MARINE PROTECTED AREAS TECHNOLOGY NEEDS ASSESSMENT

FINAL REPORT

December 2003

Prepared by the NOAA Coastal Services Center in Cooperation with the National Marine Protected Areas Center.

NOAA Coastal Services Center
LINKING PEOPLE, INFORMATION, AND TECHNOLOGY

This document should be cited as follows:
National Oceanic and Atmospheric Administration's Coastal Services Center, in cooperation with the National Marine Protected Areas Center. Marine Protected Areas Technology Needs Assessment, Final Report. Charleston, SC: Coastal Services Center, 2003.

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EXECUTIVE SUMMARY

During the period from March 2003 to July 2003, the National Marine Protected Areas (MPA) Center's Training and Technical Assistance Institute, housed at the National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center, conducted a technology needs assessment. The assessment aimed to gather information on MPA-related applications of technology and to gauge technical capacity within the marine management community. The results will guide the National MPA Center, the Coastal Services Center, and other assistance providers as they design services and products to support U.S. marine protected areas.

Methodology
Although several sources contributed to the overall conclusions of the needs assessment, a series of phone interviews served as the primary source of information. The interviews were conducted with coastal managers, scientists, and technology specialists from federal and state entities involved with MPA management or enforcement activities. Interviewees were asked to identify and discuss three high-priority management issues that could be addressed through the application of technology.

Results
Priority issues identified by those interviewed fall into three main categories: marine habitats, enforcement and boundaries, and monitoring the marine environment. Respondents specifically noted the need for benthic habitat maps and more useful benthic data (e.g., proper scale, improved spatial coverage); technologies to improve enforcement, such as on-board chart-viewing software, vessel monitoring systems, and basic equipment such as radios and cell phones; and the application of monitoring data to MPAs. The interviews also identified a need for tools that are able to convert critical information and data (both from natural and social science) into formats, such as geographic information system (GIS) maps, that are palatable to core constituencies. In addition to these materials, interactive decision-support tools and visualization technologies were noted as effective mechanisms to communicate potential impacts of a proposed activity and to engage local user groups in the decision-making process.

The assessment also determined that, rather than simply focus on the creation of more training and more data, MPA-related technical assistance must consider methods to increase the utility of existing resources. Respondents indicated that training would be more effective if it were to incorporate time for students to use their own data and if training were coordinated regionally to foster a greater level of consistency in data creation and sharing. Regional coordination related to data standardization and access is also needed.

Recommendations
The needs assessment has identified a number of technology needs that the National MPA Center, the NOAA Coastal Services Center, and other training and technical assistance providers should begin to address. The process of addressing these needs should begin with

- Expanding technology use in MPAs,
- Communicating the pros and cons of the variety of available benthic mapping technologies,
- Acquiring data that can be used to improve modeling efforts,
- Utilizing technology applications to address social and natural sciences,
- Improving accessibility of data and training,
- Continuing and expanding efforts to utilize historical data sets, and
- Evaluating the utility of existing tools and trainings.

INTRODUCTION

Executive Order No. 13158 on Marine Protected Areas (MPAs)

> *This Executive Order will help protect the significant natural and cultural resources within the marine environment for the benefit of present and future generations by strengthening and expanding the Nation's system of marine protected areas (MPAs). . . . For the purposes of this order: (a) "Marine protected area" means any area of the marine environment that has been reserved by Federal, State, territorial, tribal, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein.*
>
> – President William J. Clinton, May 2000

Signed in May of 2000, Executive Order No. 13158 calls upon federal, state, local, and tribal governments and the private sector to work together to strengthen the protection of U.S. ocean and coastal resources.

To help fulfill this task, the order directs the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA), working in partnership with the Department of the Interior (DOI), to establish a National Marine Protected Areas Center to provide the science, tools, and strategies to help build a national system of MPAs. Located in Silver Spring, Maryland, the National MPA Center will help build and support partnerships, fostering cooperation among and providing assistance to a range of governmental and nongovernmental entities working to develop, evaluate, and sustain a national MPA system.

In addition to the National MPA Center, two supporting institutes were formed to broaden both the technical expertise and the geographic representation of MPA efforts. The National MPA Center's Science Institute is located in Santa Cruz, California, and the National MPA Center's Training and Technical Assistance (TTA) Institute is located at the NOAA Coastal Services Center in Charleston, South Carolina.

<u>Overarching Goals</u>
The MPA executive order calls for a "scientifically based, comprehensive national system of MPAs representing diverse U.S. marine ecosystems, and the Nation's natural and cultural resources." The National MPA Center is charged with supporting such a network of federal, state, and tribal sites by providing assistance to existing MPAs and by supporting efforts to create a more comprehensive and coordinated set of protected areas. The order does not create any new authority for establishing protected areas; rather, the MPA Center operates within the context of existing legislation with public and private partners to enhance and coordinate marine management. As MPA efforts around the country develop and grow, the MPA Center will add value as an entity that fosters coordination, supports needed research and education, and provides tools, training, and technical assistance.

Within the National MPA Center, the two supporting institutes are designed to develop and provide specialized assistance and expertise. The Science Institute is addressing both natural and social science issues and needs. The institute supports a range of activities, including direct ecological and socioeconomic research, expert workshops, and policy analyses of resource threats and user conflicts. With the help of scientists from all over the country, the institute is in the process of creating strategies for natural and social science in order to prioritize research questions and identify entities that may be able to conduct needed studies.

The TTA Institute is working to provide resource managers with skills, products, and processes related to MPAs. Assistance may take the form of a customized technology tool, issue-based education modules, training in process skills (e.g., facilitation), or training in the use and application of geographic information system (GIS) and remote sensing technologies. The institute provides direct training and technical assistance and operates as a referral service to connect managers and other stakeholders with a network of organizations and individuals that offer MPA-related assistance and expertise. This "network of service providers" will broaden the range of assistance that can be provided and ensure that efforts are not duplicated.

As the National MPA Center and institutes move forward to put these ambitious goals into action and to continue creating products and services, it is essential that efforts be prioritized to address true and pressing needs of the MPA community. Given limited resources, the MPA Center must identify critical issues and challenges that cut across MPA efforts. To this end, the NOAA Coastal Services Center, as the National MPA Center's Training and Technical Assistance Institute, initiated an overall MPA needs assessment in 2001.

The Marine Protected Areas (MPAs) Needs Assessment (Completed March 2002)
During the period from May 2001 to February 2002, the NOAA Coastal Services Center conducted an initial needs assessment to support the newly created National MPA Center. The assessment aimed to identify information, skills, tools, and processes needed to foster effective MPAs. The results of the needs assessment guide the National MPA Center as it designs products and services to support a national network of MPAs.

The objectives of the initial needs assessment were to 1) identify overall challenges surrounding MPA management, as well as specific gaps in existing knowledge and skills of marine resource managers regarding key MPA issues; 2) determine attitudes, motivations, and disincentives that could impact managers' capacity to benefit from new information, training, or technical assistance; 3) identify subgroups of MPA managers that may benefit most from information, training, and technical assistance; and 4) identify formats and distribution methods that will maximize the utility of information, products, and services.

The executive summary of the needs assessment is located in Appendix B, and the full text is available at *www.csc.noaa.gov/cms/cls/MPANAFINAL.pdf*. The results are organized under three broad headings: 1) MPA-related policy and legal issues/responsible authorities, 2) MPA-related science and technology, and 3) MPA program implementation. Technology needs came up repeatedly in this first assessment; therefore, in an effort to better define and expand upon the broad technology topics identified, the TTA Institute initiated a technology needs assessment that focused specifically on technology needs within the MPA community.

The Marine Protected Areas (MPAs) Technology Needs Assessment
Goal and Objectives of the Technology Needs Assessment
The goal of the technology needs assessment was to gather information on MPA-related applications of technology, to gauge technical capacity within the marine management community, and to evaluate associated needs. The results will guide the National MPA Center and supporting institutes as they design services and products to support a national network of MPAs. In particular, this assessment will enhance the TTA Institute's ability to design and deliver technology-related assistance in a manner that is most useful to MPA managers.

The technology needs assessment followed two primary lines of inquiry:

1) Current applications of technology in MPA planning, implementation, and evaluation; and
2) Technology-related capacity within the management community (i.e., hardware, software, and expertise.

Target Audience

As with the initial needs assessment, marine resource managers were the target audience, but other groups may also find the information within this report useful. The assessment focused on identifying the technology needs of on-site managers and their staffs, as well as state, regional, and federal managers working to coordinate and enhance MPA efforts. While managers themselves can provide direct insight into these needs, consulting with other MPA stakeholders and technology experts led to additional ideas and provided a forum for the proposal of new possibilities for technology applications that managers might not have considered.

Sources of Information

The assessment utilized a variety of information sources, including interviews with state coastal and marine management agencies, Department of Interior park and refuge managers, Department of Commerce sanctuary and fisheries managers, Fisheries Management Councils, and U.S. Coast Guard management and enforcement personnel. A systematic approach was utilized to select a few sites from each category of marine managed areas that were defined at the national level (for more information, see *www.mpa.gov*). Other sources of information on technology needs included the 2002 NOAA Coastal Services Center's Coastal Resource Management Customer Survey, a "Special Interest Meeting" on technology needs held at the Coastal GeoTools '03 conference, and a National Estuarine Research Reserve (NERR) needs assessment conducted in 2002.

Sharing the Results

Although the MPA Center's TTA Institute strives to address many of the needs identified in the technology needs assessment, it is unrealistic to address all technology-related needs identified by the MPA management community. As such, the results of the technology needs assessment will be shared not only with the participants of the study, but also with partner organizations who may have the capacity to address specific needs identified in the report. The report will be available on the National MPA Center's Web site as well (*www.mpa.gov*).

METHODOLOGY

The technology needs assessment gathered information from five sources, described below in chronological order. Although each of these sources contributed to overall conclusions, the series of phone interviews that were conducted from March to July of 2003 served as the primary source of information, as their structure was specifically designed to assess technology needs within the MPA community.

