

**Assessment of Spatial Analysis Tools in Support of the
Southeast Florida Coral Reef Initiative (SEFCRI)
Management Options Identification Process (MOIP)**

Florida Department of Environmental Protection
Coral Reef Conservation Program
Project 26A Part 3 Task 1



Assessment of Spatial Analysis Tools in Support of the Southeast Florida Coral Reef Initiative (SEFCRI) Management Options Identification Process (MOIP)

Final Report

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Purpose:

The purpose of this project was to assist the Florida Department of Environmental Protection Coral Reef Conservation Program (FDEP CRCP) staff members, who oversee the Southeast Florida Coral Reef Initiative (SEFCRI) teams and projects, by providing a professional assessment of various spatial analysis tools for SEFCRI's *Our Florida Reefs: Your Voice, Our Future* process (originally Management Option Identifications Process).

Introduction to the Southeast Florida Coral Reef Initiative:

In 2002, the U.S. Coral Reef Task Force (USCRTF) adopted the "Puerto Rico Resolution" which called for the development of Local Action Strategies (LAS) by each of its seven member U.S. states, territories and commonwealths. These LAS are locally-driven roadmaps for collaborative and cooperative action among federal, state, territory and non-governmental partners, which identify and implement priority actions needed to reduce key threats to valuable coral reef resources.

The goals and objectives of the LAS are linked to those found in the U.S. National Action Plan to Conserve Coral Reefs, adopted by the USCRTF in 2000. From the thirteen goals identified in the National Action Plan, the USCRTF prioritized six threat areas as the focus for immediate local action: over-fishing, land-based sources of pollution, recreational overuse and misuse, lack of public awareness, climate change, and coral bleaching and disease. Additional focus areas were identified in some jurisdictions; and for Florida, the impacts of the maritime industry and coastal construction were added.

With this guidance from the USCRTF, the FDEP and the Florida Fish and Wildlife Conservation Commission (FWC) coordinated the formation of a team of marine resource professionals (state, regional, and federal), scientists, non-governmental organization representatives, and other coral reef stakeholders. This team, named the Southeast Florida Coral Reef Initiative (SEFCRI) Team, gathered to develop local action strategies targeting coral ecosystems from Miami-Dade County through Broward, Palm Beach, and Martin counties. This region was chosen because its reefs are close to an intensely developed coastal region, with a large and diverse human population. Prior to the development of the SEFCRI, there was no coordinated management plan proposed for reefs located north of the Florida Keys and Biscayne National Park.

Led by the FDEP CRCP, the SEFCRI is targeting four focus areas that address threats to coral reef ecosystems. The four focus areas are: (1) Land-Based Sources of Pollution (LBSP), (2) Maritime Industry and Coastal Construction Impacts (MICCI), (3) Fishing, Diving, and Other Uses (FDOU), and (4) Awareness and Appreciation (AA). The SEFCRI Team is comprised of four focus teams, one for each focus area, whose members are working with the FDEP CRCP to develop and implement LAS projects. The project described in the following overview was developed from the outcomes of a FDOU focus area project.

Project Overview/Background:

Under the FDOU Focus Area, the SEFCRI Team identified projects that would engage local stakeholders in making management recommendations to the appropriate agencies for improved conservation of southeast Florida coral reefs. These projects are part of a 10-step process, recently branded as Our Florida Reefs (OFR), which includes stakeholder working groups and a series of public meetings. Step 2 of the process, was the formation of a Process Planning Team (PPT), dedicated to planning the details of each additional step in the OFR. The PPT has identified the need for a mapping and spatial analysis program or application throughout the decision making process to allow for visual representation of data and information to all stakeholders, to allow for surveying of stakeholders, to provide working group members with a tool to conduct real-time analysis and planning, to model potential outcomes of different management options, and for other needs that may arise throughout the OFR process.

There are several software and web based applications, already developed, that may provide the support required for the OFR process. An expert assessment of the functionality and usability of these complex applications is necessary in order to choose the program best suited to meet the needs of the OFR process. This should include an assessment of the ability to incorporate various local datasets, run smoothly on various operating systems, run smoothly on various devices, ease of use for stakeholders and citizens not familiar with mapping or spatial analysis programs, usability and understandability of product outputs for the OFR, probable amount of time required for upkeep and maintenance, cost, and any other needs or parameters identified by the PPT. The PPT and FDEP CRCP will use this assessment and recommendation to select the most appropriate spatial analysis tool for the OFR.

