings and recommendations.

Our review, findings and recommendations are focused on seven key categories central to the development of CMSP: (i) objectives, (ii) scope, (iii) authority, (iv) participants, (v) data, (vi) decision support and (vii) measures. Across these categories, we identified 23 recommendations for NOAAs consideration. Some of the key findings and recommendations are identified below.

A. Objectives

Findings: The majority of plans started with largely conceptual objectives (e.g., conserve marine biodiversity, sustain fisheries). During the planning process, these objectives were made more operational and spatially explicit, often with the help of an independent panel of experts.

Recommendations: NOAA and the NOC should support the development of regional science and stakeholder teams that can help develop operational objectives (with indicators and reference levels) early in the CMSP process.

B. Scope

Findings: The spatial scale of the plans varied greatly. The majority of plans are at scales smaller than the ecosystem scale (as defined by Large Marine Ecosystems). The US CMSP program's regional planning areas are larger than most of the existing spatial plans. Plan development took from 1.5 – 29 years. Some plans were funded by a combination of governmental, private, and non-profit sources.

Recommendations: The US planning regions are comparatively large; NOAA and the NOC should be supportive of sub-regional planning efforts. NOAA and the NOC should investigate a variety of different opportunities to support plan development and implementation and should engage private and non-profit organizations.

C. Authority
Findings: Plans that were completed quickly typically had strict timelines identified in their legal mandates.

Recommendations: NOAA and the NOC should preferentially support regions that offer clear planning timelines and deadlines.

D. Data
Findings: Recently developed plans (in particular those in the U.S.) were completed on 2-year timelines, largely with existing data. Data compilation and assimilation efforts frequently dominated the initial stages of plan development, in terms of capacity, time and cost, likely to the detriment of the latter stages of the effort when decisions get made.

Recommendations: NOAA and the NOC should require a clear timeline and work plan for all phases of the MSP effort with benchmarks prior to funding. In particular, timelines should be set and adhered to for data gathering and compilation to allow sufficient time in the planning effort for analysis and decision making.

E. Participants
Findings: The majority of the plans were facilitated by government agencies, and other stakeholders were usually included in the planning process in all of the plans. How stakeholders were defined and their participation varied greatly.

Recommendation: NOAA and NOC should provide basic guidance to regions on stakeholder roles, responsibilities, and engagement strategies. These should be defined early in the process to avoid confusion.

F. Decision Support
Findings: Most plans used a suite of decision-support approaches including: no use of explicit decision-analysis tools, reliance on negotiations, GIS-based mapping tools, quantitative indices, and explicit decision-support tools. A number of decision-support tools used in planning processes help in the assessment of alternatives. No planning effort used a benefit-costs analysis to consider whether CMSP is the preferred alternative for spatially managing uses in the marine and coastal environments.

Recommendations: NOAA and the NOC should provide guidance on best practices for the use of decision-support tools; there is a growing body of lessons learned and best practices available from recent planning efforts. NOAA and the NOC should support the development of decision-support tools and, in particular, the connections among tools; most plans used more than one tool. NOAA and the NOC should support the development of more explicit trade-off analysis tools.

G. Measures

Findings: The successful end result of MSP efforts ranged from the development of a structured process for future spatial management decisions to the identification and implementation of these spatial management decisions. A number of plans that address development uses (e.g., mining, alternative energy) were designed at least in part to reduce conflicts and ease permitting.

Recommendations: NOAA and the NOC should require plans to explicitly identify formal metrics of success including metrics for social and economic outcomes. NOAA and the NOC should identify permitting time and costs as useful metrics for gauging the results of CMSP efforts; they should undertake efforts now to gather information on some current permitting times and costs ahead of regional CMSP efforts. This effort would clearly indicate to stakeholders that CMSP aims to address economic concerns in addition to ecological ones.

INTRODUCTION

Increasing human activities in the marine environment are causing conflicts in spatial and temporal uses and stressing ecosystem services (Crowder et al. 2006, Douvere 2008, Beck et al. 2009, Foley et al. 2010, Lubchenco and Sutley 2010). In response, marine spatial planning is being given increasing priority in many parts of the world. In the US, the Interagency Ocean Policy Task Force recommended Coastal and Marine Spatial Planning (CMSP) as one of its nine priority objectives (CEQ 2010). Acting on these recommendations, President Obama issued Executive Order 13574 (http://edocket.access.gop.gov/2010/2010-18169.htm) calling on all federal agencies to work together through a National Ocean Council to develop regional CMSP by 2015.

Among numerous federal agencies represented on the National Ocean Council, NOAA is the primary ocean agency, and therefore NOAA has responded to the Final Recommendations of Ocean Policy Task Force by creating a CMSP Program (http://msp.noaa.gov). The near-term objectives are to hold national and regional workshops, the formulation of nine regional planning bodies, the development of a strategic action plan, and development of an information management system and data portal. To assist NOAA in the process, the Ecosystem Science and Management Working Group (ESMWG) assessed a set of functioning examples of CMSP and compared these CMSPs to evaluate the state of practice for coastal and marine spatial planning, Each example was analyzed for its stated objectives, its scope, authority, stakeholder engagement, data inclusion, and performance measures. The outcomes of these comparisons are presented here along with some recommendations for the development of the CMSP program at NOAA.

For the study and recommendations, the CMSP subcommittee of the ESMWG used a working definition of CMSP that recognizes the interactions and distinctions among CMSP, ecosystem assessment (including integrated ecosystem assessments or IEAs) and ecosystem-based management (EBM). Ecosystem-Based Management is the overarching policy framework within which assessments, planning, decision-making, and implementation all take place. These definitions, provided by NOAA, are described in Table 1.

Functional Relationships among EBM, Ecosystem Assessments, and CMSP
Ecosystem-based management is fundamental to NOAA's agency-wide approach to managing coastal and ocean resources. Valued ecosystem services – a currency of EBM – are sustained by a variety of tools and approaches, including CMSP and Ecosystem Assessments. Taken together, EBM, Ecosystem Assessments and CMSP bring science, planning and action together in unprecedented ways. Central to this approach are two underlying relationships (NOAA 2011):

> 1. EBM is the *unifying principle and way of doing business* by which NOAA implements its strategic goals and objectives to enhance the sustainability of valued ecosystem services and the overall health, resilience and productivity of our nation's coasts and oceans.
>
> 2. Ecosystem Assessments are *science-based processes and tools for synthesizing and making information available*; CMSP is a *public planning process*. Along with other

relevant NOAA scientific and resource management capabilities, both approaches can inform and advance EBM across NOAA's broad stewardship mandates.

Table 1. Terms and definitions from NOAA (2011).

Term		Definition	Objective	Other characteristics
Ecosystem Based Management	EMB	Integrated approach to management that considers the entire ecosystem, including humans	Maintain an ecosystem in a healthy, productive and resilient condition so it can provide the services humans want and need.	
Ecosystem Assessments	EAs	Broad class of approaches for compiling relevant information of social, ecological, and economic variables of the natural environment.		
Integrated Ecosystem Assessments	IEAs	Synthesis and quantitative analysis of information on relevant physical, chemical, ecological and human processes in relation to specific ecosystem management objectives.	Provide a process to work closely with stakeholders and managers to identify priority management issues and provide robust decision support information.	IEAs consider possible future status based on forecasts of natural ecosystem variability coupled with evaluation of alternate management strategies. The process analyzes the benefits and risks - "tradeoffs"- to alternate management strategies.
Coastal & Marine Spatial Planning	CMSP	Comprehensive, adaptive, integrated, ecosystem-based and transparent spatial planning process, based on sound science for analyzing current and anticipated uses of ocean, coastal, and Great lakes areas.	Reduce conflicts among uses, reduce environmental impacts, facilitate compatible uses, and preserve critical ecosystem services to meet economic, environmental, security, and social objectives.	CMSP provides a public policy process to determine how ocean, coasts, and Great Lakes are sustainably used and protected - now and for future generations.

As a spatially explicit tool for planning, CMSP uses information from ecosystem assessments and diverse other sources in collective planning and consideration of management options and trade-offs. IEAs might be thought of as a way of (best) assembling and integrating information to *inform* decision-making and CMSP as a way to (best) *use* the assembled and integrated information to arrive at realistic, coherent, and publicly supported decisions for coastal and marine ecosystems.

When pursued together, IEAs, CMSP and EBM provide an integrated approach to comprehensive, place-based ocean management in the U.S. To that end, IEAs and CMSP are depicted as complementary tools and processes that make best use of science and contribute in various ways to the overarching approach of EBM, with all three advancing the sustainability of valued ecosystem services.

The goals of CMSP are to achieve societal objectives through resolving conflicts among uses of the marine environment, to achieve conservation, sustainable use, and healthy ecosystems, and to assist in better policy, management and other forms of coordination of human activities in an ecosystem-based context.

Given the quantity and complexity of data involved in CMSPs there is often a need to employ decision support tools or frameworks to access information; to develop and visualize alternative scenarios; and/or to evaluate scenarios and their ability to achieve the objectives. If and when CMSPs are implemented then monitoring is required to inform decision-making about consequences of decisions and effectiveness of measures being used to implement the decisions. Regular evaluations of monitoring results are necessary to determine whether progress is being made towards the objectives.

The format of this report is structured around our review of marine spatial planning efforts around the world. Appendix 1 contains the structured set of questions and Appendix 2 the complete answers for each spatial plan. In Appendix 3 the answers are condensed into summary tables to facilitate comparisons among the plans. Appendix 4 is a typology of economic decision-support tools. The Results section makes comparisons across the spatial plans by analyzing the responses in Appendices 2 and 3. The Discussion places our results in the context of the literature and other experiences of marine spatial planning. In particular, we examine the extent to which the decision-support tools of Appendix 4 are presently being used to inform spatial decision-making. From this combined knowledge base, we extracted Findings that lead to the Recommendations.

METHODS

In 2010 the Ecosystem Science and Management Working Group (ESMWG) formed a sub-committee to focus on Coastal and Marine Spatial Planning. The goal of the subcommittee was to provide timely information and recommendations to the ESMWG and the NOAA SAB on ecosystem science and management research with respect to the development of coastal and marine spatial plans, noting in particular, potential gaps in data and scientific understanding. The workplan was guided by the Final Recommendations of the Interagency Ocean Policy Task Force, July 19, 2010. A set of issues relating to CMSP was identified from presentations at ESMWG meetings and discussions with NOAA staff.