National Estuarine Research Reserve System (NERRS) Needs Assessment
In the summer of 2002, the NOAA Estuarine Reserves Division and the NOAA Coastal Services Center conducted a remote sensing and geographic information system (GIS) needs assessment of the National Estuarine Research Reserve System (NERRS) to identify the common issues, capacity needs, and data used in the system. The information was collected through hour-long conference calls with staff members at each reserve. Prior to the calls, reserve staff members were asked to identify three priority issues within their respective sites that they felt could be addressed with remote sensing and GIS. The executive summary can be found in Appendix E.

The NERRS needs assessment was designed to gather information on 1) habitat and land-use related issues that are already or might be addressed using remotely sensed data; 2) data sources, holdings, and needs; and 3) current and desired GIS/remote sensing capacity at the individual reserves. In particular, this project provided in-depth information about remote sensing and spatial analysis capacity across the NERRS and within many of the agencies and organizations that partner with the reserves. It also identified a range of habitat and land-use related management issues for which remote sensing, spatial analysis, and mapping technologies could be useful.

NOAA Coastal Services Center Customer Survey
Every three years, the NOAA Coastal Services Center conducts a survey of its customer base—coastal resource managers. The latest survey was distributed in October of 2002, and was sent to offices of state coastal management programs, state departments of natural resources (or equivalent agencies) responsible for coastal resource management, National Estuarine Research Reserves, Sea Grant College Programs, National Estuary Programs, and National Marine Sanctuaries. The Center uses the information collected to determine priorities, plan projects, build partnerships, and improve products and services. Data from the 2002 customer survey informed the MPA Technology Needs Assessment, as it contains detailed information about current technology capacity and use—including specifics about hardware, software, and data needs—as well as information about managers' interest in applications of technology and technical training for their staff.

Initial Scoping Interviews
Five initial scoping interviews were conducted from July 2002 to August 2002 with coastal managers, scientists, and GIS/technology specialists. The names of those interviewed can be found in Appendix C. Interview participants were asked to identify their key technology needs or issues and were also provided an opportunity to make general comments about technology and its application to resource management. The purpose of these scoping interviews was to determine the range of needs and issues that were likely to surface in later interviews and to aid in the design of the overall interview process. Specifically, these scoping interviews allowed Center staff members to formulate a process for selecting the agencies and organizations to be interviewed and the range of topics to be explored.

Special Interest Meeting, Coastal GeoTools '03
At the Coastal GeoTools '03 conference, TTA Institute staff convened a Special Interest Meeting on the MPA Technology Needs Assessment. A meeting summary, including a list of the 18 attendees, can be found in Appendix D. Participants were provided background information on the MPA executive order and the initial MPA needs assessment. Participants brainstormed current protected area management issues to which technology could be applied. The discussion covered existing underutilized technology, data analysis needs, communication of results, and suggestions for future developments.

Phone Interviews
The amount and quality of information generated by interviews with individuals during the initial MPA needs assessment demonstrated the value of this method. As a result, the technology needs assessment employed phone interviews as the primary method of data collection. In order to generate a call list, MPA staff members first determined who would be most appropriate to include in the assessment by selecting federal and state entities involved in MPA management or enforcement activities. These were identified as state coastal zone management programs, National Wildlife Refuges, National Parks & Seashores, National Marine Sanctuaries, NOAA Fisheries regional offices (National Marine Fisheries Service), and U.S. Coast Guard enforcement personnel. National Estuarine Research Reserves were not included because much of the relevant information was captured in the NERR Needs Assessment completed in 2002. After the six categories were identified, a four-person working group identified several potential sites or agencies for interviews within each category. This selection attempted to achieve adequate regional representation. It should be noted that certain programs within the pool of participants view MPAs as merely one potential management tool among a suite of others being used, rather than as a primary focus area.

All 24 organizations included on the final list were contacted via e-mail and telephone and, in the process of scheduling their calls, were asked to identify three high-priority management issues that could be addressed through the application of technology. (For the purposes of the interviews, technology was defined broadly, including not only geospatial technologies, but also things such as Web-based systems, visualizations, and enforcement technologies.) Participating entities were encouraged to invite managers, GIS specialists, researchers, education/outreach specialists, enforcement personnel, and other relevant individuals to participate in a conference call. The number of participants on any given call ranged from one to seven. Two-to-four NOAA Coastal Services Center staff members, including at least one technology expert, participated in each of the calls in order to guide the discussions.

At the beginning of each call, participants were given a brief introduction to the technology needs assessment, including background on Executive Order 13158 on Marine Protected Areas, the National MPA Center and supporting institutes, and the initial needs assessment. (This material was also made available to them electronically before the call.) Participants were then asked to expand upon each of the three technology-related issues or needs that were identified before the call. An open discussion format allowed interviewers to gather a great deal of relevant information from the discussion, following up on individual issues as they arose. Although many of the ensuing discussions centered on GIS and remote sensing technology needs, participants were encouraged to discuss other technology needs as well.

RESULTS

The results from the technology needs assessment have been organized into four broad categories: priority issues that technology can help to address, issue-specific applications of science and technology, data needs, and capacity to use technology. The sections are further divided into distinct topic areas. Because many of the needs are interconnected, there may be some duplication across sections.

Section I: Priority Issues That Technology Can Help to Address
This first section of results deals with priority issues that can be addressed by technology. These issues are further divided into three more specific categories: marine habitats, enforcement and boundaries, and monitoring of the marine environment.

Marine Habitats
Many of those interviewed identified mapping of benthic habitats and marine communities as a high-priority need. The consistent message communicated is that managers "can't do anything without good habitat maps." Benthic mapping is needed to help sites inventory both natural and cultural resources. Sites use this information to establish baseline condition, monitor habitat loss, and identify specific areas that may require further research or a greater level of protection. A basic inventory of benthic habitats and their condition also allows sites to perform change analysis as data are collected over time.

The sites reported a wide range of available data on benthic habitats. Some sites have literally no information to describe their benthic habitats, some have only textual descriptions of where resources are located rather than graphically displayed data, and some have patchy or incomplete spatial data coverage. Sites interviewed generally fit into three categories with respect to benthic habitat mapping:

1) The site has been mapped but at a resolution that is too coarse to support resource management activities or decision making,
2) Existing data are patchy and incomplete, or
3) The site is not mapped.

Some of those interviewed said benthic habitat data are useful to analyze effects of MPAs and to perform comparative studies of protected areas and the surrounding areas. It was also suggested that benthic habitat maps could be used in combination with social science data related to fishing efforts to identify potential gear-related impacts. A number of sites expressed a need for a technology that could effectively characterize the benthic habitat within a dynamic nearshore environment (e.g., the rocky nearshore environment of the Pacific coastline). These sites had investigated the use of Light Detection and Ranging (LIDAR) and remotely operated vehicles (ROVs) to address this issue, but were faced with a number of constraints that may limit their usefulness, such as low visibility and high-energy environments and conditions.

Finally, a few sites expressed a need for modeling based on benthic habitat data. Specifically, there was an interest in modeling the effects of marine protected areas with regard to fisheries. Such analyses would be useful to determine appropriate regulations both inside and outside MPAs, appropriate sizes of MPAs, and biological responses to the implementation of MPAs. Although there is a clear need for models that relate benthic habitat data to specific biological parameters, such modeling efforts should be considered a secondary need, as it is first necessary to have sufficient data (e.g., benthic habitat data, water quality data, species/habitat affinities) at an adequate resolution.

Habitat-Related Needs Identified by Participants

- ► Need to inventory resources to establish effective management strategies
  - → For most sites complete coverage is not available
  - → Data must be collected at an adequate resolution and mapped to an appropriate scale
- ► Need to perform change analysis (e.g., habitat loss and effectiveness studies for closures and other management efforts)
- ► Need to use habitat data for modeling efforts
- ► Need for effective technologies to map the dynamic nearshore environment
- ► Need more cost-efficient technologies to map surficial geology

Enforcement and Boundaries

Discussions on enforcement and boundaries typically focused on difficulties associated with MPA enforcement, inadequacies inherent in current enforcement regimes, and technological solutions to enforcement constraints.

The technology needs assessment confirmed that enforcement of regulations in MPAs and other marine managed areas is a difficult task. It requires not only a great investment in personnel and time, but also in technologies to make enforcement more effective. The reasons enforcement can be so difficult are many; however, the importance of accurate, legally defensible, easily enforceable, and digitally rendered boundaries was repeatedly mentioned during this needs assessment. Site-specific problems with boundaries ranged from sites having boundaries only described in legal text and not mapped or charted in any way, to sites with inaccurate digital boundaries or legal descriptions from which it is difficult to prosecute violations.

A number of key points regarding boundaries can be made based on the conversations with the MPA management and enforcement community. First, the legal text describing boundaries must be clear and chartable. Boundaries that follow bathymetry contours or lines that are described in relation to a certain distance from shore do not meet these criteria. Descriptions should include references to specific latitude and longitude points; these coordinates must have a degree of precision appropriate for enforcement. What this means in terms of modern Global Positioning System (GPS) technology is that the boundary descriptions must be precise enough to pinpoint the actual boundary location to within a matter of meters. Lack of clarity and accuracy in legal descriptions and the resulting boundaries make convictions for violations that occur near the boundaries unlikely. Second, having boundaries mapped digitally makes them much more enforceable, especially in areas that are very large, do not have easily referenced landmarks, or are not marked with buoys. Buoys are often prohibitively expensive to install and maintain, especially in deep waters. Third, many resource users, including recreational boaters, do not know the boundaries of MPAs or that they even exist in a given area. There is a great need for education in terms of general regulations and the boundaries of restricted areas. This need is exacerbated by the fact that many MPAs are based on temporary or seasonal restrictions, and therefore do not appear on charts.

Technology-based systems have the potential to address a number of enforcement challenges by providing a mechanism for constant and consistent monitoring across protected areas. Nevertheless, new and emerging enforcement technologies do have a number of limitations. The resources required to train staff in the proper utilization of these new technologies was mentioned as an important constraint, as were the limitations in the effectiveness of technologies to address

all potential violators. For example, today, vessel monitoring systems (VMS) are only used on commercial vessels and thus do not report activities of recreational vessels. Similarly, some radar systems are not sensitive enough to register small vessels that may be in a restricted area.