Methodology

A comprehensive assessment of all available decision support tools (DSTs) was not possible in the given timeframe and budget; therefore, this work built off of a previous assessment published in 2011 by the Center for Ocean Solutions (COS) called “Decision Guide: Selecting Decision Support Tools for Marine Spatial Planning.” This document provided a summary of information gathered over several years from multiple workshops with many DST developers and practitioners in attendance. It was created specifically to inform practitioners in selecting appropriate DSTs to conduct marine spatial planning in their own jurisdictions. Six critical DST functional elements were identified and expanded upon to include more specific functions that may be important for addressing particular objectives. All of these functions were arranged in a matrix to allow for comparison between different DSTs so practitioners can decide which tool best suits their specific needs.

We used the COS decision guide to derive a survey for the Process Planning Team (PPT) (Appendix 1) to rank the importance of each specific tool function in the guide’s tool matrix and add any additional functionality they felt missing from the COS. The mean PPT rating for each question were tabulated and placed in the tool function matrix table to weight each function by the PPT’s rated importance (Appendix 2). For example, the mean score for Data Provisioning was 4.2. Only the tools providing that function (e.g., ARIES, Coastal Resilience) received a 4.2

in the corresponding matrix cell and the others received a 0 (e.g., Atlantis, MarineMap). Once the tool function matrix was filled with the PPT scores, each column was summed to give a total score for each tool. Mean scores were also tabulated for each critical DST functional element (section headers in Appendix 1) to understand which ones the PPT ranked most important for the SEFCRI marine spatial planning process. Two more recent tools were not originally assessed by the Center for Ocean Solutions, Seasketch and Ecotrust/MARCO (named Ecotrust here forward). Seasketch developers were asked to fill out the tool survey in terms of what specific functions Seasketch performs. Ecotrust tool was given full functionality (every box checked) because it is fully customizable to suit the user's needs.

Results

We received 13 out of 18 responses from the PPT, equating to 72% participation. Of the six critical functional elements, the PPT scored Mapping and Visualization the highest followed by Stakeholder Participation and Collaboration, and Community Outreach (Figure 1). Therefore these functions were viewed as most important for the final OFR decision support tool. Data Management received the lowest scores, and therefore was not as high a priority in the OFR DST functionality.

Of the eleven tools assessed Seasketch and Ecotrust received the highest scores (Figure 2). Aries, InVEST, and MIMES also scored high. Atlantis, Multipurpose Marine Cadastre, and Marxan with Zones received the lowest scores. Aries, InVEST, and MIMES had much of the functionality listed in the tool matrix which gave them their high scores. However, they were all lacking in one or more of the important functions within Stakeholder Participation and Collaboration, Community Outreach critical functional element, including User Collaboration, Comment, and Communication, and Participatory Interface. Since this critical functional element ranked second highest among the OFR PPT, it was decided that these tools did not perform some of the most desired functions and were therefore not considered further.