This report is a literature review and synthesis combined with a comparative evaluation of how other CMSP exercises from around the world dealt with ecosystem science and management complexities. To this end, the subcommittee conducted a structured review of existing CMSPs. Criteria for the selection of spatial plans were:

1. The set of plans is representative of all of the plans known to have been developed to date;
2. The set of plans spans a diverse range of scales; in addition
3. Each plan included multiple objectives;
4. The outcomes of each plan include spatially explicit measures; and
5. Each plan is complete and ready for implementation.

The set of issues was organized into a list of 42 questions in seven categories:

A. Objectives (3);
B. Scope (8);
C. Authority (4);
D. Data (3);
E. Participants (8);
F. Tools and Decision Support (9);
G. Monitoring and Performance Measures (7).

The number of questions in each category is given in parentheses. The full list of questions (Appendix 1) can be considered a check list for the development of a CMSP. Consideration of the diversity of responses should help the NOAA CMSP program to tailor spatial plans to different regions of the U.S. Subcommittee members completed the questionnaire for each spatial plan by consulting the source documents. Each questionnaire was then reviewed by an expert (e.g. a plan author) to fill-in answers that were not apparent from the source documents and for general quality control. The answers were compiled and interpreted in light of existing literature and the committee’s own experience and knowledge. Key findings and recommendations derived from these findings are contained in separate sections.

RESULTS

We reviewed 17 coastal and marine spatial plans, mainly from Europe, North America, and Australia (Fig. 1). The working group recognizes that these spatial plans are not experimental replicates. They were created for different purposes and differ in many respects, some of which are tabulated below. Three of the national efforts developed spatial plans within previously determined national frameworks, whereas the others were developed without such frameworks. We retained these national frameworks in our review because of their similarities with the nascent CMSP program in the US. The differences among the plans can create informative contrasts among the responses. The results are organized by the seven main categories of questions. Each section contains a factual summary of the response table and the associated analysis.

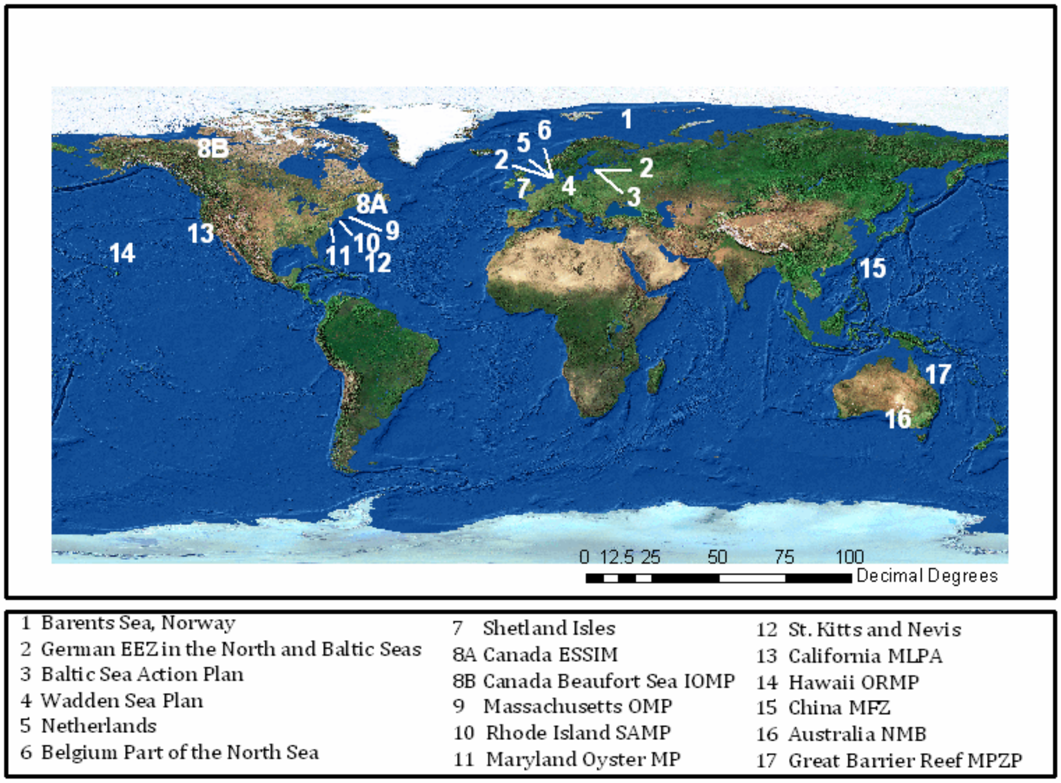

Figure 1. Locations of the coastal and marine spatial plans reviewed in this study.

A. Objectives

Objectives are part of all contemporary governance planning processes, spatial or otherwise. The objectives of CMSP address any or all of the three major dimensions of sustainability: environmental/ecological, economic, and social/cultural (Appendix 3, Table A). All 17 plans include ecological objectives, which address the conservation of biodiversity and critical habitats, the sustainable use of natural resources, avoiding pollution and eutrophication, and resilience to climate change. Twelve of the plans have explicit economic objectives, which relate to energy development, fisheries, maritime transport, and sand extraction. Market and Non-market uses are contained in seven of the plans. These involve the maintenance of culturally important marine areas, sustaining culture and livelihoods in coastal and indigenous communities dependent on marine resources, and enhancing public participation and support for decision-making.

In general, the objectives of Coastal and Marine Spatial Planning do not differ from those of Ecosystem Based Management. In addition to these general objectives, five of the plans contain spatially explicit objectives to identify areas for particular uses such as sand extraction (Netherlands), public use and scientific research (GBRMP), and the establishment of marine protected areas (California MLPA).

Objectives can also be expressed anywhere along the continuum from conceptual to fully operational. Conceptual objectives are statements of overarching goals such as: conserve marine biodiversity, sustain fishery-dependent communities, or accommodate new uses like ocean energy and offshore aquaculture. An objective is fully operational when it has sufficient specificity that appropriate indicators and reference levels for decision rules can be calculated by technical experts without further consultation about what activities and outcomes are intended by the objective. Conflicts are rare at the most conceptual objective level. It is as the objective setting process increases the specificity of objectives that differences in expectations and goals of diverse participants, and incompatibilities among the expectations are uncovered and addressed in the planning process. Most of the plans have conceptual objectives, such as a Baltic Sea unaffected by eutrophication. Eight of the plans have more operational components to meet the objectives and seven have both (Fig. 2). For example, the Barents Sea plan specifies that "operational discharges from activities in the area will not result in damage to the environment or elevated background levels of oil or other environmentally hazardous substances over the long term." The operational objectives are usually more spatially explicit than the conceptual ones. For example, the Barents Sea plan also specifies that "a representative network of marine protected areas will be established in Norwegian waters, at the latest by 2012."

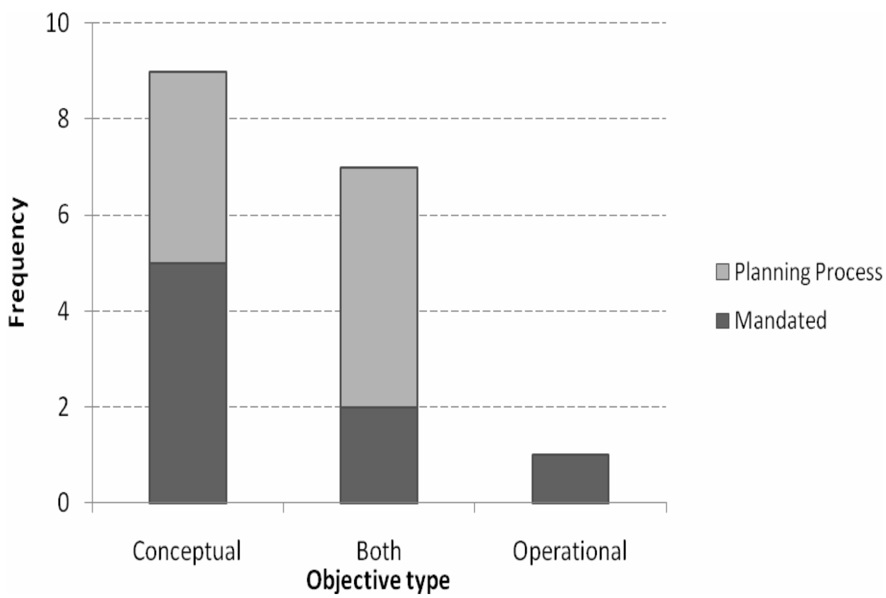

Figure 2. Objectives of coastal and marine spatial planning categorized according to whether they are conceptual or operational, and whether they were mandated by legislation or identified as part of the planning process.

The spatial plans are evenly split between those for which the objectives were mandated by government legislation and international conventions (9) compared with those that identified the objectives at the outset of the planning process (8). Plans with government mandates are more likely to have conceptual objectives, whereas objectives identified during the planning process are slightly more likely to have operational components (Fig. 2). The larger the spatial scale, the less specificity was contained in the objectives (comparison from this study). As a plan is developed and implemented a process is implied, but often not articulated, by which objectives are made more operational and conflicts are addressed. In summary, we infer from the set of plans that defining objectives at the start of the planning process that have some operational components is possible, but we also found that none of the spatial plans have fully operational objectives.

B. Scope

Under the heading scope, we compare the basic attributes of the plans: which spatial uses are included, the spatial scale, when planning started, how long it took, which steps took the longest, and how much it cost.

Most of the plans are intended to consider all sectors of human uses (Appendix 3, Table B). For example, the Massachusetts OMP explicitly considers natural, social, cultural, historic, and economic interests. As with the objectives, there is a spectrum in the breadth of scope. For example, the Maryland Oyster Plan is focussed exclusively on oysters but considers the explicit spatial management of fisheries, aquaculture and conservation. In contrast, the German EEZ plans, although they do not consider all uses, are more comprehensive in that they include shipping, the exploitation of non-living resources, laying of pipelines and submarine cables, scientific marine research, wind power production, fisheries and mariculture, and protection of the marine environment, but they do not consider military use, leisure and tourism.