In cases where enforcement officers are on site, they often lack the basic tools to get their jobs done. In some cases, these "tools" are simply things such as vessels, cell phones, radios, and digital, video, and still cameras for documentation. In other cases, they have these basic tools, but lack more advanced technical equipment that they feel is necessary to do an adequate job of enforcement. Charting software, GPS systems, and visual displays capable of showing a vessel's location in reference to protected area boundaries were listed as high-priority enforcement needs at some sites. The need for real-time monitoring systems, such as VMS, was mentioned by a number of sites as well. It should be stressed that simply supplying sites with new enforcement technology only creates another need—the need for training staff and enforcement personnel in the use and application of such technologies.

Individuals interviewed proposed a number of possible solutions to enforcement needs and issues. Proposed solutions involved educational efforts, the application of new technologies, and partnerships and cooperative agreements. One of the greatest enforcement-related needs that sites mentioned was having effective outreach tools and mechanisms to educate the public. In many cases, they explained, violations were occurring simply because boaters were not aware of the rules, regulations, and boundaries. Some sites touted the success of boater education programs in curbing violations. Other mechanisms such as signage or brochures that display MPA boundaries on a map and explain the applicable regulations can also be effective enforcement tools.

A number of new "remote enforcement" technologies were cited that could address enforcement needs, particularly the need for real-time monitoring of activities in protected areas. These include

- Shore-based radar,
- Buoy-based radar,
- Underwater acoustic sensors,
- Aerial surveys with manned and unmanned aircraft, and
- Vessel monitoring systems (These systems can obtain information on vessel type, speed, time, location, and identification).

Such technologies may be especially useful at sites that do not have a large enforcement staff or for sites that are farther offshore. Since the purpose of this report is not to identify solutions, but rather to describe the technology needs and capacity of the MPA management community, this report does not explain each of these technologies. However, a number of existing and emerging technologies may address the enforcement needs identified during the assessment.

Enforcement and Boundary-Related Needs

► General needs
- → Adequate enforcement programs for existing and new MPAs
- → Real-time monitoring of violations
- → Training to use new enforcement technologies
- → Charting software and other basic enforcement equipment
- → Accurate and consistent mapping of boundaries
- → Enforceable digital boundaries
- → Reduction of competition between enforcement and other management priorities
- → Enforcement techniques that simplify identification of violations in multi-use areas
- → 24/7 enforcement "presence" over large areas of water
- → More enforcement personnel

Monitoring the Marine Environment

A third category of priority issues that technology can help address relates to monitoring of marine resources. Participants mentioned the need to monitor the effects of visitor use, invasive species, and site-specific effects of regional land-based activities (e.g., septic drainage), among others.

Managers are interested in technologies that can expand and enhance monitoring efforts, as well as facilitate the analysis and presentation of monitoring data. Some sites expressed a need for additional baseline information, such as habitat classification data and hydrology models, in order to create a framework for more effective monitoring programs. While the benefits of monitoring buoys were mentioned, managers also talked about constraints such as fouling, weather impacts, and maintenance. According to one site, there is great potential for the coastal and ocean observing systems to be used for MPA site selection and site monitoring. Another site stated the need for universal MPA monitoring buoys that have the versatility to host a variety of sensors.

Buoys have the potential to monitor currents, an important and highly influential aspect within the marine environment. Certain sites mentioned the potential to characterize currents as a mechanism to predict larval transport. This information can be useful when sites evaluate boundary locations and prioritize areas for protection. Also, there is a need to measure the effectiveness of closed areas and to compare the habitat and existing conditions with those in surrounding areas. Observational or remotely sensed data have the potential to provide some of the information needed to conduct this type of analysis and repeat the process over time.

Because conditions within the marine environment are highly variable (both spatially and temporally), monitoring efforts require the collection of data on a continual basis. In-situ monitoring can be quite costly and time-consuming as researchers attempt to collect data over a broad region and within a defined time series. Remote sensing technologies are an integral part of many ongoing monitoring efforts. These technologies allow for concurrent data collection over a wide geographic region and have the benefit of not requiring analysts' accounting for large differences in ambient conditions. Also, satellite technologies are providing a nearly continual data stream that can be received in near real-time. Rather than a point-by-point sampling of the conditions at a particular site, remotely sensed data is now providing managers with seamless coverage for an entire region and with data that can be continually updated. Still, while many managers recognize the utility of these technologies, they note that they are often quite costly and difficult to access. In addition, most sites do not have the capacity to utilize these data unless they are provided as processed, GIS-compatible files that do not require the purchase of additional software or a great deal of additional expertise. Such data could be utilized establishing baselines and for ecological forecasting or predictive modeling with high levels of certainty (e.g., forecasting the probability of ship/boat collisions with reefs; forecasting propeller scars in seagrass beds).

Monitoring Needs

- ► General needs
  - → Need for adequate monitoring programs for existing and new MPAs
- ► Specific parameters to monitor
  - → Invasive species
  - → General water quality
  - → Harmful algal blooms
  - → Effects of land-based activities
  - → Habitat change
  - → Visitor-use impacts
- ► Monitoring technology needs
  - → Universal monitoring buoys
  - → Coastal observation application to MPAs
  - → Models
  - → Baseline data

Section II: Issue-Specific Application of Science and Technology
Sites participating in the needs assessment mentioned a number of specific tools, technologies, and trainings that they would like to have to apply to their local problems. This section is divided into four specific categories: GIS tools, remote sensing tools and technologies, applied social science, and outreach and education applications of science and technology.

Geographic Information System (GIS) Tools
Participants brought up a number of GIS-based tools that would help them address specific needs. GIS data, customized applications, and maps are needed for resource management efforts, outreach and education, and analysis of marine reserves. GIS can be particularly useful when applied to the inventory of natural and cultural resources, the analysis of socioeconomic parameters, and the monitoring of species of particular concern. Applied decision-support tools would also be useful for ocean zoning and site designation. Demonstration and visualization tools that can lay out different scenarios for public groups and describe potential options would be especially useful in public meetings and can help engage stakeholders in the process. For example, an application that could demonstrate within a public meeting the aesthetic impact of wind farms in various locations could be very effective to show potential impacts to stakeholders. An example of a valuable tool that is currently in use is the Massachusetts Ocean Resource Information System (MORIS). This is an ArcView® 3.x extension that provides many data sets and georegulatory information that can be used for management decision making about aquaculture and other coastal uses and issues. In summary, sites are interested in tools that they can "plug" data into and get results that inform management decisions and that enhance outreach and education efforts.

Need for GIS Tools

- GIS-based tools are needed for
  - → mapping efforts
  - → outreach & education
  - → analysis of marine reserves
  - → inventory of natural and cultural resources
  - → modeling of socioeconomic parameters
  - → management of species of particular concern and invasives
  - → decision support in ocean zoning and site selection
  - → demonstrating and visualizing impacts of management options

Remote Sensing (RS) Tools and Technologies
Remote sensing technologies are evolving and changing on a regular basis, and coastal managers are finding new ways to use this problem-solving technology. Coastal managers are utilizing a number of different sensors such as IKONOS, Landsat TM/ETM+, LIDAR, and SeaWiFS. Coastal zone management applications of these issues include coral reef mapping, monitoring phytoplankton levels, monitoring coastal development, runoff control, establishing beach setback lines, dredge material siting, and many more.

The needs assessment revealed a need for access to real-time remotely sensed data. These data could have a number of potential applications, including the prediction of oceanographic phenomena, such as harmful algal blooms. Participants also said that such data could be helpful when applied to oil spill response, and that it would be very useful if the data were made available on-line. The theme of easily accessible and easy-to-work-with data and products came up repeatedly, as managers often do not have the staff time or expertise to process data. A number of those interviewed conveyed a need for tools to make remote sensing data, such as Advanced Very High Resolution Radiometer (AVHRR) and sea surface temperature data provided by

NOAA's CoastWatch program, "easier to work with." The text box below contains technologies that interviewees cited as either currently utilized or potentially useful technologies for MPA management.

Remote Sensing Technologies

- Buoy systems
  - → An example is the buoy system off of Cape Cod that has a number of sensors and is connected to a fiber-optic cable that sends real-time information to shore for water-quality monitoring and Right Whale/Humpback whale monitoring
- Satellite and airborne surface imaging (e.g., IKONOS, Landsat, SeaWiFS, LIDAR)
- Radar beacon technology
  - → Potential uses beyond resource protection include immigration and smuggling
  - → Limited in that it may not pick up small-boat fishermen
- Vessel monitoring systems (VMS)
  - → A useful technology, but limitations to VMS systems need to be addressed
- CODAR (Coastal Ocean Dynamics Applications Radar)
  - → Can be utilized to get a better picture of surface currents over large areas
- Coast Guard Automatic ID System (AIS) system
  - → *www.navcen.uscg.gov/enav/ais/how_ais_works.htm*
  - → Users may need utilities to help look at data from this system
- Remote surveillance cameras
  - → 24-hour live streaming video on the Web
- Drones (unmanned aircraft)
  - → Could be utilized for monitoring activities in marine protected areas

Applied Social Science

Many interviewees mentioned the importance of applying social science research to management issues. The "technology" needs associated with social science are generally related to data collection, data analysis and interpretation, and data distribution mechanisms to share results with the public and stakeholders. There is also a need to incorporate these data into decision-support tools that are designed to analyze various types of data and display results to aid with decision-making processes.

A primary constraint is data availability. Social science data are quite limited within many regions and, at times, provided in a format that requires a great deal of preprocessing before the data can be useful. Also, there are often sensitivity issues and restrictions with these data that may hinder distribution. There was interest in technologies that facilitate the collection and assimilation of fishing practices data (through electronic data loggers), general socioeconomic data (to complement existing rapid assessment data), economic data to aid in zoning efforts, and basic human-use patterns. These data would be very powerful within a GIS to assess the economic impacts of MPAs. Managers are also calling for data that are specific enough to suit their needs. For example, one site mentioned that existing data aggregate recreational fishing, scuba, and other tourism activities into a single "tourism" category, but it would be useful to have data on each discrete activity. Finally, once socioeconomic data are collected, there is a secondary need to model the relationships between biological data, such as fisheries data, and the broad socioeconomic impacts of different management activities. In addition to data-gathering tools and technologies, managers expressed interest in any tools or technologies that may help with data

distribution. Certain sites highlighted the utility of Internet mapping, given the fact that it has the capacity to reach such a broad range of users without requiring them to purchase any additional software. Training in social science tools (e.g., electronic survey tools for in-the-field interviewing) and software (e.g., Atlas.ti, The Ethnograph) was also mentioned as a need by a number of those interviewed.