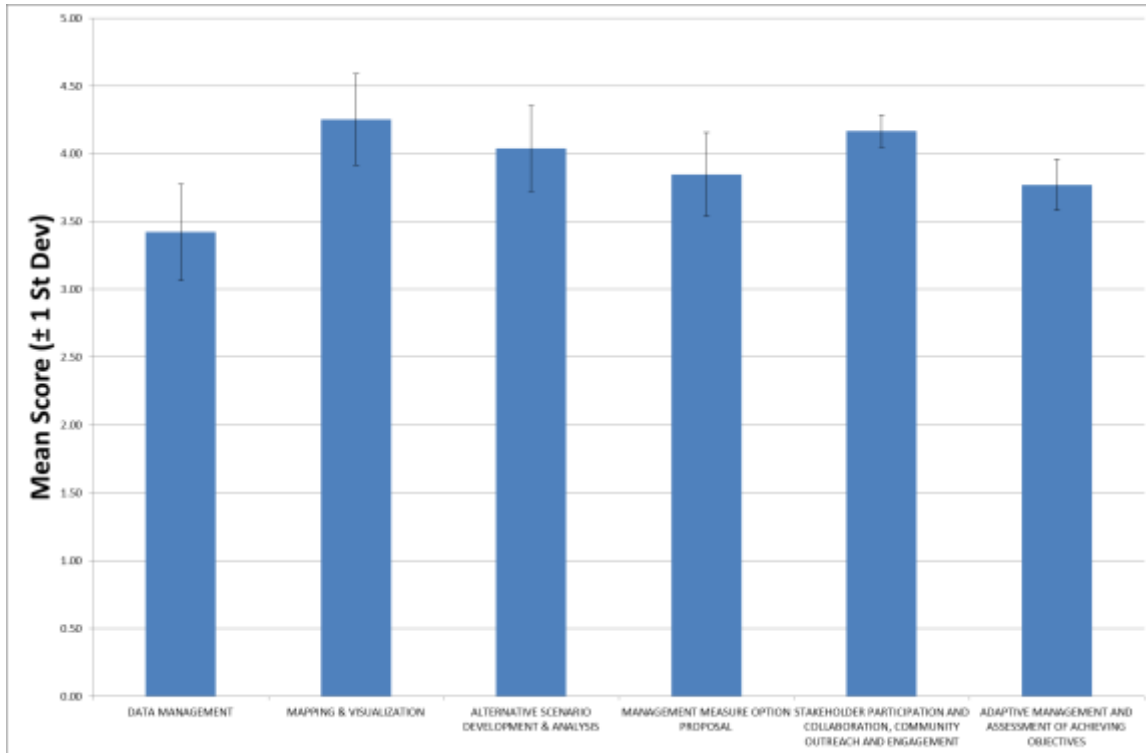


Figure 1. Mean PPT survey scores for the Center for Ocean Solution’s six critical functional decision support tool elements. Error bars represent one standard deviation.

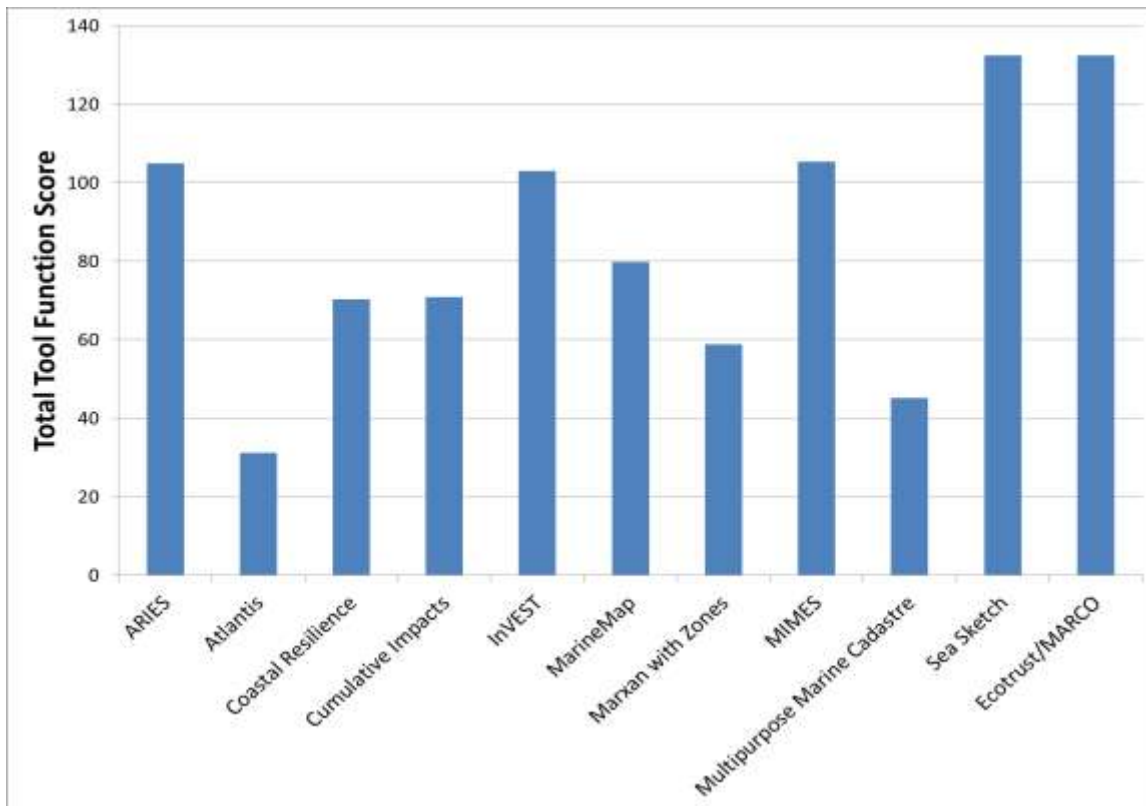


Figure 2. Total tool function survey scores of the eleven assessed decision support tools.