Plan development took from 1.5 to over 29 years, with a mode of two years. Four of the plans were initiated some time ago (Wadden Sea, California MLPA, China, GBRMP) and the most recent version represents a second or third iteration of the planning process. For example, the Wadden Sea Plan was initiated with a conference in 1991; the most recent version is a further development of the 1997 Wadden Sea Plan. The remaining 11 plans are relatively young, having been started after 2002.

The most demanding steps were data collection (3), setting ecosystem targets (1), and stakeholder engagement (5). Planning intervals range from 2-year updates (Barents Sea) to 15-50 year planning horizons (China)(See Appendix, Table 3B).

National and state governments funded most of the spatial plans. One plan was funded with international government aid (St. Kitts & Nevis) and three with public-private partnerships (Shetland Isles, Massachusetts, California). For the plans with funding amounts available, the costs were on the order of $1 million USD per year. An exception is the Shetland Isles, which cost £144,000 over four years (£36,000 per year or ~$54,000), but did not include data collection or synthesis. In contrast, the Rhode Island SAMP cost $6.6 million over two years ($3.3 million per year), a large part of which was devoted to field work and data synthesis. For the St. Kitts and Nevis effort, the total cost including some new ecological and socio-economic data was $700,000. The main effort for the California MLPA was a public–private partnership that brought private funds for contractors, studies, and tool development to support the public agency (CDFG) responsible for implementation. The private funding investment for 7 years was US$19.5million (~2.8 million per year). Funding amounts were not available for most other plans.

The spatial scale of planning ranges over four orders of magnitude from 260 to 8.5 million km^2 (Fig. 3). We use the large marine ecosystems corresponding with each spatial plan to define the ecosystem scale (http://www.lme.noaa.gov/). Three of the cases (Canada Oceans Act, China Marine Functional Zoning, and Australia National Marine Bioregionalization) differ from the rest in that they are national frameworks to support regional spatial planning efforts. These frameworks therefore encompass several ecosystems and are implemented on a regional scale. Of the remaining 14 plans, five encompass the specified entire marine ecosystem and the remaining 9 are smaller than the corresponding ecosystem scale. Generally, marine spatial planning in Australia and Europe is being conduced at a larger spatial scale by national governments. In contrast, in the U.S. to date, spatial planning has been initiated by state governments at a smaller scale.

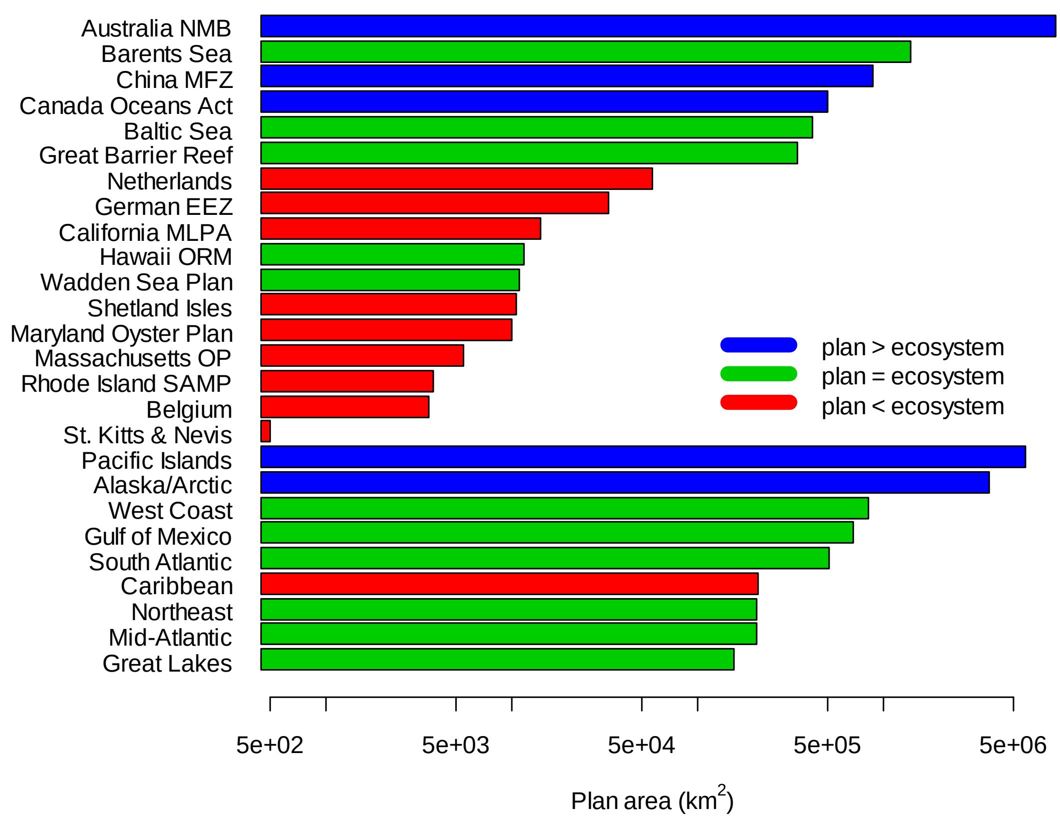

Figure 3. Spatial scale of marine spatial plans. The top group consists of 17 existing plans; the bottom group is the nine US regional planning areas. Colors indicate the area of the plan relative to the marine ecosystem: blue >, green =, red <).

In seven of the 17 cases, the planning area is divided into sub-areas for implementation. This implementation scale is smaller because international agreements are implemented by member countries (e.g. Wadden Sea) or because large plans encompass several regions (e.g. Great Barrier Reef). In one plan that is smaller than the ecosystem (Rhode Island) implementation is further divided into state and federal waters.

The spatial scope of the current U.S. CMSP program exceeds that of the other countries that have initiated marine spatial planning. In fact, the summed area of the nine U.S. regional planning areas equals the summed area of all the existing marine spatial plans. The individual regional planning areas are of the same order of magnitude as the entire planning frameworks (Canada, China, and Australia) and the largest of the marine spatial plans (Barents Sea, Baltic Sea, GBRMP) (Fig. 3).

C. Authority

The legal basis of coastal and marine spatial plans is scale-dependent (Appendix 3, Table C). Multinational plans are governed by international conventions (e.g. HELCOM), whereas federal acts provide the legal basis for plans in the sole jurisdiction of single countries (e.g. GBRMP Act). U.S. state statutes apply only to state waters (for most states 3 nm from shore) but there is consistency with federal acts. Rhode Island used provisions in CZMA for spatial planning (particularly for areas not in state waters) and this appears to be a promising approach that other states/regions may be able to follow. The Belgian and St. Kitts & Nevis plans do not have legal basis, although the latter plan was developed by an NGO in collaboration with a government steering committee. The level of government driving the plan is likewise scale dependent, with federal governments driving the international and national plans and state governments driving the state plans (Table C). The Great Barrier Reef Marine Park appears to be driven more equally by federal and state governments.

Interestingly, no institutional changes were made in creating the plans. New bodies were formed within existing institutions, but it appears that the legal authority for spatial planning was already vested in existing institutions. For example, three new bodies will be formed to implement the Barents Sea plan: a reference group, an advisory group on monitoring, and a forum on environmental risk management. California created an MPA Monitoring Enterprise. Government arrangements to implement the plans are somewhat more diffuse in that they involve multiple government agencies. The responsibilities for implementing and enforcing spatial zones may be decentralized to state and local authorities. Several of the plans including those in particular without legal mandates (Belgium St. Kitts & Nevis) have yet to be implemented.

D. Data

Here we use the term “data” broadly to include the different types of information used in spatial planning. These include conventional numerical data and other sources of information, such as locations, and the traditional knowledge of aboriginal people. All categories of data were broadly used in marine spatial planning (Appendix 3, Table D); however biological data were used more frequently and chemical data less frequently than other data types (Fig. 4). Time series data were used most frequently for biological variables. In many cases a geological snap shot provides a sufficient base map for spatial planning, but there are concerns that the sedimentary characteristics of near-shore habitats could be altered, for example, by increased storm intensity. In all data categories there is a strong dependence on qualitative data and expert opinion (Fig. 4).

Economic and social data were used in 13 of 17 plans. There was no indication that socio-economic data were used less frequently than ecological information. However, even where a data category was used in a plan, there may still be gaps in the availability of particular data types. For example, market-based economic data are more readily available than non-market data (Holland et al. 2010). Stakeholders and others often have excellent information on spatial patterns of use (e.g., fisheries) although proprietary rights considerations often impede the use of such data to inform decisions and trade-offs.

Three of the plans had no clear criteria for data inclusion. For the remainder, data sets were reviewed by science advisors and expert groups. However, only in few cases (e.g. CA MLPA) were there explicit criteria for data inclusion. For the GBRMP an independent Scientific Steering Committee developed a set of Biophysical Operating Principles (BOP). There was also an independent Social, Economic and Cultural Steering Committee that developed operating principles to complement the BOP. The Wadden Sea Plan is proactive in that data collection is guided by the trilateral targets of the plan. Four of the plans did not rely on qualitative information or expert opinion and therefore set no standards for their use. The remaining plans sought best available knowledge, as determined by peer review and public comment. Only two cases had actual standards for the inclusion of expert opinion and qualitative information. In California, quality standards were provided by the Science Advisory Team. In Canada, all information, including expert opinion, was reviewed according to Canadian Science Advisory Secretariat protocols for peer review.