Summary of Social Science Needs

- General need for collection of social science data
  - → Regional and local data
  - → Data at a useful "resolution"
- Tools and training for the analysis and interpretation of social science data
- Tools for communicating results of social science research
- Need for socioeconomic modeling

Outreach and Education Applications of Science and Technology

When GIS and remote sensing are applied to outreach and education, these powerful tools can address a number of issues, including lack of compliance with regulations, fear and suspicion of management, and lack of understanding of both ecological information and management policies and impacts. Managers said outreach and education need to be utilized to answer locals' questions and to demonstrate the impacts and outcomes of protected areas. Some of those interviewed said that they are already taking data and research results to public meetings, and that they could make use of technology tools to facilitate the dissemination of this information and engage the stakeholders in the process. In addition to being used for research and management purposes, GIS data and tools are also being used at public meetings for general education purposes. GIS and remote sensing data have been shown to be useful to communicate both the status and location of resources, human activities and impacts, management efforts, and potential scenarios that result from changes to management policies or different levels and types of human activities.

A number of outreach and education needs voiced during this study related specifically to enforcement issues. In fact, depending on the severity of the violation, most sites stated that their enforcement officers tend to focus more effort toward public education than on the punitive aspects of enforcement. There is a need for maps, interactive applications, and visualization tools that can engage the public and encourage compliance with management policies.

Summary of Outreach and Education Needs

- Technology tools for encouraging stakeholder involvement
- Tools to aid development of effective outreach materials (signage, brochures, visualization tools, etc.)

Section III: Data Needs

Managers provided information on data sources, methods of acquiring data, applications of existing data, and critical data sets. Data needs can be explained by looking at the typical pathway that a manager might go through to find existing data. Some questions a manager may face are the following: What type of data do I need? Do I know where to find existing data? Do the data exist? If the data exist, can they be shared? Will the data be usable and useful in the decision-making process? Will they require processing and are the tools and resources available to do this? Looking at these questions gives us a good idea as to the host of issues that many managers and their staffs face when dealing with data.

What Type of Data Are Managers Looking for?

Technical guidance is needed to educate managers about which types of data are most appropriate for a particular resource management question and whether it is possible to combine those data with existing resources. A number of those who were interviewed expressed the utility and importance of historical data sets. Historical data sets help monitor and address the effects of anthropogenic impacts on resources and how those resources and conditions have changed over time.

As part of the interview process, participants identified what they consider to be the most essential data sets, regardless of whether they actually had access to those data sets. It is difficult to rank these data sets in terms of priority, given that the management focus varied considerably among many of the sites that were interviewed. The text box below lists, in alphabetical order, the general types of data sets considered essential by those interviewed.

Interviewee's Most Essential Data Sets

- Aerial photography
- Bathymetry and elevation data
- Data to characterize functional relationships between habitats and productivity
- Distribution and abundance of fish in closed areas
- Environmental sensitivity indices / areas of particular concern
- Essential fish habitat and human-use patterns
- Fisheries baseline data
- Fishing effort data
- Habitat data
- Human use data
- Protected species data
- Sediment types and soils data
- Water quality data
- Wetlands data

Do Managers Know Where to Find Existing Data?

According to participants, a primary obstacle to data sharing is the difficulty in determining what data already exist and how to access them. Often, staffs lack the expertise needed to search for data or the personnel time required to complete that search and convert the data into compatible formats. A number of participants suggested data clearinghouses as a mechanism for improving access. For example, one site expressed a need for a state repository for data sets such as up-to-date digital orthophotography. Another identified the need for a single Internet resource for protected species data so that users could click on an area of ocean and determine all available data on protected species in that location.

Although managers call for more and better access, they are already taking advantage of data available from a range of partner entities. Primary sources of external data identified by those

interviewed include university researchers, the U.S. Geological Survey, the National Park Service, the U.S. Army Corps of Engineers, and other federal and state programs.

Do the Data Sets That Managers Are Looking for Exist?
In some cases, the data sets that managers desire simply do not exist or are not available for managers. Many sites noted significant data gaps where data were not available.

If the Data Exist, Can They Be Shared?
There is an overall need for data-sharing protocols. Many of those interviewed described some level of difficulty in obtaining data from academics and others who place proprietary restrictions on their data. This reluctance to share data is often based on a fear that data may be misused or misinterpreted, or because of legal concerns. An example cited during the needs assessment was the lack of existing fisheries data in the hands of MPA managers. These are valuable data that could help to establish biological and socioeconomic indicators, yet they typically are not made available to managers because of sensitivity issues.

Will the Data Be Usable?
Data standardization is an issue that was raised by many managers, given the need to ensure data utility and eliminate duplicative efforts. Particularly on the larger ecosystem or regional levels, it is necessary to ensure that shared data are delivered in a compatible format because the process of cleaning and editing incompatible data often negates the benefits gained through sharing. It was suggested that one way to foster such standardization would be to establish local or regional networks of collaborators to share data using established data-quality standards. Such GIS consortiums have already formed in certain parts of the country and have been shown to be quite useful for locating available data resources and prioritizing future collections. Another way to foster standardization would be to have regional training that presented consistent methodologies for data collection and documentation. Participants emphasized that once data quality standards are established, those collecting the data must be trained in the implementation of those standards. This would allow for easier storage and assemblage of consistent data. One example of an effort to foster increased data standardization and compatibility on an international scale is the marine habitat classification standards that are being compiled by NatureServe, under contract with the NOAA Office of Habitat Conservation and the NOAA Office of Protected Resources. This project is developing a comprehensive classification system to facilitate ecosystem-based management in the marine environment by providing consistent terms that can be applied to data from diverse locations.

The need for well-written metadata also cannot be overlooked. Metadata records are often ignored because data creators do not envision the data being used beyond their immediate interests. Without metadata or data quality standards, it is often easier for sites to gather new data rather than use existing data of questionable quality. The use of standardized protocols for metadata creation will also allow for proper indexing by search engines and incorporation into data distribution centers.

Summary of Data Standardization Results

- ► Data standardization and data quality standards needed to ensure usability by regional entities
- ► Adequate metadata are of great importance
- ► Regional trainings needed to standardize methodologies for data collection and documentation

Overall Data Needs

The technology needs assessment revealed an overarching need for better communication regarding 1) which groups are collecting data, 2) the purpose(s) of collecting those data, and 3) whether the data are available for distribution. Improving communication on these topics would help managers initiate collaborations and reduce duplicative efforts. Partnerships that are developed could help not only with data sharing but also with maintenance and upkeep of cumbersome data sets. Regional metadata clearinghouses could serve to describe the data, source, and contact information. Such a system would be most useful if it were able to integrate various sources of information, including federal, state, and university sources.

Section IV: Capacity to Use Technology

A portion of the MPA Technology Needs Assessment was structured to gain an understanding of the capacity of the MPA management community to utilize existing and future technologies. This section will discuss the hardware and software that MPA managers are currently using, as well as the training and partnerships that can be used to increase capacity. In general, it seems the biggest challenge faced by many MPA managers is a lack of resources to apply various types of technology. Often this lack of resources is described in terms of limited staff time available to utilize existing training or technological tools. Staff members are often too busy with tasks related to overall management activities to accept additional technical responsibilities. In some cases, more senior staff members are reluctant to utilize new technologies and are unsupportive of the development or application of these tools within the program. Some would rather leave tasks such as geospatial analysis to other staff members.

GIS and Remote Sensing Hardware and Software

Based on the responses of those interviewed, there is a broad range of in-house GIS capacity, from sites not using any GIS to sites with full GIS labs and multiple site licenses. In one case, a site had access to significant data resources, but did not have the GIS and data processing infrastructure required to make use of such large and complex image-based (i.e., raster) data formats. The majority of sites do use GIS to some extent, and many of these sites are still utilizing Environmental Systems Research Institute (ESRI®) ArcView® 3.x. Although some sites stated that they have not yet migrated to ArcGIS® 8.x because their partners are still using ArcView 3.x, they plan to upgrade sometime in the near future. There may also be an increase in the use of the Arc Internet Map Server (ArcIMS®) in the future, as some sites have begun to implement this technology and others commented on its utility. For example, managers from California reported at least six ArcIMS sites that are currently being used in their state.

According to the NOAA Coastal Services Center's 2002 Coastal Resource Management Customer Survey, of the 143 respondents who identified "protected areas management" as a high priority, 92.8 percent work in offices that are currently using GIS. Within this subset, the majority of respondents are utilizing ESRI ArcView version 3.x, but 41.1 percent have transitioned to ESRI ArcGIS version 8.x. Of those who do not currently use ArcGIS, 16.4 percent indicated that they have plans to convert to ArcGIS in the future. Spatial Analyst is the most commonly used ESRI extension, with 58.9 percent of the 143 respondents indicating use. These results are consistent with the information gathered during the needs assessment interviews.

With regard to how GIS products are being used, many sites reported employing GIS primarily as a mapping tool for research and outreach purposes, but some do make use of its more advanced statistical and analytical functions. More often than not, the more advanced functionality of GIS goes unused due to a lack of staff time and/or training and expertise. The Coast Guard primarily utilizes charting systems such as the Electronic Chart Display (ECD) for search and rescue operations. Coast Guard interviewees did, however, foresee an expanding role for electronic navigational charts in enforcement efforts, and are working to make digital protected area

boundaries available to all Coast Guard vessels. Currently those boundaries are plotted manually on paper charts.

Some sites reported that they lack the required computer speed or storage requirements to operate the higher-end GIS and remote sensing applications. Certain sites have technically trained staff members, but lack the computing power required to perform the complex data calculations needed for certain analyses and to process very large, high-resolution data sets. At a more basic level, some sites lacked such equipment as GPS units for data collection, digital cameras, and underwater still and video cameras. Others cited the need for more expensive remote sensing data collection equipment, such as remotely operated vehicles (ROVs), for use in deepwater environments.