Discussion

Seasketch and Ecotrust received the highest scores possible. Seasketch developers claimed that it can perform every function in the matrix including all of the functions in the most critical functional elements. Ecotrust was given full functionality in this assessment as well because it is fully customizable based on the PPT and stakeholder working group's preferences. This was not surprising because both Ecotrust and Seasketch developers worked together during the California Marine Life Protection Act Initiative to create MarineMap (Merrifield et al., 2013). Since these tools scored the highest and contain (or could contain) all the functionality in the tool matrix, it is recommended that they be given the most consideration for use as the chosen OFR DST.

Both Seasketch and Ecotrust gave presentations to the PPT and smaller planning groups to give a better understanding of their capabilities. Seasketch has undergone significant research and development (R & D) over the past few years. This R & D equates to a huge amount of development time. Seasketch provides all the functionality in the tool matrix survey and out-scored all but one (Ecotrust) working tool in our evaluation. Seasketch provides excellent functionality on stakeholder participation and collaboration and community outreach. Users' activities are tracked and collaboration among and between user groups is instantly available to determine which groups are active and how much communication is occurring between them. This could be beneficial in reducing project management time and providing valuable information to help direct OFR efforts to ensure and promote collaboration between user groups. It also has an experienced, dedicated staff to support and resolve any technical problems and is constantly being updated based on user recommendations and new developments.

Similar to Seasketch, Ecotrust is able to provide the full functionality required for the OFR. They have extensive experience conducting marine spatial planning throughout the US. Ecotrust's role in these processes is varied depending on the need of the sponsor. This flexibility is beneficial to the OFR where Ecotrust can be hired as the DST tool provider and an advisory consultant on the OFR process. They have many customizable DST modules to employ and can advise the PPT as to what has worked in past efforts. These modules can be added to the website at the appropriate stage in the process so not to confuse the user with unneeded functionality at the beginning of the process. And depending on data preparation and hosting, a data portal can be online in a week's time, an important aspect given the short timeline of this project. Similar to Seasketch, Ecotrust has user management options to track users and their efforts, allowing the program manager to manage user accounts, user access, and track individual activities.

Because these two DST options (Ecotrust and Seasketch) were so similar in functionality, other key considerations were taken into account (Figure 3).

One important need of the OFR DST will be soliciting stakeholders for their information on use and demographics. Although both tools have survey capabilities, Seasketch's tool is beta testing in March 2013, while Ecotrust has done this many times in the past. It is unclear if Seasketch's survey tool has been used before, but Ecotrust appears to out-weigh Seasketch in survey experience. Furthermore, Ecotrust can develop the survey and provide data analyses of the results as part of their role. This would be very beneficial to the OFR.

	Ecotrust	Seasketch
Provided all functionality in tool comparison survey	X	X
Survey tool and experience	X	
Fully customizable	X	
Low long-term cost	X	
Spatial Bibliography Integration	X	
Integrating with other regional CMSP efforts (e.g., GSAA RIMS)	X	

Figure 3. Side-by-side comparison of other DST key considerations.

The OFR requires a customizable, flexible, and adaptable user experience. Seasketch is a program that has set functionality and does not have this flexibility. Ecotrust is a group that will customize a DST specifically for the OFR based on the OFR’s needs. This is a huge asset because functionality can be customized at any point during the process. This allows adaptation of the tool during the process based on user’s experience and the specific needs of the working groups. For example, one aspect that will set this process apart from others is the incorporation of a spatial bibliography, where a user can highlight an area and receive all relevant publications associated with it. NOAA is currently building the spatial bibliography framework, which we hope to incorporate into the DST. This would not be possible with the present version of Seasketch.