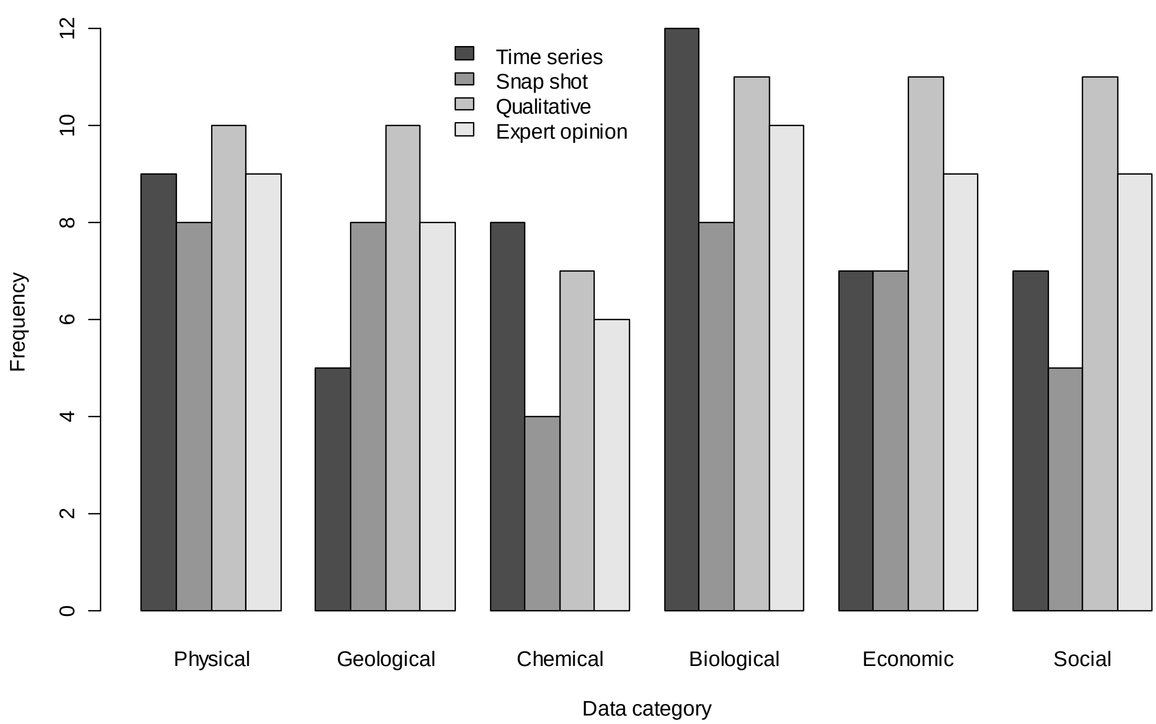

Figure 4. Frequencies of the inclusion of different categories and types of data in coastal and marine spatial plans. Note that plans could have more than one data type in each category, such that the maximum frequency of each bar is the number of plans (17).

During the development of RI SAMP, CA MLPA, SK&N plans, it became clear that some additional key data sets were needed. However while clearly an important factor, the need to acquire new data is seldom the limiting factor in developing plans. For example, the Shetland Isles plan identifies spatial uses but does not quantify them. This example indicates that lack of quantitative data is not, in itself, an impediment to plan development, and that high-level spatial plans can be created based on qualitative information.

E. Participants

Federal and/or state government agencies were part of the planning process for all of the marine spatial plans (Appendix 3, Table E). The level of participation of entities outside of government varied among plans. Two of the plans were driven by non-governmental entities: Belgium by academia and St. Kitts and Nevis by an NGO. In these cases the government agencies informed the plan development (as least in SK&N) and were considered as end users of the spatial plans. Three of the plans (Barents Sea, Beaufort Sea IOMP, and MA OMP) had aboriginal participation. Five of the plans included external scientific advisors as part of the planning process, three included non-governmental organizations, three included academia, two included private business, and three included other stakeholders. Thus there is a contrast between plans developed primarily by government agencies (mainly in Europe and China) and those in which outside entities actively contributed to plan development (mainly in North America and Australia). In only a few cases (Belgium, Shetland Isles, St. Kitts & Nevis) the participants had equal status in the planning process. In the other cases government agencies had the lead role, but the roles of external entities were often clearly defined.

Stakeholders were included in the planning process of all the spatial plans, except in China (in the GBRMP stakeholders are referred to as "affected groups"). The definition of stakeholders varied from formal application and selection of a set of stakeholder groups with direct interests in spatial decisions (e.g. California) to self selection from all affected groups (e.g. GBRMP). Where stakeholders were part of the planning process, they played active roles in developing goals, synthesizing data, assessing impacts, and suggesting designs (e.g. St. Kitts & Nevis). In the California MLPA, stakeholders were allowed to directly submit suggested areas for MPAs. In contrast, where the plans were developed primarily by government agencies, stakeholders participated in the public review process (e.g. German EEZ). Six of the planning processes arranged for stakeholder groups to hold meetings and conferences separately from the government-lead meetings. For example, the Wadden Sea Forum is a separate stakeholder group. Thus stakeholder roles ranged from active participation on steering committees (e.g. St. Kitts & Nevis) to public comment and written review (e.g. Barents Sea).

We can distinguish a set of plans which encouraged active stakeholder participation {WS, CAN, MA, RI, SKN, CA, GBR} and a set with limited or more passive stakeholder engagement {BAR, DE, BAL, NL, BE, SI, MD, HI, China}. It is mainly the distinction between the American and Australian approach, which tends to be more participatory, and the European and Chinese approach, which tends to be more autocratic. Of the plans with extensive stakeholder involvement, five listed public and stakeholder engagement as the most demanding step. Of the plans for which funding levels were available, these were the most expensive. The plans with limited stakeholder involvement took less time to develop (median 2 years) than the plans with extensive stakeholder involvement (median 10 years). The cases with extensive stakeholder participation include second-generation plans {WS, CA, GBR}, for which the most recent versions were developed more quickly. This group also includes three first-generation plans that were developed more quickly {MA, RI, SKN} with significant funding, some of which came from private foundations.

There was participation from the broader public in 11 of the 17 plans, which took the form of public comment and written reviews. Six of the plans gathered extensive economic, social, and cultural data, which reflect affected individuals and communities not always represented by stakeholders. Other plans did not collect economic and social data, or emphasized certain sectors, such as fisheries (e.g. California MLPA).

F. Decision-support Tools

Five of the plans were not intended for making decisions or did not use explicit decision-support tools (Appendix 3, Table F). Half of the remaining 12 plans use GIS-based mapping tools (e.g. Marine Atlas in the Shetland Isles). The Barents Sea and Wadden Sea plans rely on negotiated agreement among expert groups. The other four plans (in Australia and America) used some from of quantitative index and/or decision tool. For example, Rhode Island used a Technology Development Index to guide the location of offshore wind turbines and an Ecological Services Value Index to assess potential impacts on the ecosystem (Appendix 2). Other spatially-explicit decision-support tools include MarZone (St. Kitts & Nevis), MarineMap (California), Marxan (GBRMP). These tools allow users to designate spatial use zones and to estimate the benefits and costs (risks, impacts) of alternate zoning plans. Given a set of objectives, the implicit cost of alternative actions, and a budget constraint, spatial decision support programs (e.g. Marxan) can provide a set of outcomes that best achieve the objectives without exceeding the funding or budget constraint. In this example, varying the budget constraint results in a cost frontier or trade-off curve.

There is a range of approaches to framing key trade-offs in spatial uses. Key trade-off issues can be framed by the underlying plan goals and, for example, by Biophysical Operating Principles (GBRMP). Priority uses may be designated for spatial zones (e.g. German EEZ) or conversely, the primary impacts identified (e.g. fishing impacts in Maryland). In the Netherlands, trade-offs are framed by the criteria for assessing new permits. The trade-offs can be framed by expert groups (CA) and/or with a public process (RI). In some plans it remains unknown how trade-offs will be framed because this is a longer-term goal (Barents Sea, Canada).

Trade-offs are analyzed with quantitative and qualitative methods (Barents Sea, Netherlands) and with expert judgment (Wadden Sea). Where there has been prioritization of spatial uses, trade-off analysis consists of prohibiting incompatible uses (e.g. German EEZ) and permitting decisions (Shetland Islands and China). In some cases, decision support tools were used to develop and compare alternative scenarios to identify potential ‘least-cost’ solutions (SK&N, Belgium, California). Two areas already use (GBRMP) or plan to use (Baltic Sea) benefit-cost analysis when selecting management measures.

Stakeholder evaluation and negotiation systems can be thought of as an informal approach to benefit-cost analysis. Evaluation of options by stakeholders allows for their values and positions to be reflected in the determination of spatial plans. For example, several of the European plans rely on planning principles to obtain negotiated agreement among affected groups, informed by GIS maps. Stakeholder processes may also be used to assess trade-off curves or cost frontiers but all relevant values may not be reflected in this process. Even in the case of benefit-cost analysis, a governance structure is required to evaluate the analysis and choose from the alternatives, which may or may not be the alternative with the highest net benefit.

Market and non-market economic components of trade-off analysis are explicitly mentioned in six of the plans and not mentioned in six others. In the remaining five plans economic components are either implicit or are considered in some cases. Only the Belgian plan explicitly deals with uncertainty and risk related to marine activities, pollution, and "the protection of the hinterland against a 1000-year storm." Ten of the plans recognize risk implicitly or the need to deal with uncertainty in the future (e.g. Barents Sea). For example, the uncertainty arising from data gaps (e.g. German EEZ) and the uncertainty in future states of nature (e.g. Canada) are both recognized. The remaining six plans do not consider explicitly risk or uncertainty.

Of 13 plans that use decision tools, only two are dynamic over time, in seven the dynamics are implicit, and the remaining four are not dynamic. Seven of the plans have a strategy for updating and improving the decision support tools based on monitoring and evaluation. The remaining plans either do not yet have an explicit strategy (6), have no strategy (2), or it is not applicable (2). In all cases, adaptive management is passive, whereby decisions on investing in information do not guide the planning process but rather plans will change as information is gathered via monitoring activities (Doremus 2007). The finite duration of many of the plans (e.g., Netherlands plans are for 6 years) is a closed-loop mechanism for this information to be included in an assessment of the CMSP.

In many cases, conflicts are resolved by negotiated agreement among the experts appointed to boards, committees, and advisory teams. For example, in developing the California MPA plan, some conflicts were addressed through a Science Advisory Team and in public meetings. Following more formal procedures, Article 26 of the Helsinki Convention addresses a sequence of steps in conflict resolution, starting with negotiation and progressing through mediation, tribunals, and finally the International Court of Justice. Conflicts can also be resolved through the rules associated with permitting. For example, in China the owner of a permit is able to appeal a decision and in certain cases to sue. Eight of the plans did not address conflict resolution.