There remains a great need for training and technical guidance for sites that are just getting started with GIS and remote sensing, expanding their capacity, or upgrading to newer software. However, while many sites identified training as a priority need, others reported that they prefer to contract out technical work. Managers who favored external contracts cited a lack of available staff time for technical work, and a general feeling that it often requires fewer resources to contract this work out than it does to build the required in-house capacity in training, software, and hardware.

Summary of GIS and Remote Sensing Hardware and Software Capacity

- Majority of managers still using ESRI® ArcView® 3.x; many transitioning to ESRI® ArcGIS® 8.x
- Increased interest in the use of ESRI® ArcIMS®(Internet Map Server)
- Site-based needs vary from basic equipment (e.g., GPS units) to remotely sensed data collection equipment and increased computing power for complex data sets
- Need for training in basic GIS and remote sensing skills, and in new versions of software

Training

There is no question that technical training is a key need for staff involved in the management of marine protected areas. Although GIS training is an important and often-cited need, training needs go well beyond GIS technologies. Training is also required in remote sensing, statistical software, social science tools and software, enforcement technologies, Web site design and creation, emerging technologies, regional data collection techniques, and other areas. Many sites lack the hardware and software to support highly trained personnel, and these needs must be addressed before training can be truly useful. As mentioned above, some sites choose to contract out technical work, which can range from buoy maintenance to GIS analysis work. Others, such as the National Marine Sanctuaries, continue to increase their in-house capabilities for GIS analysis. Although it is often difficult to fund new positions, some sites stated a need to employ dedicated GIS staff members, rather than tasking existing staff with new responsibilities. These sites felt that dedicated GIS staff members would achieve a higher level of efficiency, as they could focus on time-consuming data collection and analysis.

In fact, staff time constraints were one of the most commonly cited obstacles to building adequate in-house GIS capacity. At times, staff members receive training in the use of these technologies, but because there is insufficient time allocated for the application of these technologies and refinement of technical skills, the net increase in technical capacity at the site level is minimal. Participants felt that, to be applied most effectively within the organization, the content of technical training courses should be applicable to ongoing projects. Managers also pointed out that

increased technical capacity from training is often lost due to staff turnover. Finally, because training often requires travel, organizations working with limited budgets may find it cost-prohibitive.

A number of individuals interviewed offered possible solutions for some of the training issues that were brought up. Many expressed interest in the Center's GIS and RS trainings; however, because travel restrictions make it difficult to attend, many participants called for on-site training. It was also suggested that regional trainings would be useful not only to overcome travel limitations, but also to address the lack of consistent methods for data collection and usage. Another suggestion heard a number of times was that training sessions should allot a portion of time to allow attendees to work with their own data with the help of the instructors. Managers felt that the process of allowing staff members to work on their own data as part of a training session might increase the chances that the lessons learned would be applied.

Summary of Training Needs

- ► Training needs go beyond GIS and remote sensing. Also need training in statistical software, social science software, social science "tools," emerging technologies, regional data collection
- ► Some sites want to increase in-house capabilities, while others think it makes more sense to contract out technical work
- ► On-site training preferred by many because of budget restrictions on travel
- ► Need for regional trainings
- ► GIS trainings should incorporate time for participants to work on their own data and issues with trainers present

Partnerships

Given the concerns regarding limited budgets and staff time, many agreed that partnership opportunities are an important mechanism for increasing technology-related capacity within organizations. Some of the managers we interviewed already have formal or informal partnerships established with international, federal, state, and local governmental entities, universities, nongovernmental organizations, and fishermen and seem eager to collaborate with others to receive data and technical assistance wherever possible. These existing partnerships provide a variety of benefits to the MPA management community, including data collection (e.g., social science data, oceanographic data, radar systems data), data analysis, and monitoring activities. Some organizations do not collect any field data but, rather, rely on partnerships to gather such data. Partners such as those within academia and the private sector have the capacity not only to collect the data, but also to provide processed geospatial data layers or complex data analyses. Another area in which partnerships have been very effective is enforcement. Many sites have implemented cross-deputization or maintain concurrent jurisdictions to aid enforcement efforts, especially in cases where sites lack the technologies needed to enforce their regulations adequately. Sites work with state marine patrol, the Coast Guard, National Park Service, and other enforcement entities in cooperative enforcement efforts.

Summary of Information on Partnerships

- ► Much interest in strengthening of partnerships
- ► Many managers utilize different types of formal and informal partnerships to address site-specific and regional technology issues

Miscellaneous Issues Raised by Managers

During the course of the interviews, some important needs were expressed that were not technology related. Although the primary purpose of this report was to identify technology needs, these other needs bear mentioning.

- Social science training: Some managers interviewed said they understand the need for social science research, but that they have neither the necessary tools nor the experience to conduct this type of research. Some expressed an interest to be trained specifically in the design and implementation of social science surveys and in the analysis of survey results. To understand the public better, sites need training and information related to survey techniques, polling, and other social science methodologies, as well as the limitations of each. Because social science information is lacking within the community but seen as an essential element for participatory processes, many were eager to collect additional data but unsure how to go about it.

- Education and outreach: On a site-specific level, there is a need for signs, brochures, and outreach materials to explain existing MPAs to the public, as well as naming systems, regulations, and evolving aspects of protected areas. There is a need for training of enforcement personnel in effective enforcement-related outreach and education activities.

- Enforcing MPA regulations: According to enforcement personnel, the easiest type of area to enforce is a "no-access" area. If a vessel is detected within such an area, it is automatically in violation. As regulations become less restrictive (e.g., certain types of gear restrictions, midwater trawling but no bottom trawling), they become more and more difficult to enforce. In some cases, it is necessary to board individual vessels and inspect catch in order to determine if a violation has occurred. When regulations are drafted, the challenges associated with enforcement should be considered. The involvement of enforcement personnel in management decisions and implementation, such as boundary delineation, should be considered.

- Enforcement funding: The resources needed to provide constant monitoring of MPAs are often not available, and sites consistently reported understaffed, underfunded, and even nonexistent enforcement programs. On the federal side, the advent of homeland security is putting the Coast Guard's ability to effectively enforce regulations to the test. For example, some of those interviewed reported that Coast Guard overflights at their sites have become less frequent since the events of 9-11-2001, as priorities have understandably shifted. It was evident throughout the needs assessment that the use of MPAs as a resource management tool without providing for adequate enforcement is troubling, especially in situations where a single violation can cause significant resource damage (e.g., trawling in sensitive areas like deep-sea coral habitats).

- Use of partnerships: The use of partnerships was mentioned as a way to overcome personnel and budget limitations. For example, many sites have had great success with the use of formal and informal enforcement agreements and cross-deputization among various agencies.

DISCUSSION

This report will be used by the MPA Center's Training and Technical Assistance (TTA) Institute to help guide their programs and projects in coming years and to ensure that current projects are addressing priority needs in the MPA management community. It is anticipated that partner agencies and organizations will also have an interest in addressing many of these needs. To that end, the results will be shared not only with assessment participants, but also with partners who may have the capacity to address specific needs identified in the report. In order to increase its visibility and accessibility, the technology needs assessment report will be made available at *www.mpa.gov*.

Priority Issues and Cross-Cutting Needs

While all comments expressed within the body of this report are important to characterize the needs and technical capacity of protected area sites, certain issues came up repeatedly and were echoed by many sites across the country. These issues emerge as priority, cross-cutting issues.

Benthic Habitat Data and Modeling

Benthic habitat maps were listed as a primary need by many managers and there seemed a general frustration with the lack of necessary information about the resources they are tasked with managing. It is difficult to determine the most appropriate management measure in the absence of significant information about what types of habitats are present and where they are located. Often, the proximity of these sensitive resources to known hazardous activities presents the greatest management challenge. This type of spatial relationship is a key strength of GIS analysis but cannot be conducted without sufficient data to describe the seafloor habitat. In some cases, managers reported that benthic habitat data were available but that the resolution was of an insufficient scale for desired analyses. In other cases, existing data were provided at an adequate resolution, but the spatial coverage was patchy and did not provide sufficient information about the entire area of concern.

Modeling activities were typically listed as a secondary requirement that is closely tied to the need for habitat data. Managers are eager to have models that characterize the impacts of human activities and management decisions on marine habitats, but recognize that these modeling efforts will not provide useful results until adequate data resources are made available. One of the challenges with modeling in the marine environment is that an accurate depiction requires three- and four-dimensional aspects, which are not represented adequately using current GIS technologies. The fourth dimension (representing time) is especially relevant (and difficult to represent) when modeling highly dynamic conditions such as oceanographic currents.

Enforcement

A number of needs identified during the assessment related directly to enforcement. Technology-related needs identified ranged from basic equipment (e.g., cellular phones and on-board chart-viewing software) to more complicated monitoring systems (e.g., vessel monitoring systems). It is important to note that the enforcement-related needs pertained to more than just on-the-water enforcement of regulations. Education and outreach are critical to an effective enforcement regime, and many of the needs identified related to these aspects of enforcement, such as the need for boater education programs, maps, signage, and brochures.

Tools for Education and Outreach and for Public Participation

Many managers expressed a desire for tools that are able to convert critical information and data into formats (e.g., maps, brochures) that are palatable to their core constituencies. Managers and site personnel repeatedly expressed the usefulness of maps and visualization tools to communicate a particular message to the public and to use during meetings in which public

participation and comment are solicited. In addition to maps that include natural science information, managers need social science data and maps to convey the expected socioeconomic impacts of certain management measures. Unfortunately, social science data are often not available, let alone mapped.

Although simple maps are useful to depict current conditions and potential areas of concern or to highlight the need for a particular management strategy, interactive decision-support tools and three-dimensional visualizations were noted as extremely effective mechanisms not only to communicate potential impacts of a proposed activity but also to engage local user groups in the decision-making process. Because some MPA processes have become contentious, managers appreciate the need for participatory tools that allow the public and stakeholder groups to feel that their input is being considered in a very tangible manner.

More Data and Training Are Not Always the Answer

The assessment demonstrated that MPA-related technical assistance must consider needs that extend beyond those that can be solved by simply providing more training and more data. One of the most commonly expressed concerns regarding "more training" related to instances in which the training was not utilized when staff members returned to the office. One suggested way to address this concern is to customize training and allow students to spend additional time after the completion of the course working with their own data in the company of the instructor. This would allow students to integrate elements of their daily activities and to immediately apply the lessons learned to locally relevant data and issues. Another mechanism to increase the effectiveness of training is regional coordination. Regional trainings that describe data collection protocols would improve data consistency and increase the utility of shared data.