Another fundamental requirement is the continued availability of the OFR database and web portal after the OFR process is complete. Ideally, using adaptive management strategies, the effort and funding used to develop the OFR web portal will be used in future CMSP efforts. Seasketch is a software that must be paid for and maintained. It will cost between \$5,000 and \$9,000 to maintain a license of Seasketch software, allowing the data portal and all the project components to function past the project’s end (not including additional costs to host the web application and data). Ecotrust has no software license maintenance fee associated with it. The potential for future grant funding to support a software license is uncertain, and therefore Ecotrust fulfills this requirement.

Although both tools have similar functionality, only Ecotrust meets the requirements and is capable of supporting the OFR objectives. Ecotrust provides all of the functionality rated to be most important by the PPT and has extensive experience in conducting CMSP efforts. This experience can be used in an advisory capacity to help guide the OFR throughout. The flexibility and customizability of the DST tools will be advantageous and help focus stakeholder and user groups on specific tasks. Their survey development and analyses will cut costs by saving time and reducing mistakes while acquiring the data needed for the working groups. And the open-source software model will reduce web application costs in perpetuity thus allowing cost-effective long-term use of the data portal and real-time analyses.

Literature Cited

Center for Ocean Solutions. 2011. Decision Guide: Selecting Decision Support Tools for Marine Spatial Planning. Stanford University, California: The Woods Institute for the Environment.

Merrifield MS, McClintock W, Burt C, Fox E, Serpa P, Steinback C, Gleason M. 2013. MarineMap: A web-based platform for collaborative marine protected area planning. *Ocean & Coastal Management* 74:67-76

Appendix 1. Marine Spatial Planning Tool Survey

The purpose of this survey is to provide a professional assessment of various spatial analysis tools for the SEFCRI Management Options Identification Process (OFR). This questionnaire, prepared for the PPT, is designed to identify the potential needs from a decision-making spatial analysis tool to aid in the OFR. The criteria include data management, ease of stakeholder use, analysis potential, usability of outputs, and stakeholder engagement. It will be used to assess existing software and web based spatial analysis tools and to recommend the most appropriate tool based on this assessment.

The questions below will serve as a guide when evaluating the functionality of the marine spatial planning tools to be assessed and the relative importance of that functionality to the management options process. Please rank how important each criteria is when evaluating the tool on a scale from 1-5 (1 being very important, 5 being least important). Topic headings are for organizational purposes only. These questions were derived from the Decision Guide: Selecting decision support tools for marine spatial planning by the Center for Ocean Solutions, The Woods Institute for the Environment, Stanford University, California.

...for the tool to provide data to the user?	
...for the tool to assess the quality of the available data?	
...for the tool to allow the stakeholder to upload and archive their data?	
...for the tool to set standards and protocols for data compilation and intercalibration?	
MAPPING AND VISUALIZATION	
Spatial	
...for the tool to provide a visually pleasing display of physical characteristics of an area such as basemaps, bathymetry, depth, temperature etc.?	
...for the tool to provide a visually pleasing display of biological info such as the distribution of relevant species and habitats?	
...for the tool to show the distribution and location of ecosystem goods and services that are provided?	
...for the tool to include seasonal species distribution, oceanographic conditions, and time series data?	
...for the tool to include vulnerability of ecosystems to future changes including new uses, cumulative impacts, and climate change?	
...for the tool to show existing or proposed human uses or activities including the footprint of activities and value of those uses?	
...for the tool to display incompatible activities and/or impacts to ecosystems, natural resources, or particular uses?	
...for the tool to provide legal and jurisdictional information including marine protected areas, essential fish habitat, or shipping safety measures?	
Non-spatial	
...for the tool to include graphical displays of analyses including percentage of planning area with overlapping uses, threat values for activities, emoticons, (thumbs up/thumbs down)?	
...for the tool to include text-based displays of analyses, including lists of uses, species, or habitats that occur in planning area, amount of overlap of uses or area of incompatibility?	