The primary mechanisms used to implement decisions are zoning areas for different uses, including leasing and permitting. The first round of planning in the Netherlands zoned some areas for exclusive use, such that all other areas were for up for grabs. So the second-generation plan moved to dominant use without adverse effects, with recourse to the courts to resolve conflicts. In China, market-based mechanisms are used to a limited extent to allow bidding to obtain highest lease value. Three of the plans do not use explicit mechanisms but refer to Best Available Practices (Baltic Sea) or the analysis of alternative spatial use maps (California, St. Kitts & Nevis).

G. Monitoring and Performance Measures

There is a clear dichotomy among the plans with respect to the intended products of marine spatial planning (Appendix, Table G). In the larger group of 12 the products are data sets, maps, the plan document, and the legal enactment of the policies and regulations contained therein. In the other group of four plans {MD, SKN, CA, GBR} the product is a zoning plan or a network of marine protected areas.

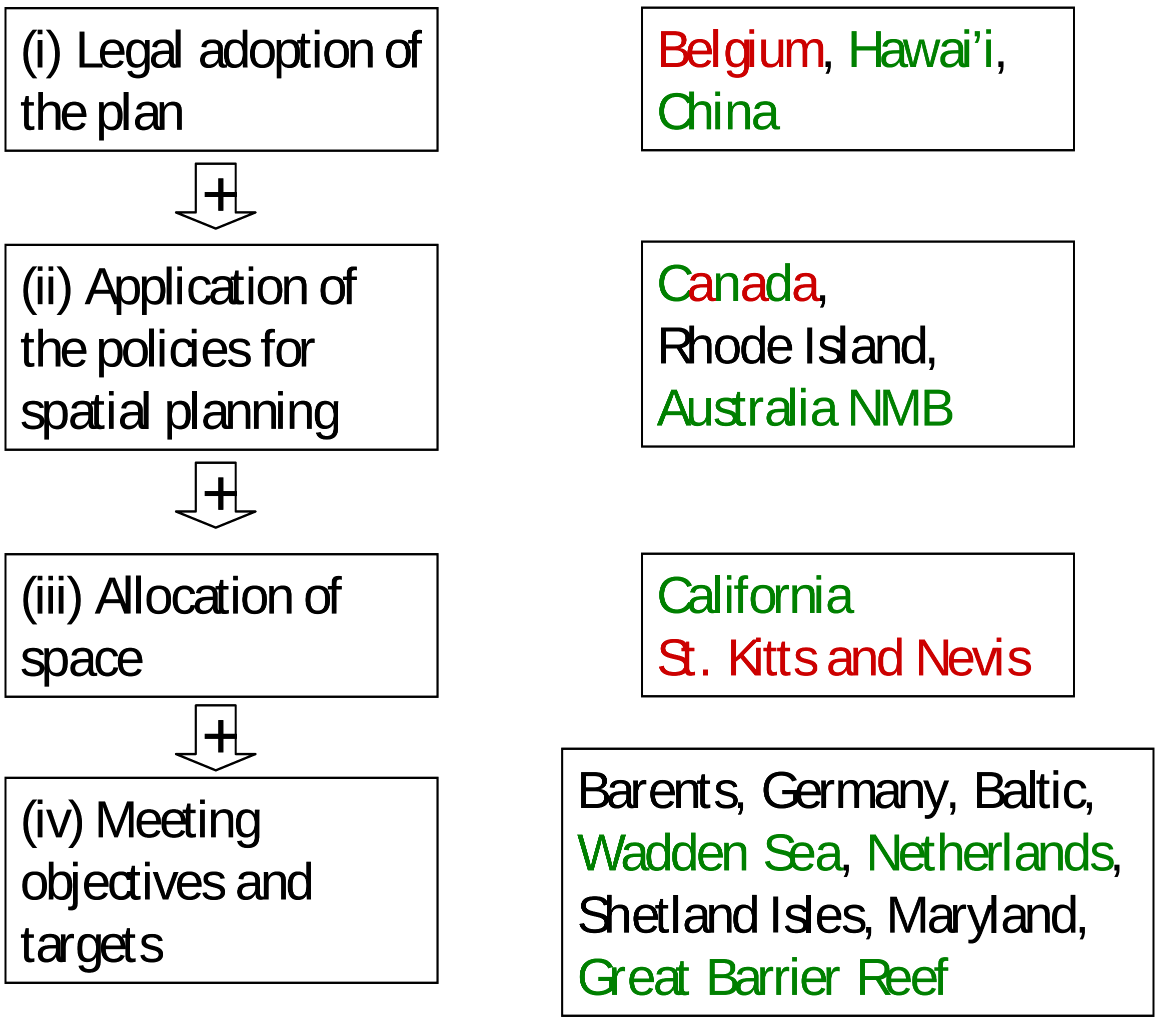

Figure 5. Criteria for progression of coastal marine spatial planning. Boxes on the left progress cumulatively in stages of implementation. Boxes on the right contain those plans that use the corresponding definitions on the left. Green type indicates that the plan has completed that stage; red type, stage incomplete; and black type, no basis for judgment.

Regarding what constitutes success of the plan, there appears to be a sequence of steps represented by the set of plans, (i) legal adoption of the plan, (ii) application of the policies for spatial planning, (iii) implementation of new spatial management (e.g., zoning or other allocations of space, and (iv) meeting the objectives and targets (Fig. 5). To date, most of the American plans (with the exception of Maryland) consider success to be the adoption and implementation of the plans, whereas meeting the objectives denotes success in the European plans and the GBRMP. For the first three definitions of success, there are preliminary indications of whether those plans will be successful. The Belgian report was completed in 2005 and not adopted by the government. In Canada, the Beaufort Sea IOMP was implemented in 2010, but the ESSIM has not been implemented due to a dispute over the eastern boundary of the plan. Many new plans, including RI, MA and SK&N have not yet been used to allocate space. For many of the plans that define success as meeting the objectives and targets, it is too soon to gauge whether they have been successful because some of the targets are still in the future (e.g. good environmental status by 2021). The second-generation plans (Wadden Sea, Netherlands, GBRMP) have made demonstrable progress in meeting their objectives, but it is difficult to gauge success if there are no metrics related to those objectives (see below).

Roughly half the plans (9) do not have formal metrics of success, even four of the plans for which success is considered meeting the objectives. Of the eight plans with formal metrics, only three have already identified reference levels of these indicators (Netherlands, Canada) or are in the process of doing so (Maryland). For example the Baltic Sea Plan has indicators for eutrophication, hazardous substances, nature conservation and biodiversity, but not performance outcomes defined by minimum (or maximum) values. In California, a statewide MPA monitoring enterprise has been established to monitor a subset of MPAs in the statewide network, though long-term funding for this enterprise is uncertain. The MPA Monitoring Enterprise has identified indicators and priority efforts for baseline monitoring. These examples show that it is possible to define quantifiable metrics for success in meeting the objectives, but that the hard (and most meaningful) negotiations about reference levels may still lie ahead.

Most of the plans (12) incorporate some level of monitoring. Some plans take advantage of ongoing monitoring programs to inform spatial planning (e.g. German EEZ, Canada). Others have instigated and committed to ongoing monitoring as part of the spatial plan (e.g. Wadden Sea). In other cases monitoring was initiated to develop the plan but there is no commitment to continue monitoring once the plan is adopted (e.g. RI, CA).

Passive adaptive management is an explicit component of seven of the 17 plans. For example, the Barents Sea Plan envisions response to monitoring results and implementation reports on a two-year cycle. Likewise in California, an adaptive management framework is in place to review the MPAs at approximately five-year intervals. In five other cases, passive adaptive management is implied by periodic plan revision based on new information, such as in the Baltic Sea Action Plan where "objectives and targets should be periodically reviewed and revised using a harmonized approach and the most updated information." In the former seven cases the feedback from monitoring to adaptive management is explicit, whereas the latter five cases call for periodic review but without an explicit feedback response to monitoring results. In no case is there a formal rule that specifies how management decisions will respond adaptively to new monitoring data. For example, in the Wadden Sea Plan there is generally response from policy-makers and/or politicians to important changes coming out of the monitoring and assessment process. In summary, adaptive management has been widely adopted as a guiding principle for spatial planning, but has been made operational in only two or three plans.

DISCUSSION

This section places the results of our structured survey of coastal and marine spatial plans in the more general context of marine spatial planning literature and the expertise of members of the ESMWG. The discussion is organized by the main headings of our review of plans. Perhaps the most important observation is that the standards and expectations for CMSPs should be commensurate with the financial and human resources for the work and, further, that there exists a governance structure with political capabilities to implement a plan. As members of the ESMWG subcommittee we are careful to note that we do not attempt to set standards for CMSP in the U.S.

A. Objectives

The need to formulate clear objectives during the early stages of planning is critical, as the remaining process, from data collection, to decision support, to stakeholder involvement, depends on clarity of purpose (Gleason et al. 2010, Sievanen et al. 2011). Conceptual objectives (e.g., conserve marine biodiversity, sustain fisheries, accommodate new uses like ocean energy and offshore aquaculture) are usually identified in formal mandates or policy—often on a sectoral basis. These objectives can and should be made progressively more operational during the planning process, often with the help of scientific advisors engaged in stakeholder processes (Gleason et al. 2010). Very often it is the setting of increasingly operational objectives that reveals, for the first time, the potential incompatibilities of outcomes sought by different stakeholders, and between uses and conservation. Hence making the objectives operational is usually a key part of the planning process, and not something done and set in stone before the planning process starts. None of the plans we reviewed have fully-operational objectives, which leaves further opportunity for new conflicts to arise during implementation, and may make it difficult in the end to measure the effectiveness of spatial planning.