Regional coordination related to data access and distribution is essential. Managers are eager for more information regarding existing data resources and ongoing research projects or data collections. Managers are also interested in improved data distribution mechanisms and said there is a need to increase the comfort level associated with data distribution so that groups share their data more freely. Case studies that describe positive collaborative experiences would be useful to foster increased participation in such efforts. One participant suggested it should be standard practice for funding entities to require the public distribution of all resulting data products.

Finally, while managers frequently raised the need for data and/or training, in some cases managers said they prefer to contract out technical work rather than build in-house capacity. Given staff time, training, and equipment requirements to create quality data and products, external contracts can be a more practical solution to some technology-related needs.

Recommendations

- Expand technology use in MPAs: Technology is already doing a great deal for MPA management, and it can do more to improve the effectiveness of management activities in the future. Training and technical assistance providers should foster the expansion of existing technology-related activities that improve management (e.g., via case studies and tailoring existing tools to new sites), and they should support the development of additional data applications and resources (e.g., new decision-support tools, more benthic habitat data.)

- Communicate the pros and cons of different benthic mapping technologies: Because benthic mapping was a priority issue for so many of the managers we interviewed, one recommendation is for assistance providers to help managers sort out some of the confusion surrounding the technologies available to map benthic habitat. Because there are so many available technologies, it would be useful to teach managers about the strengths and weaknesses of each one, so they can select the technology that is most appropriate for their immediate and future needs.

- Acquire data to improve modeling efforts: Managers are interested in initiating and/or expanding modeling activities (e.g., modeling species-habitat interactions). The biggest impediment to enhanced modeling is often a lack of appropriate data. Raw data on habitats, environmental conditions, and species presence and abundance must be collected before useful models can be built. New spending should ensure that required variables are being collected, and/or that existing monitoring data are incorporated in modeling efforts.

- Utilize technology applications to address social and natural sciences: Technology can and should be used to work with both natural and social science information. Managers need tools that help them collect, organize, interpret, apply, and disseminate natural and social science information.

- Improve accessibility of data and training: Training and technical assistance providers should work to make data and training more accessible (e.g., via data clearinghouses, on-site training, and training that allows attendees to work with some of their own data) and should improve awareness of data sources. In addition, managers would benefit from working together to foster private sector partnerships for data collection and processing.

- Continue and expand efforts to utilize historical data sets: A number of ongoing efforts are currently addressing aspects of this issue, such as the NOAA Coastal Change Analysis Program (C-CAP), which is dedicated to the development, distribution, and application of land cover and change data for the nation's coastal zone.

- Evaluate utilization of tools and trainings: Finally, this needs assessment demonstrated the utility of assessing not just needs for new products, services, and information, but also how existing products, services, and information are currently being used by the management community. Periodic evaluations of how tools and training are used (or not used) by managers should be part of any assistance provider's project planning process. Also, by publicizing this information, other sites may be able to learn from the challenges associated with a particular project or generate ideas for how the concept could be applied at their sites. It is possible that, with only minor modification, many existing tools and resources could be applied to a different purpose or in a different geographic region.

REFERENCES

Frankic, A. 1999. *Technology and Information Needs of the Coastal and Estuarine Management Community*. National Oceanic and Atmospheric Administration (NOAA) Office of Ocean and Coastal Resource Management. Report number 40AANC801324. 60 pages. <*http://ciceet.unh.edu/additional/TechInfo/TINeeds/Full%20Report.pdf*>.

National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center. 2002. *Coastal Resource Management Customer Survey*. NOAA Coastal Services Center: Charleston, SC. <*www.csc.noaa.gov/survey/*>.

National Oceanic and Atmospheric Administration (NOAA) Coastal Services Center. 2002. *Marine Protected Areas Needs Assessment*. NOAA Coastal Services Center: Charleston, SC. <*www.csc.noaa.gov/cms/cls/MPANAFINAL.pdf*>.

National Oceanic and Atmospheric Administration (NOAA) Estuarine Reserves Division and NOAA Coastal Services Center. 2002. *Addressing Habitat Issues with in the National Estuarine Research Reserves: Needs Assessment Final Report, October 2002.* <*www.csc.noaa.gov/crs/nerr/*>.

Appendix A
Glossary of Acronyms

(In addition to defining acronyms, this glossary also provides descriptions of technical terms.)

ArcIMS	Arc Internet Mapping Server. ArcIMS,® a software product developed by Environmental Systems Research Institute (ESRI®), provides the foundation for distributing high-end geographic information system (GIS) and mapping services via the Internet. ArcIMS software enables users to integrate local data sources with Internet data sources for display, query, and analysis in an easy-to-use Web browser.
AVHRR	Advanced Very High Resolution Radiometer. AVHRR is an instrument on the NOAA orbiting polar satellites that returns 1- and 4-kilometer resolution data about the Earth in 4 wavelengths. It is used extensively for large area land cover and vegetation mapping, and weather prediction.
C-CAP	Coastal Change Analysis Program
CICEET	Cooperative Institute for Coastal and Estuarine Environmental Technology
CZM	Coastal Zone Management
DNR	Department of Natural Resources
DOI	Department of the Interior
ECDIS	electronic chart display information system. ECDIS is a navigation information system. When interfaced to navigational sensors such as the Global Positioning System (GPS), it is able to display a vessel's position in real time and provide grounding warnings. When integrated with the automatic radar plotting aid (ARPA) radar, it also provides collision warnings to mariners. ECDIS is approved by the International Maritime Organization (IMO) as a paper chart equivalent.
EFH	essential fish habitat
ESA	Endangered Species Act
FMC	Fisheries Management Council
FWS	Fish and Wildlife Service
GIS	geographic information system. A GIS is a system of computer software, hardware, and data, as well as personnel, to help manipulate, analyze, and present geospatially referenced information.
HAB	harmful algal bloom
IKONOS	IKONOS is a commercial satellite that collects high-resolution imagery at 1- and 4-meter resolution. It offers multispectral (MS) and panchromatic (PAN) imagery. IKONOS was launched on September 24, 1999, and began providing imagery on January 1, 2000. Space Imaging, Inc., distributes IKONOS imagery under the product name CARTERRA.

LANDSAT	The Landsat project is a joint initiative of the U.S. Geological Survey (USGS) and the National Aeronautics and Space Administration (NASA) to gather Earth resource data using a series of satellites. The primary objective of the Landsat project is to ensure a collection of consistently calibrated Earth imagery. The instruments on the Landsat satellites have acquired millions of images that form a unique resource for applications in agriculture, geology, forestry, regional planning, education, mapping, and global change research.
LIDAR	Light Detection and Ranging. LIDAR is an active sensor, similar to radar, that transmits laser pulses to a target and records the time it takes for the pulse to return to the sensor receiver. This technology is currently being used for high-resolution topographic mapping by mounting a LIDAR sensor, integrated with the Global Positioning System (GPS) and inertial measurement unit (IMU) technology, to the bottom of aircraft and measuring the pulse return rate to determine surface elevations.
MPA(s)	marine protected area(s)
NERRS	National Estuarine Research Reserve System
NGO	nongovernmental organization
NMFS	National Marine Fisheries Service (NOAA Fisheries)
NMS	National Marine Sanctuary
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NWR	National Wildlife Refuge
PFMC	Pacific Fishery Management Council
RS	remote sensing. Remote sensing is often defined as indirect (remote) observations (sensing) that yield information about a feature or target. The observations are made by sensors, which are measuring energy reflected or emitted from the target. Examples are aerial photography and the use of satellites to observe the Earth.
SAV	submerged aquatic vegetation
SeaWiFS	Sea-viewing Wide Field-of-view Sensor. This instrument is designed to monitor the color of the world's oceans. Subtle changes in the ocean's color result from changes in the concentrations of marine phytoplankton, resuspended sediment, and dissolved substances in the water column. Data from SeaWiFS provide insight into our understanding of the marine ecosystem and the ocean's role in the global carbon and other biogeochemical cycles.
USGS	United States Geological Survey

Appendix B
MPA Needs Assessment (2002) Executive Summary

During the period from May 2001 to February 2002, the National Oceanic and Atmospheric Administration's (NOAA) Coastal Services Center conducted a needs assessment to support the newly created National Marine Protected Areas (MPA) Center. The assessment aimed to identify information, skills, tools, and processes needed to foster effective MPAs. The results of the needs assessment will guide the National MPA Center as it begins to design services and products to support a national network of MPAs.

Overview of the Marine Protected Areas Needs Assessment
A 12-member planning team of individuals from NOAA and the Department of the Interior (DOI) advised NOAA Coastal Services Center on the MPA needs assessment. Although numerous audiences may look to the National MPA Center for information and assistance, the team agreed that this initial, nine-month assessment should focus on the needs of coastal and marine resource managers. This target audience included both site managers and their staffs, as well as state, regional, and federal managers. A wide range of MPA stakeholders was consulted, since input from groups such as fishing interests and tourism providers gave important perspectives on management issues and processes. The assessment examined the gap between current and desired knowledge, skills, and tools needed for effective MPA management, and identified potential strategies and tools for filling those gaps.

Four objectives were defined for the assessment:
- *What*: Identify overall challenges surrounding MPA management, as well as specific gaps in existing knowledge and skills of marine resource managers regarding key MPA issues.
- *Why*: Determine attitudes, motivations, and disincentives that could impact managers' capacity to benefit from new information, training, or technical assistance.
- *Who*: Identify subgroups of MPA managers that may benefit most from information, training, and technical assistance.
- *How*: Identify formats and distribution methods that will maximize the utility of information, products, and services.

Recognizing the multidisciplinary, multijurisdictional nature of marine resource issues, the MPA needs assessment looked at needs across levels of government, across marine uses, and across the categories of science, education and outreach, and training and technical assistance. Similarly, identified needs cover multiple disciplines and call for action by different levels of government.