ALTERNATIVE SCENARIO DEVELOPMENT AND ANALYSIS	
...for the tool to assign value to the amount and type of ecosystem services delivered under different management scenarios?	
...for the tool to assess trade-offs under different management scenarios?	
...for the tool to assess impacts of individual as well as multiple activities to ecosystems?	
...for the tool to provide visual context for different planning options to help stakeholders visualize the array of possible planning scenarios?	
...for the tool to allow stakeholders to calculate the best returns for defined planning objectives?	
...for the tool to provide reports, maps, or other forms of information that show users whether a proposal meets one or more plan objectives?	
...for the tool to be capable of modeling future scenarios?	
...for the tool to give stakeholders a sense of the risk and uncertainty associated with each scenario?	
...for the tool to assess the sensitivity of models, including the amount and scale of data?	
MANAGEMENT MEASURE OPTION PROPOSAL	
...for the tool to allow the stakeholder to propose and/or analyze siting locations, permit conditions, or mitigation measures for specific projects?	
...for the tool to allow the stakeholder to propose and/or analyze area-based management measures based on compatibility with other uses and the ecosystem?	
STAKEHOLDER PARTICIPATION AND COLLABORATION, COMMUNITY OUTREACH AND ENGAGEMENT	
...for the tool to allow the stakeholder to discover information through data queries and map layers?	
...for the tool to allow interaction with it both on the stakeholders' own time (web-based) and during meetings (desk-based)?	
...for the tool to incorporate local and traditional knowledge about the location of uses or resources in the area?	
...for the tool to allow iterative feedback to the tool developers so that the users can shape the format and type of outputs of the tool?	
...for the tool to allow stakeholders to share proposals with other stakeholders and collaborate on a project?	
ADAPTIVE MANAGEMENT AND ASSESSMENT OF ACHIEVING OBJECTIVES	
...for the tool to allow the stakeholder to compare initial conditions with conditions under a proposed management plan to assess plan effectiveness?	
...for the tool to allow the stakeholder to test assumptions in original scenarios and change model parameters as needed if management measures are not achieving the objectives?	
...for the tool to allow the stakeholder to generate reports, graphs, and maps to illustrate progress, or lack thereof, toward objectives?	

Appendix 2. Tool function matrix adapted from the COS Decision Guide (p. 24) with mean survey scores for each function the tool provides.

DATA MANAGEMENT	ARIES	Atlantis	Coastal Resilience	Cumulative Impacts	InVEST	Marine Map	Marxan with Zones	MIMES	Multipurpose Marine Cadastre	Sea Sketch	Ecotrust/MARCO	MEAN CRITERIA VALUES
Does the tool provide data to the user?	4.00		4.00	4.00	4.00			4.00	4.00	4.00	4.00	4.00
Does the tool assess the quality of the available data?	3.08									3.08	3.08	3.08
Does the tool allow the stakeholder to upload and archive their data?	3.42		3.42	3.42				3.42	3.42	3.42	3.42	3.42
Does the tool set standards and protocols for data compilation and intercalibration?			3.18					3.18	3.18	3.18	3.18	3.18
MAPPING AND VISUALIZATION												
Spatial												
Does the tool provide a visually pleasing display of physical characteristics of an area such as basemaps, bathymetry, depth, temperature etc.?	4.42		4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42
Does the tool provide a visually pleasing display of biological info such as the distribution of relevant species and habitats?	4.75		4.75	4.75	4.75	4.75		4.75	4.75	4.75	4.75	4.75
Does the tool show the distribution and location of ecosystem goods and services that are provided?	4.33				4.33			4.33		4.33	4.33	4.33
Does the tool include seasonal species distribution, oceanographic conditions, and time series data?	4.00		4.00		4.00	4.00		4.00		4.00	4.00	4.00
Does the tool include vulnerability of ecosystems to future changes including new uses, cumulative impacts, and climate change?	4.08		4.08	4.08	4.08			4.08		4.08	4.08	4.08
Does the tool show existing or proposed human uses or activities including the footprint of activities and value of those uses?	4.50		4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50	4.50
Does the tool display incompatible activities and/or impacts to ecosystems, natural resources, or particular uses?	4.33		4.33	4.33	4.33	4.33	4.33	4.33	4.33	4.33	4.33	4.33
Does the tool provide legal and jurisdictional information including marine protected areas, essential fish habitat, or shipping safety measures?	4.58		4.58	4.58		4.58			4.58	4.58	4.58	4.58
Non-spatial												
Does the tool include graphical displays of analyses including percentage of planning area with overlapping uses, threat values for activities, emoticons, (thumbs up/thumbs down)?	4.00	4.00			4.00	4.00		4.00		4.00	4.00	4.00
...for the tool to include text-based displays of analyses, including lists of uses, species, or habitats that occur in planning area, amount of overlap of uses or area of incompatibility?	3.54	3.54				3.54		3.54		3.54	3.54	3.54
ALTERNATIVE SCENARIO DEVELOPMENT AND ANALYSIS												
...for the tool to assign value to the amount and type of ecosystem services delivered under different management scenarios?	3.92	3.92			3.92					3.92	3.92	3.92
Does the tool assess trade-offs under different management scenarios?	4.33	4.33			4.33	4.33	4.33	4.33		4.33	4.33	4.33
Does the tool assess impacts of individual as well as multiple activities to ecosystems?	4.25	4.25	4.25	4.25	4.25	4.25		4.25		4.25	4.25	4.25
Does the tool provide visual context for different planning options to help stakeholders visualize the array of possible planning scenarios?			4.67	4.67	4.67	4.67	4.67	4.67		4.67	4.67	4.67
Does the tool allow stakeholders to calculate the best returns for defined planning objectives?							4.17	4.17		4.17	4.17	4.17
Does the tool provide reports, maps, or other forms of information that show users whether a proposal meets one or more plan objectives?		3.85		3.85	3.85	3.85	3.85	3.85		3.85	3.85	3.85