President Obama's Executive Order 11547, July 19, 2010 based on the Ocean Policy Task Force Final Report of the same date (CEQ 2010) specifies the following policies:

Sec. 2. Policy. (a) To achieve an America whose stewardship ensures that the ocean, our coasts, and the Great Lakes are healthy and resilient, safe and productive, and understood and treasured so as to promote the well-being, prosperity, and security of present and future generations, it is the policy of the United States to:

- (i) protect, maintain, and restore the health and biological diversity of ocean, coastal, and Great Lakes ecosystems and resources;
- (ii) improve the resiliency of ocean, coastal, and Great Lakes ecosystems, communities, and economies;
- (iii) bolster the conservation and sustainable uses of land in ways that will improve the health of ocean, coastal, and Great Lakes ecosystems;

- (iv) use the best available science and knowledge to inform decisions affecting the ocean, our coasts, and the Great Lakes, and enhance humanity's capacity to understand, respond, and adapt to a changing global environment;
- (v) support sustainable, safe, secure, and productive access to, and uses of the ocean, our coasts, and the Great Lakes;
- (vi) respect and preserve our Nation's maritime heritage, including our social, cultural, recreational, and historical values;
- (vii) exercise rights and jurisdiction and perform duties in accordance with applicable international law, including respect for and preservation of navigational rights and freedoms, which are essential for the global economy and international peace and security;
- (viii) increase scientific understanding of ocean, coastal, and Great Lakes ecosystems as part of the global interconnected systems of air, land, ice, and water, including their relationships to humans and their activities;
- (ix) improve our understanding and awareness of changing environmental conditions, trends, and their causes, and of human activities taking place in ocean, coastal, and Great Lakes waters; and
- (x) foster a public understanding of the value of the ocean, our coasts, and the Great Lakes to build a foundation for improved stewardship.

These conceptual and comprehensive objectives of CMSP address all three major dimensions of sustainability: ecological, economic, and social. Conflicts and trade-offs among these objectives will become more apparent as they are made operational in regional plans.

B. Scope

Some of the earliest efforts in marine spatial planning (GBRMP and California) focused on resolving "user-environment" conflicts with the establishment of marine protected areas and other conservation zones (Douvere 2008). More recent plans, including those in Europe, additionally seek to reduce the "user-user" conflicts that result from competing uses of ocean space. Trade-offs are made in choosing the number of sectors (e.g. energy, fisheries, transportation, and aquaculture) to include in the planning process. On one hand, the time and cost of planning can be reduced by focusing on more limited sets of activities and objectives, which can then form the foundation for future planning exercises that are more comprehensive (McCrea-Strub et al. 2010). On the other hand, focusing on more limited sets of activities and objectives may mean the resultant plan does not address some of the most important conflicts over uses and conservation. For example, leaving fisheries out of a plan including, say, aquaculture and recreational boating could easily make it impossible to achieve any of the plan's biodiversity objectives, and not contribute to resolving conflicts between fishing and those sectors, which could be much larger than the conflicts between aquaculture and boating. Thus an important part of the scoping process is to identify the key constraints and conflicts, so that the resultant plans are better positioned to achieve outcomes and resolve conflicts.

There is a hierarchy in the spatial scales of national planning efforts, ecosystems and decision-making. At the largest scale ($\sim 10^6$ km^2) are national planning frameworks that often include multiple ecosystems. Some marine spatial plans are created at the ecosystem scale ($\sim 10^5$ km^2)

while others are smaller than the ecosystem (10^4 km^2) but also consider the broader ecosystem context. The spatial scale of human activities and regulations is often smaller than the ecosystem. Therefore, implementation is often carried out on more local scales than covered by the full plan. (i.e., *implementation scale < spatial plan < ecosystem scale*). Jurisdictions with longer coastlines (e.g., California and Australia) divided their planning and implementation area in to sub-regions. Mismatches of ecosystem and decision-making scales are likely in the U.S. given the large regional planning areas. The regional planning scale for the Pacific is the Pacific Islands, but the jurisdiction and social/economic needs are very different across the region. Similarly, Alaska is considered a planning region yet it encompasses three ecosystems--Gulf of Alaska, Bering Sea and Aleutian Islands and Arctic Ocean (Fig. 6). Whether or not the mismatch leads to inefficiency in planning depends on the tools used in implementing the plan (Sanchirico et al. 2010).

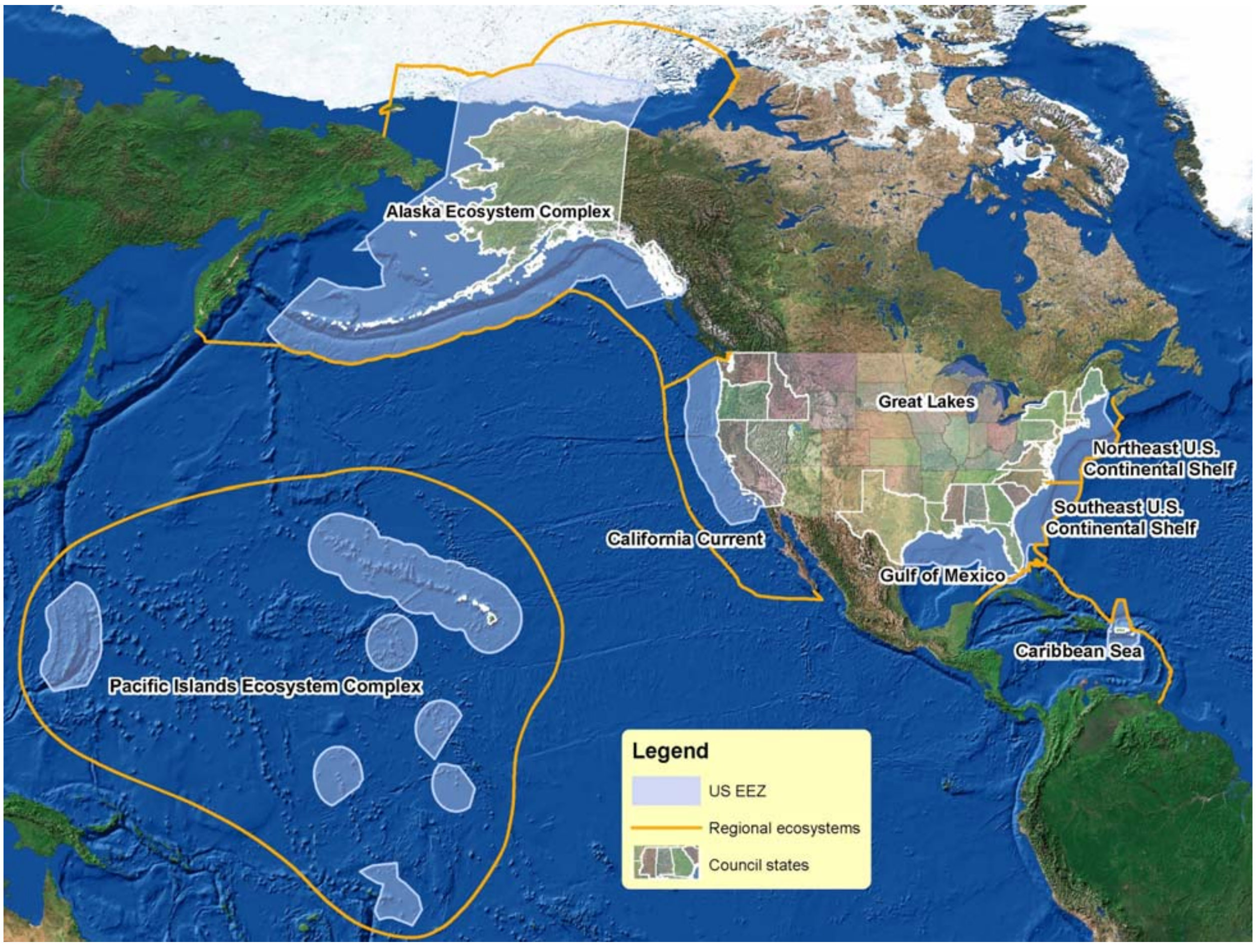

Figure 6.   U.S. regional ecosystems for Coastal and Marine Spatial Planning. NOAA (www.msp.noaa.gov)

In the US context there is a mismatch between the definition of CSMP and the CZMA (2005). Coastal Zone Management explicitly includes the Great Lakes as does CMSP. However, CMSP, as considered in the Executive Order (CEQ 2010), starts at mean high water and extends seaward whereas Coastal Zone management includes riparian areas, beaches, salt marshes, and wetlands

(CZMA 2005). This mismatch of definitions will need to be resolved in implementation of CMSP if a truly ecosystem-based management approach is to be realized. This mismatch could impede progress on CSMP in cases where it leads to disagreement over spatial coverage of a plan. CMSP needs all parties to cooperate within their respective frameworks, and legal competences, so the mismatch is more technical than conceptual.

Simply by virtue of their size, larger planning areas will contain a diversity of spatial uses and stakeholders. Most completed plans focused on areas that were smaller (sometimes substantially smaller) than the ecosystem scale. There is little indication that focusing within sub-regions (or sub-ecosystems) limited ecological considerations. Indeed at least for many coastal and near-shore systems, many socio-economic and ecological patterns have coherence at sub-regional scales. In the California MLPA process, for example, the reduction of planning units to sub-regions in the state made sense socio-economically, politically and ecologically (Gleason 2010). There is clearly value in understanding planning efforts as part of a larger regional context, but this larger context does not need to be the functional planning scale. In the US at a federal level, there is a present need to provide early examples of the process and potential benefits of CMSP, which argues for consideration of smaller areas (and possibly fewer objectives) that can be nested within larger regions over time. Making plans as extensive and comprehensive as possible at the outset may be counter-productive if there are no early examples that are tractable and achievable.

C. Authority

The legal basis of spatial planning tends to be scale dependent, with international agreements and national governments driving the larger plans and state governments driving the smaller plans (Ehler and Douvere 2009). While no institutional changes were made in governing bodies to accomplish or implement CMSP, it remains to be seen whether this approach will be successful in meeting the objectives of the planning process (Eagle et al. 2008). The primary *modus operandi*, however, is to call upon existing agencies to cooperate in producing CMSP plans and to implement them with existing authorities. It is unclear if that is because it was too difficult to change existing authorities or if the existing authorities were considered to be sufficient. Where implementation depends on the cooperation of multiple federal agencies (e.g., Canada, US), integrated planning may be difficult to achieve without clear lines of leadership or authority.