Methodology
Although a number of needs had been identified by the National MPA Center before this project began, a formal assessment provided a systematic approach to identifying and documenting managers' needs. Certain issues and stakeholder concerns have received a great amount of attention during individual MPA efforts, but the needs assessment provided an opportunity to hear from a wide range of stakeholders on a variety of MPA-related issues.

Multiple methods were used to gather information for the needs assessment, but the majority of ideas came from focus groups and phone interviews, since these formats allowed targeted, in-depth discussion of management needs. A traditional literature review was also performed, and NOAA Coastal Services Center staff members gleaned information from MPA-related meetings and from electronic discussion list postings over the nine-month period. Finally, a computer-

assisted content analysis of news media from the previous six years examined public opinion and awareness surrounding MPAs.

Results

Needs assessment results were organized under the three broad headings of 1) MPA-related policy and legal issues/responsible authorities, 2) MPA-related science and technology, and 3) MPA program implementation. Together these categories address 23 individual topic areas, and each is summarized briefly below:

Section I: MPA-related policy and legal issues/responsible authorities

- *Identifying MPA goals and defining MPA terminology*: Individuals across stakeholder groups repeatedly called for an articulation of MPA goals, and for clear and consistent definitions of MPA-related terminology. Site managers need clear direction from upper-level management on agency goals and involvement regarding MPAs.
- *Integrating management across jurisdictions*: MPA efforts are hindered by the current lack of integration and cooperation between agencies involved in different aspects of marine resource management. Integration is needed across levels of government, across the land/sea interface, and across pieces of ocean policy legislation.
- *Information sharing and management*: Managers need accessible, comprehensive information about coastal and marine resources and management.
- *Intra- and interagency coordination and cooperation*: Many MPA efforts are under way at local, state, national, and international levels, and there is an overwhelming need for coordination between the various public entities involved.
- *Fisheries management issues*: Long-standing fisheries issues were raised both as a reason why MPAs are needed, and as a reason why MPA development is incredibly complex and demands careful planning, stakeholder consultation, and adaptive management.

Section II: MPA-related science and technology

- *Inventorying and monitoring*: Existing MPAs need more resources for inventorying and monitoring, and any new MPA must incorporate these activities from the beginning.
- *Mapping and spatial analysis*: MPA managers need maps and spatial analysis tools to define boundaries and resource locations, to help with planning processes, and to contribute to public outreach and education efforts.
- *Natural science needs*: Four needs were raised repeatedly—comprehensive habitat information, larval transport research, evaluation of current closures, and modeling work.
- *Social science needs*: Social science work related to MPAs is extremely limited. Research is needed on topics such as socioeconomic impacts, public opinions, and cultural values.
- *Science in management*: To ensure that research is *applied*, scientists and managers need to collaborate, and managers need improved mechanisms for accessing research findings.
- *Climate change*: Sources felt managers are not dealing sufficiently with the topic of climate change, and recommended both more research and planning for potential impacts.

Section III: MPA program implementation

- *Public education and outreach*: There is an overwhelming need for public education about MPAs and about marine resources in general.
- *Planning methods for identifying MPAs*: Sources stressed the need for improved planning methods. Zoning and geographic information system (GIS) technology were

highlighted as two specific tools that should be used in future planning efforts.

- *Stakeholder/community involvement*: Community participation needs to be made more meaningful by including more stakeholders and extending beyond a few public meetings.
- *Working with indigenous peoples*: Indigenous peoples' traditional connections to and knowledge of marine resources makes them critical, valuable participants in MPA processes.
- *Working with fishermen*: Fishermen's reliance on marine resources demands that they be included in MPA processes and that efforts be made to enhance communication with them. Fishermen also can contribute unique and detailed natural and social science information to management efforts.
- *Managing visitor impacts*: MPA managers need to consider and address the ecological and social impacts of increasing marine and coastal recreation.
- *Historical and cultural issues*: Resources with historical and cultural significance need to be inventoried, monitored, and protected. Cultural knowledge is crucial to working effectively with users.
- *Enforcement*: Current managers need more resources to deliver adequate enforcement, and any new MPA efforts must plan for enforcement. New technologies need to be explored, and agencies must join forces to maximize the impact of existing enforcement resources.
- *Evaluating MPA effectiveness*: Current and future MPAs must be evaluated to see if they are meeting established goals, and to quantify impacts. Regional- and national-level evaluations are needed to examine the efficacy of MPA networks.
- *Funding*: Site and regional managers need more resources to address gaps identified throughout the assessment. Sustainable funding is a prerequisite for new MPA efforts, and it is essential to pursue innovative sources.
- *Growth and land-based threats*: Several sources raised growth as an important issue, and said that marine resource managers need to focus more on land-based threats.
- *Site- and sector-specific issues*: This final section presents several issues that did not receive extensive discussion but that bear mentioning as current challenges that were identified by individual areas, management entities, or user groups.

Two stand-alone sections of the report discuss managers' information sources and the results of the computer-assisted content analysis of MPA media. The needs assessment revealed that managers utilize a wide range of information sources, which in turn means that new information should be delivered in multiple formats. Content analysis findings reinforced the need for pubic education and outreach on MPAs, and demonstrated that marine areas are important for a host of environmental, social, commercial, and recreational values.

Discussion

The report concludes with a brief summary of overarching, crosscutting needs, followed by several possible areas for further assessment. (Please note that these topics are not in any priority order.)

<u>Crosscutting needs</u>

- *Partner wherever possible*: The results of the assessment demonstrate that a network of both public and private support must be identified, fostered, and coordinated to provide effective assistance to the resource managers who are working to protect the nation's marine resources. Collaboration is essential both to address existing conflicts and duplications of effort, and to maximize the resources directed toward long-term protection of marine ecosystems. Enhanced intra- and interagency cooperation is needed, and partnerships with stakeholders are important both to build trust and to take advantage of the skills and resources of various groups.

- *Pay attention to the human dimension*: Social science regarding MPAs is desperately needed, and there is universal agreement across the MPA community that stakeholder/community involvement is critical to success.
- *Connect managers with information, technical assistance, and funding that already exist*: Extensive information, technical assistance, and funding opportunities exist to help address management needs, but mechanisms are needed to identify and coordinate these resources for managers.
- *Take time to define MPAs and associated boundaries and authorities*: Managers and stakeholders alike are calling for more definition of MPA terms and goals. Beyond a basic definition of the concept, there is a need to clearly delineate authorities and boundaries of individual MPAs.
- *Learn from past processes*: There is much to be learned from existing MPAs and MPA planning processes. Case studies can demonstrate effective tools and techniques for achieving MPA goals, providing models for future development and management efforts.
- *Institute program evaluation*: Evaluation is essential to determine if MPAs are achieving identified goals, to identify and quantify impacts, and to allow adaptive management. Evaluation is needed both within individual sites and at regional and national levels. Potential areas for future assessment work
- *Needs assessment targeting indigenous peoples*: Working with indigenous peoples is at once a critical and extremely complex component of MPA efforts. A targeted needs assessment could examine ways to create more meaningful involvement in MPA processes and to incorporate indigenous knowledge into marine management.
- *Needs assessment targeting recreational and commercial fishermen*: This initial assessment only scratched the surface of the particular concerns, desires, and knowledge of fishermen. A targeted needs assessment would examine how to better address fishermen's fears and involve them in MPA processes, as well as how to access fishermen's extensive knowledge of marine resources.
- *Review of MPA-related technology*: It would be valuable to identify current and potential uses of technology in MPA planning and implementation. A review might also examine managers' capacity to use technology and identify sources of technical assistance.
- *Review of stakeholder/community involvement processes*: Managers recognize the need for enhanced stakeholder/community involvement in MPA processes, but are unsure how to create this. Identifying "lessons learned" from past participatory processes is important both to avoid repeating mistakes and to document effective techniques.
- *Areas for further analysis within the computer-assisted content analysis*: Existing data could be used to examine how attitudes and issues vary across different types of management areas, and developing trends could be tracked by rerunning the content analysis in future years.

Appendix C
Participating Organizations and Individuals

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Appendix D

Coastal GeoTools '03 Special Interest Meeting Summary
MPA Technology Needs Assessment
January 6, 2003

Welcome and Introductions, MPA Background

Marine Protected Areas (MPAs) are defined by Executive Order 13158 as, "any area of the marine environment that has been reserved by federal, state, territorial, tribal or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein." The term MPA is often misinterpreted as meaning an area which has a "no-take" policy, but MPAs include many other types of managed areas. U.S. MPAs may include national marine sanctuaries, fishery management zones, national seashores, parks, monuments, national wildlife refuges, national estuarine research reserves, state conservation areas, reserves, and others. The MPA Executive Order calls upon government and private sector entities to work together to strengthen and expand the national system of MPAs and directed the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA) and the Department of the Interior (DOI) to establish the National MPA Center. The National MPA Center is supported by two regional institutes, the MPA Science Institute in Santa Cruz, California, and the MPA Training and Technical Assistance Institute in Charleston, South Carolina.

The MPA Training and Technical Assistance (TTA) Institute completed a MPA needs assessment in March 2002. The goal of the assessment was to identify information, skills, tools, and processes needed to foster effective MPAs. Coastal and marine resource managers—site managers and their staffs, as well as state, regional, and federal managers—were the target audience. The results continue to guide the National MPA Center and supporting institutes as we begin to design services and products to support a national network of MPAs. Results are also being shared with partner entities that can help address identified needs.

Overview of MPA Technology Needs Assessment

Technology needs came up repeatedly in the initial needs assessment completed in March 2002. Specific needs were expressed in reference to planning and siting MPAs, stakeholder involvement, enforcement, and interagency data sharing. For example, the need for more mapping and spatial analysis during planning and implementation was mentioned frequently. In an effort to better define and expand upon the broad technology topics identified, and in order for the TTA to meet those technology needs effectively, a MPA *technology* needs assessment is now underway. The goal of the assessment is to gather information on MPA-related applications of technology and to gauge technical capacity within the marine management community.

There will be two primary lines of inquiry in the technology needs assessment: 1) current applications of technology in MPA planning, implementation, and evaluation, and 2) the capacity within the management community to use existing technology. The assessment will utilize a variety of information sources, including literature, the National Estuarine Research Reserve (NERR) remote sensing needs assessment, the NOAA Coastal Services Center 2002 customer survey, and conference call interviews with managers of existing MPAs.