Appendix 2. continued.

ALTERNATIVE SCENARIO DEVELOPMENT AND ANALYSIS (CONT.)	ARIES	Atlantis	Coastal Resilience	Cumulative Impacts	InVEST	Marine Map	Marxan with	MIMES	Multipurpose Marine Cadastre	Sea Sketch	Ecotrust/MARCO	MEAN CRITERIA
Is the tool capable of modeling future scenarios?	3.75	3.75	3.75		3.75			3.75		3.75	3.75	3.75
Does the tool give stakeholders a sense of the risk and uncertainty associated with each scenario?	3.75		3.75		3.75					3.75	3.75	3.75
Does the tool assess the sensitivity of models, including the amount and scale of data?								3.67		3.67	3.67	3.67
MANAGEMENT MEASURE OPTION PROPOSAL												
Does the tool allow the stakeholder to propose and/or analyze siting locations, permit conditions, or mitigation measures for specific projects?	3.54			3.54	3.54			3.54	3.54	3.54	3.54	3.54
Does the tool allow the stakeholder to propose and/or analyze area-based management measures based on compatibility with other uses and the ecosystem?				4.15	4.15	4.15	4.15	4.15		4.15	4.15	4.15
STAKEHOLDER PARTICIPATION AND COLLABORATION, COMMUNITY OUTREACH AND ENGAGEMENT												
Does the tool allow the stakeholder to discover information through data queries and map layers?	4.25		4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25	4.25
Does the tool allow interaction with it both on the stakeholders' own time (web-based) and during meetings (desk-based)?	4.17		4.17	4.17	4.17	4.17	4.17		4.17	4.17	4.17	4.17
Does the tool incorporate local and traditional knowledge about the location of uses or resources in the area?	4.33			4.33	4.33	4.33	4.33	4.33		4.33	4.33	4.33
Does the tool allow iterative feedback to the tool developers so that the users can shape the format and type of outputs of the tool?	4.08		4.08		4.08	4.08	4.08	4.08		4.08	4.08	4.08
Does the tool allow stakeholders to share proposals with other stakeholders and collaborate on a project?	4.00				4.00	4.00	4.00			4.00	4.00	4.00
ADAPTIVE MANAGEMENT AND ASSESSMENT OF ACHIEVING OBJECTIVES												
Does the tool allow the stakeholder to compare initial conditions with conditions under a proposed management plan to assess plan effectiveness?	4.00				4.00			4.00		4.00	4.00	4.00
Does the tool allow the stakeholder to test assumptions in original scenarios and change model parameters as needed if management measures are not achieving the objectives?								3.77		3.77	3.77	3.77
Does the tool allow the stakeholder to generate reports, graphs, and maps to illustrate progress, or lack thereof, toward objectives?	3.54	3.54		3.54	3.54	3.54	3.54			3.54	3.54	3.54
TOTAL SCORES	104.9	31.2	70.2	70.8	103.0	79.7	58.8	105.4	45.1	132.4	132.4	132.4