The path being taken by the US federal government (CEQ 2010) resembles the Australian and Canadian planning frameworks. In the US, the authority for making decisions about the spatial uses of marine areas rests with the competent agencies, but new institutions are being created to develop CMS plans. At a national level, the National Ocean Council will coordinate the activities of federal agencies with respect to CMSP and ensure consistency among regions. Nine regional planning bodies will be required to develop CMS plans and indications are that regional CMSP should build on existing efforts, e.g., West Coast Governors Agreement, Gulf of Mexico Alliance, etc. If existing regional arrangements are incapable of implementing CMSP then other arrangement will need to be created to develop CMS plans.

A government mandate appears to be a necessary condition for implementation of CMSP. A top-down mandate can provide legitimacy, authority, and financial incentives (Sievanen et al.

2011). Two plans developed in the absence of legislation or other authority, e.g., Belgium and St. Kitts & Nevis, have yet to be implemented. It appears from the literature that plans that were completed quickly responded to obvious drivers and needs, had clear timelines set in legislation or policy; and were provided with sufficient resources (e.g., Maryland, Rhode Island and Massachusetts). The Maryland experience was among the cheapest and fastest probably because (i) it had significant top-down pressure and timelines, (ii) stakeholder participation in decision making was comparatively low, and (iii) the issues that it addressed were quite limited ecologically and in the uses and direct stakeholders (Appendix 2).

As described below, there is evidence that strict deadlines can result in time pressure that reduces the time available for spatial analysis, stakeholder engagement, and obtaining buy-in. The trade-off between data synthesis and spatial planning can be addressed in part by (i) budgeting time for each step of the process, allowing for case-specific differences in state of preparations before the CMSP process commences and (ii) clearly indicating when there will be subsequent review and adaptive management of outcomes.

D. Data

Among the planning efforts that identified the most demanding steps, the two most common were data collection and stakeholder engagement. Although data are often incomplete, the planning efforts we reviewed were not stalled by lack of data. The Shetland Isles plan, for example, was developed without an intensive data-collection phase. The criteria and approach for deciding on data inclusion were often unclear except in a few plans such as the California MLPA. Few if any if the MSP efforts have a clear plan or framework for data management and decision support after the effort is done. There is often a strong reliance on qualitative data and expert opinion, with few criteria or standards for data inclusion. Data have been used both analytically (i.e., in formal analyses) and illustratively (for consultation and review but not in formal analyses) in the planning efforts.

To date most marine spatial plans developed dedicated databases or data portals for their efforts. However, there has been a rapid expansion in the development of data portals in the past few years by federal and state agencies, businesses and NGOs. NOAA alone is supporting dozens (likely hundreds) of data portals with few connections among them. Existing data are held by a variety of agencies at the federal and state level. Certain types of fine-scale spatial information in the United States are considered proprietary (e.g., fishing locations, data collected by companies in support of permit applications). There is no obvious mechanism or incentive for bringing these proprietary data layers into the planning process in a transparent way. These data should be important for representing areas of high value to certain users and other non-compatible spatial uses could be avoided if there was generalized information on critical areas (e.g., the U.S. Census Bureau generalizes household data in to census block groups, which are roughly comparable to zip code areas).

Data collection can take significant time and resources (even just gathering and organizing existing data), which can limit the time available for other important aspects of spatial planning. There are a couple of common reasons: (i) data are considered absolutely critical to robust and credible planning efforts, (ii) data compilation is 'safe' for scientists, decision-makers and other stakeholders because new decisions are not made and conflicts are avoided. There were indications that time spent on data gathering and collection limited the time spent on analysis and decision-making, at least in the Rhode Island, St. Kitts & Nevis, and Massachusetts plans. Data assembly and integration should not be at the cost of time needed for consultation and decision-making. However if the process moves to decision-making while relevant data are not integrated into the process, interests likely to be dissatisfied with a direction in which the process is headed could selectively bring forward only such additional information as suits their preferences. Alternatively they could try to discredit *any* decision as premature, because relevant information had not been considered fully.

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 (Beck et al. 2009). 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. 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 risk causing intrinsic biases in subsequent analyses.

E. Participants

The set of plans that we reviewed balanced various levels of government (federal, state, and local) and stakeholder driven approaches. Moving from planning to implementation, planning tends to devolve from federal to state to local government. There is a contrast between plans developed primarily by government agencies and those in which outside entities actively contributed to plan development. Planning efforts led by scientists, such as the first phases of the California MLPA and Belgium (Douvere et al. 2007) were not implemented. The California effort failed twice until (among other things), they developed interactive decision-support tools that enabled stakeholder participation (Weible 2008, Gleason et al. 2010, Sievanen et al. 2011)

Stakeholder involvement is considered critical to a successful outcome of marine spatial planning (Pomeroy and Douvere 2007). As noted above, stakeholder engagement was one of the top two most demanding steps in the plan development. There is a wide spectrum in how stakeholders are included: from largely public comment (e.g., Maryland) to active engagement of stakeholder groups in the use of decision support tools to identify spatial alternatives (California). This spectrum arises partly from the cultural and political norms for public participation in decision-making in different countries. Extensive stakeholder engagement appears to increase the time, effort and cost of planning (McCrea-Strub 2010). Recent plans have incorporated stakeholder input more quickly, but at substantial cost (Gleason et al. 2010). It is unclear as of yet whether extensive stakeholder engagement increases buy-in, feasibility or long-term success. Some plans appear to be successful with limited stakeholder engagement.

F. Decision Support-Tools

Most of the plans that we reviewed used at least some form of mapping tool to support the negotiation process. Four plans in Australia and America also used some form of quantitative index or decision-support tool. Decision-analysis tools should not be thought of as a mechanism for making the decision (Holland et al. 2010). The "optimal" solutions identified with decision support tools are seldom the ones selected for implementation. Instead, the outputs of the planning tools provide decision makers with a highly structured set of information to aid in decision-making and analysis. The use of decision-support tools is clearly growing and they are being used more effectively and becoming more user friendly. The value of structured decision-support tools tends to increase with the number of planning objectives and tradeoffs; in turn, the amount of data, technical challenges, and cost of tool implementation also appear to increase.

Two of the plans already use, or plan to use, benefit-cost analyses (BCA). In the CSMP context, BCA would include a description of the alternatives to be evaluated (e.g. zoning patterns, or mechanisms for spatial allocation of harvesting activities) and an evaluation of these alternatives relative to a baseline (e.g., status quo) using models that integrate the ecological and economic activities. Changes in zoning, for example, may affect commercial fishery harvesting patterns, populations and spatial patterns of aquatic species, and values associated with improvements in threatened species. A fully specified BCA would provide decision makers with the net benefits of each option, as well as a description of the distribution of benefits and costs over the region (Holland et al 2010). A set of impacts on ecosystems would also be presented as part of the analysis.

Full trade-off analyses (including clear benefits and costs) have yet rarely been used in MSP efforts to date, however many decision-support tools helped in assessing trade-offs. Some tools help in formally comparing the costs of alternatives through optimization approaches (e.g. MarZone (St. Kitts & Nevis), Marxan (GBRMP)) while others allow users to compare costs of different scenarions (e.g., MarineMap and precursors (California)). These approaches can capture spatial and temporal complexity and in some cases can include representations of the interaction between economic agents and biological factors. They provide information on the response of the system to changes in ecosystem condition, but often lack the ability to capture economic behavioral change that is necessary to conduct cost effectiveness analysis or BCA.

Most importantly, tools should be used together not in isolation. In the California MLPA, while there was a strong focus on stakeholder-designed plans through MarineMap, some parties used Marxan outputs to examine potential alternatives. MarZone is starting to be used in much the same way in other plans–to suggest alternatives to stakeholder or decision making groups. One can envision using BCA tools in addition to these as well to explore the cost and benefit of some of these alternatives developed through site selection tools and/or stakeholder processes.

When used effectively, tools can increase transparency because they require clarity in the data, targets, goals and issues are being considered (e.g., Beck et al. 2009, Gleason et al. 2010). Interactive decision-support software can capture, share, and compare many people's ideas about planning options; help people to understand the real-world implications of different management regimes and environmental conditions; and reveal trade-offs among possible management scenarios. However when used ineffectively, analytic decision-analysis approaches create the appearance that decisions are made by programs (in a black box) on subsets of information with little stakeholder input. Developers must continue to improve tools so that they are more user friendly and planning teams must clearly communicate how tools support decisions (not make them).

Opportunities exist to improve decision-support tools with the use of improved information (cost-effectiveness analysis, simulations, trade-off curves, and eventually forms of benefit-cost analysis). But doing so will require identifying causal relationships between economic sectors and ecosystems. The existing plans are inconsistent in the measurement of economic components, such as economic activity (jobs) and non-market values. Ecosystem services are frequently discussed but are rarely explicitly assessed in MSP; it appears that interest is high in these analyses and tools are catching up to that interest. Moving from conceptual to more operational objectives will allow for the increased use of quantitative decision-support tools. Market-based mechanisms for coordinated decision making could include trading spatial access, and auctions of permits (e.g. China) (Sanchirico 2004, Sanchirico et al. 2010).

G. Monitoring and Performance Measures

The products of coastal and marine spatial planning can range from structured processes for spatial decision making to maps that describe alternative approaches to spatial management. There is no one preferred product of these planning efforts. The US CMSP program is clearly intended as a spatial planning process that should inform future spatial management (CEQ 2010).

The proximate criteria for success are adoption of the plan and application of its policies for spatial decision making. However the ultimate criteria for success are whether ecological, social, and economic outcomes are improved with CMSP. Such criteria would involve determining indicators of the ecological (e.g. water quality), social (e.g. some measure of livelihood viability), and economic (e.g. kwh of electricity) objectives, then monitoring the indictors over time to see if they did indeed trend upward.

The existence of a legally-adopted planning structure helps to provide investment certainty for marine developers and users of ocean resources (Sanchirico 2004; Douvere 2008). A number of plans that address development uses (e.g., mining, alternative energy) were intended to reduce conflicts and shorten permitting times (North Sea, Massachusetts, Rhode Island). These proximate benefits (at least the permitting time and cost) would be comparatively easy to measure before and after plan implementation. Conflict is more difficult to measure, but it may be reflected in the numbers of permits denied, appealed, and legal cases.

In theory, success of CMSPs would be measured against a baseline (or counterfactual) in terms of their ability to meet pre-defined operational objectives. Ongoing monitoring programs would measure these indicators and the results would feed into rule-based management responses (Ehler and Douvere 2007). Such closed-loop feedback systems are common in forest and fisheries management. For example, catch control rules specify that the total allowable catch available for fishing changes automatically year to year based on the status of the fish stock

(Sanchirico and Holland 2006). Many marine spatial plans contain elements of passive adaptive management but do not yet have operational feedback between monitoring and decision-making nor structured decision rules. While adaptive management may be viewed as a future priority, an immediate benefit of a closed-loop feedback policy is that it can avoid irrevocable decisions about spatial uses. Stakeholder support may be increased if there is an agreed-on process for revising spatial decisions in response to new information.

FINDINGS AND RECOMMENDATIONS

Below we summarize findings under each of the major themes of Marine Spatial Planning. We then identify recommendations based on these findings. Given that we are a working group for NOAA's SAB, we focused our recommendations on areas where NOAA has key roles and responsibilities in CMSP. However, some of our recommendations reflect the fact that many aspects of MSP have to be developed through the National Ocean Council (NOC) where NOAA has a key role.

A. Objectives

Findings:
(A1). In general, the objectives of coastal and marine spatial planning do not differ from those of Ecosystem Based Management (EBM), except that the objectives of CMSP may be spatially explicit whereas those of EBM may or may not be.

(A2). The majority of plans started with largely conceptual objectives (e.g., conserve diversity, sustain fisheries). During the planning process, these objectives were made more operational and spatially explicit, often with the help of an independent panel of experts. The development of increasingly operational objectives, with indicators and reference levels, is a critical part of the planning process and fundamental to identifying outcomes and trade-offs.

Recommendations:
(A1) NOAA and the NOC should facilitate the crafting of clear objectives and identify a clear process to produce them (e.g., Gleason et al. 2010);

(A2) NOAA and the NOC should support the development of regional science and stakeholder teams that can help develop operational objectives and data needs early in the CMSP process;

(A3) NOAA and the NOC should facilitate the development of operational objectives with indicators and reference levels as part of the regional planning process.

B. Scope

Findings:
(B1). Most of the plans were developed with the intent to consider all uses, but few were truly comprehensive.

(B2). Plan development took from 1.5 – 29 years. The majority of plans were developed fairly recently (after 2002) and were usually completed in 2 years.

(B3). Plan revision intervals vary, but most plans have a planning interval from 2 to 5 years.

(B4). Federal and state governments funded the majority of the plans. Some plans were funded by a combination of governmental, private, and non-profit sources.

(B5) Typical costs were on the order of $US 1 million per year.

(B6). Spatial scale of the plans varied greatly. The majority of plans are at scales smaller than the ecosystem scale (as defined by Large Marine Ecosystems). The efforts that are larger or equal to ecosystem-scale, which are mainly national frameworks, are subdivided into smaller regions for the main planning efforts. In many efforts, planning and implementation was done at sub-regional scales. The US CMSP program's regional planning areas are larger than most of the existing spatial plans.

Recommendations:
(B1). NOAA and the NOC should recognize the trade-offs between costs and comprehensiveness.

(B2). Once regions make decisions about the number of objectives and planning areas, NOAA and the NOC should support robust and thorough data collection and stakeholder engagement across the selected scope even if these steps are especially demanding of time and resources.

(B3). NOAA and the NOC should investigate a variety of different opportunities to support plan development and implementation and should engage private and non-profit organizations.

(B4). The US planning regions are large compared with existing marine spatial plans; NOAA and the NOC should be supportive of sub-regional planning efforts.

C. Authority

Findings:
(C1). The legal basis of plans varied and included international, federal, and state driven plans.

(C2). A legal basis is a necessary but not sufficient condition for success of a plan. Plans that did not have a legal basis have not yet been implemented.

(C3). No institutional changes were made as part of creating the plans.

(C4). Plans are usually implemented by multiple agencies and often with assistance from outside groups and experts (e.g., advisory groups for monitoring).

(C5). Plans that were completed quickly typically had strict timelines identified in their legal mandates.

Recommendations:
(C1). To help ensure the success of CMSP, NOAA and the NOC should strive to increase the strength of the CMSP legal mandate.

(C2). NOAA and the NOC should preferentially support regions that offer clear planning timelines and deadlines.

(C3). NOAA and the NOC should partner with other federal, state, academic, private, and non-profit agencies and institutions to coordinate the development and implementation of CMSP.

D. Data

Findings:
(D1). Few of the CMSP efforts have a clear plan or framework for data management and data decision support after the effort is done.

(D2). Data have been used both analytically and illustratively in the planning efforts.

(D3). In all plans there is a strong reliance on qualitative data and expert opinion, with few standards for data inclusion.

(D4). Data have been have been collected across all the disciplines; however biological data are used more frequently and chemical data less frequently than other data types.

(D5) Recently developed plans (in particular those in the US) were completed on 2-year timelines largely with existing data.

(D6) Data compilation and assimilation efforts frequently dominated the initial stages of plan development, in terms of capacity, time and cost, likely to the detriment of the latter stages of the effort when plans are developed and decisions get made.

(D7) There has been a rapid expansion in the development of data portals in the past few years by federal and state agencies, businesses and NGOs. NOAA is supporting numerous portals with few connections between them.

(D8) Some important data on uses (e.g., fishing and energy) are proprietary and identify critical areas for these users.

Recommendations:
(D1). NOAA and the NOC should require a clear timeline and workplan for all phases of the MSP effort with benchmarks prior to funding. In particular, timelines should be set and adhered to for data gathering and compilation to allow sufficient time in the planning effort for analysis and decision-making.

(D2) NOAA and the NOC should recognize and budget sufficient time and capacity for data gathering and compilation.

(D3). NOAA and the NOC should ensure that scientific and technical expertise is available to the CMSP processes at all stages. This expertise should include the development of science advisory boards at the,

- National level - who should evaluate and disseminate technical guidance on elements such as types of data to include and their resolution and how to manage data portals and the connections between them;
- Regional level - to interpret and apply the guidance identified by the national group of experts, refer needs to the national group as they emerge, and address regional scientific and technical issues as appropriate (e.g. decisions on specific data sets).

(D4) NOAA and NOC should ensure that there is a clearly delineated process for data management after initial regional planning efforts.

(D5) NOAA should provide leadership and guidance in ensuring (i) that there is greater connection among its portals and (ii) that efforts are not duplicated among portals it supports.

E. Participants

Findings:
(E1). The majority of the plans were facilitated by government agencies, and other stakeholders were included in the planning process in all of the plans except for China's.

(E2). How stakeholders were defined and their participation varied greatly across all plans.

Recommendations:
(E1). NOAA and NOC should provide basic guidance to regions on stakeholder roles, responsibilities, and engagement strategies. These should be defined early in the process to avoid confusion..

F. Decision-support Tools

Findings:
(F1). Decision support approaches varied among plans, including: no use of explicit decision-analysis tools; reliance on negotiations; GIS-based mapping tools; quantitative indices; and explicit decision support tools. Most plans used a suite of decision-support approaches.

(F2). A number of decision-support tools used in planning processes (e.g., MarineMap, MarZone) help in the assessment of alternatives. No planning effort used benefit-cost analysis to consider whether CMSP is the preferred alternative for spatially managing uses in the marine and coastal environments. Rather benefit-cost analysis when used was to consider alternative plans for a subset of sectors.

(F3). Non-market economic values (ecosystem services) were rarely explicitly assessed, but the tools to include these values in decision-making are new(er) and growing rapidly.

(F4). Risk and uncertainty are implicitly addressed in most of the plans, but only one plan addressed these explicitly.

(F5). Of the plans that explicitly use decision-support tools, only half have a strategy for updating and improving their tools based on monitoring and evaluation.

(F6). Conflict resolution was only addressed in half of the plans and methods for resolution ranged from negotiated agreement among the experts, to formal steps established by international conventions, to resolution through permitting.

Recommendations:
(F1). NOAA and the NOC should provide guidance on best practices for the use of decision support tools; there is a growing body of lessons learned and best practices available from recent planning efforts.

(F2) NOAA and the NOC should support the development of decision support tools and in particular the connections among tools; most plans used more than one tool.

(F3). NOAA and the NOC should support the development of more explicit trade-off analysis tools.

(F4). NOAA and the NOC should support the training and development of researchers who can use and develop these tools.

G. Monitoring and Performance Measures

Findings:
(G1). The successful end result of MSP efforts ranged from the development of a structured process for future spatial management decisions to the identification and implementation of these spatial management decisions.

(G2). The majority of the plans do not have formal metrics of success. The proximate criteria for success are adoption of the plan and application of its policies for spatial decision-making. However the ultimate criteria for success are whether ecological, social, and economic outcomes are improved with CMSP.

(G3) A number of plans that address development uses (e.g., mining, alternative energy) were designed at least in part to reduce conflicts and ease permitting. These outcomes could be explicitly measured.

(G4). Most of the plans incorporate monitoring and most of these plans will incorporate feedback from monitoring into plan revisions but none of the plans specify *how* management should responsd to monitoring. .

Recommendations
(G1). NOAA and the NOC should require plans to explicitly state what constitutes success.

(G2). NOAA and the NOC should require plans to develop formal metrics of success.

(G3) NOAA and the NOC should identify permitting time and costs as useful metrics for gauging the results of CMSP efforts; they should undertake efforts now to gather information on some current permitting times and costs ahead of regional CMSP efforts. This effort would clearly indicate to stakeholders that CMSP aims to address economic concerns in addition to ecological ones.

(G4) NOAA and the NOC should develop performance metrics for social and economic outcomes in addition to ecological outcomes of CMSP.

(G5). NOAA and the NOC should require that feedback from the monitoring of success metrics be utilized for plan revision.

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