Initial Brainstorm of Current Management Issues (Participant Discussion)
The discussion covered a large number of issues related to technology and its management applications. Comments seemed to fall within three main areas: the technology itself (existing or needed), analysis of data, and the communication of results (see Figure 1). The following specific management topics were identified as issues where technology is needed: identification of beach renourishment areas and source areas, characterization of essential fish habitats and fish spawning areas, mapping of treated sewage discharge areas, and demonstration of the impact of terrestrial activities on the land-water interface (auto/boat traffic, planning/transportation).

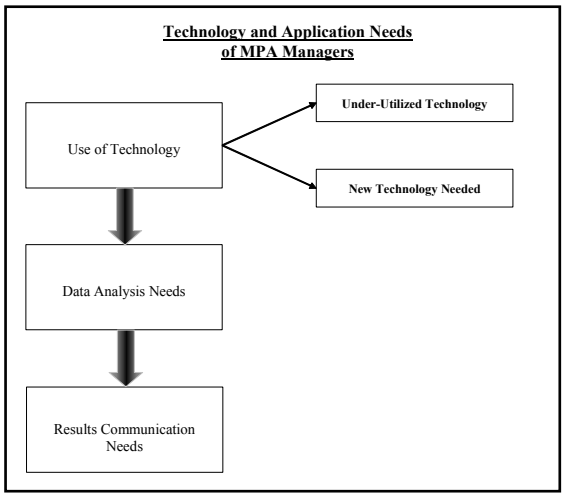

Figure 1

Existing, Underutilized Technology:
This discussion began with a dialogue on the need for accurate, enforceable boundaries of marine managed areas. It was mentioned that, while spatial technology is being applied to the delineation of marine boundaries, a number of issues (both technical and nontechnical) can arise that impede its overall effectiveness. There was also mention of the need for increased use of remotely operated vehicles (ROVs), Global Positioning System (GPS), and remote sensing (RS) technologies in relation to bottom mapping efforts.

The remainder of the discussion focused on mapping needs. The technology for creating these maps and data sets exists, but it is not being used as effectively as it could be. Baseline mapping and, more specifically, benthic habitat maps were mentioned as key needs. The discussion highlighted the need for high-resolution data, specifically bathymetry and bottom type. There was little, if any, discussion about water column data collection. One participant mentioned that such high-resolution data are, in fact, collected for the creation of nautical charts; however, such data is not easily accessible and is not made available for habitat-related or hydrology applications. Efforts are underway at the Office of Coast Survey to make data available beyond their immediate use for charting.

New Technology, Suggestions for Future Developments:
Mapping needs, specifically more comprehensive land cover data, were again raised in this discussion. Technology is needed to accurately map vegetation on land and at the land-water interface. The application of LIDAR to map mangrove-covered shorelines was offered as an example of an underutilized, yet potentially useful technology. Other suggested future technologies or applications mentioned were an enhanced buoy system, enforcement-related satellites, and handheld devices for data entry by scientists and, possibly, fishermen. One participant pointed out that the usability (particularly, time requirements) of such devices must be considered during their development. Voice command and barcodes were discussed as possible solutions to time-intensive data entry on handheld devices.

Data Analysis Needs:
Participants discussed three primary needs associated with data analysis: modeling/prediction needs, data synthesis/integration needs, and personnel needs. The ability to use data for ecological forecasting or predictive modeling with some level of certainty would be a great tool for managers (e.g., forecasting the probability of ship/boat collisions with reefs; forecasting propeller scars in seagrass beds). Although the ability to use geographic information system (GIS) tools for mapping purposes seems to be increasing within the management community, the full capacity of

GIS has not been realized in terms of analytical or decision-making properties. This is largely due to the scarcity of high-quality or high-resolution data. Participants found it useful to be able to synthesize data quickly and integrate that data into the decision-making process. Issue-specific tools that allow managers to "plug in" the data to generate a product that is usable for management decisions would be indispensable.

Finally, problems with the basic structure of many organizations were identified. It was suggested that there are not enough technical resources available at each site to complete the necessary analysis and presentation of data. Some commented that they weren't able to have a dedicated GIS/RS staff, while others said they didn't want a dedicated GIS/RS staff and would prefer to use contractors instead.

Communication of Results:
The subject of delivering results to stakeholders and constituents was discussed at some length. One participant specifically mentioned the need for the "cultural and social technology" to deliver key data and maps to all interested parties easily, calling for improved communication tools. There is a great need for tools to communicate results confidently, specifically to legislators and other decision makers. It is imperative to make the data easily accessible (e.g., on-line) to those who need it. One participant added, "We need the technology to [virtually] get the legislators underwater."

Preliminary Results of the Triennial Coastal Resource Management Customer Survey
The NOAA Coastal Services Center conducts a customer survey every three years. The purpose of the survey is to develop an understanding of major coastal management issues, information needs, and technological capabilities of resource managers. Over two hundred survey packets were distributed to state coastal natural resource management programs, state Sea Grant programs, National Estuary Programs, NERRs, and National Marine Sanctuaries. The response rate was high, with 70 percent of contacted offices responding. A complete report on survey results will be available in May 2003.

Preliminary results of the survey reveal several priority management issues, namely partnership building, outreach, access to information and technology, and the applied use of data and technology. Public involvement and professional development also ranked among the most important issues. Examination of the top ten issues managed within a spatial framework revealed a trend toward growth management issues and related impacts. Shoreline, coastal land cover, protected areas, and coastal land use spatial data sets were reported as the most often used, while elevation, fish habitat distributions, and benthic habitat maps were listed as the most needed data sets. Offshore data sets ranked as "very important" were bathymetry, marine jurisdictional boundaries, and sea surface temperatures. (Note: During this presentation, SIM participants mentioned a specific need for high-resolution data sets from technologies such as LIDAR.)

In the 1999 customer survey, a majority of respondents said only 1-2 staff members were regularly using GIS; however, in this 2002 survey, the majority reported that 6-10 staff members were regularly using GIS. Although overall numbers remain low, the number of staff using remote sensing is also increasing. There is a general trend towards an increased use of both GIS and remote sensing technologies. Of the available GIS software products, the vast majority of coastal managers are still using or moving toward ESRI products such as the ArcGIS family of products. Internet access within the community has increased slightly to 93 percent, of which 86 percent have high-speed connections.

Although 27 percent of surveyed managers reported never making data available to the public, 67 percent of respondents believe that increased access to information and technology will be a high priority over the next three years. The main impediment to data sharing reported by survey respondents (33 percent) is the lack of human resources. (Note: One SIM participant mentioned the need for an assessment of the use of clearinghouses for data distribution. The participant mentioned firewalls and size of data sets as potential problems and questioned if the Web was the appropriate medium for the distribution of these types of data sets.)

When asked what type of technology training was most desirable, many managers (49 percent) were interested in applied, issue-based training options such as identifying and mapping coastal hazards.

Results of the National Estuarine Research Reserves Remote Sensing Needs Assessment
In 2002 a needs assessment was conducted of the 25 National Estuarine Research Reserve (NERR) sites. The objective was to identify the critical issues within the NERR system that can be addressed using remotely sensed data. The assessment not only reviewed the capacity of the different NERR sites to use remote sensing and GIS, but also examined data and hardware needs. Phone interviews were conducted with each reserve, and a primarily qualitative analysis of the results was performed.

When asked to prioritize their data needs, four of the top five data sets reported were land cover-related. Over 30 percent of those surveyed reported that the most essential analysis in their NERR would be change-related (short-term variations and long-term change). Land use, water quality, and erosion were also reported as analysis priorities. NERR management priorities were also evaluated. Policy, planning, and restoration were identified as top priorities. An assessment of management strategies, education and research, and acquisition were also among the top five reported management priorities. The list of existing technologies included aerial photography, satellite imagery, GIS, GPS, side scan sonar, and single beam sonar. Shallow water bathymetry and mapping systems were identified as a high-priority technology need for the management of estuaries. Remote sensing software, training, aerial water quality mapping (spatial parameters), modeling, and LIDAR were also listed as specific needs. There was a general need for higher resolution (1-4 meter), multispectral imagery, as well as high-quality topographic data; both are considered important for identifying watershed-scale phenomena.

A common theme throughout the assessment was the need for dedicated GIS and RS staff. This is especially relevant considering that GIS and RS applications cut across all reserve activities, from management to research, education, and stewardship. The assessment also revealed that GIS is primarily being used to display existing data rather than as a spatial analysis tool.

<u>Participant Commentary</u>
One participant mentioned the need to bridge the gap between technicians who are experts with the technology (GIS/RS) and scientists who are experts in terms of the issues and analyses. It was suggested that it would be useful to get away from the notion that the utilization of spatial technology requires an entirely separate role or position within the agency. The optimal situation would be for the managers and scientists to view GIS and remote sensing as accessible options within their suite of potential management tools. GIS expertise must not remain in a single position, but rather capacity should be raised across staff members.

One participant commented that mapping “change” is not very important from the ecological perspective; identifying the cause of changes is what is important. On the subject of utilizing existing and historical data vs. the collection of new data, participants said there are significant problems with combining different data sets. Often data sets collected at different times have

different datums, scales, and spatial accuracy. In one case mentioned, 90 percent of existing data was discarded in favor of newly collected data because of spatial resolution problems. Participants discussed the greater need for high-resolution field data over lower-resolution data. It was noted that the use of multibeam backscatter is now quite cost effective (it can be towed at 7-8 knots).

Break-Out Issue Discussions

SIM participants prioritized issues for discussion by each choosing three top issues. The top five issues identified by the group were:

(1) Application of terrestrial models to the marine environment and across the land-sea interface
(2) Baseline mapping: data requirements to map or model impacts
(3) Data analysis and ecological forecasting
(4) Oceanographic modeling and high-resolution bathymetry
(5) Data sharing

(1) Application of terrestrial models to marine environment and land-sea interface

This discussion focused on the possibility of applying terrestrial models to the marine environment. It was mentioned that the marine environment is more dynamic and, therefore, requires more temporal information. There is a great need for high-resolution data, especially for bottom habitat, but according to one participant the feasibility of having a benthic habitat map equivalent to a terrestrial land cover map is still being debated. Some feel it is impossible to model the marine ecosystem until there is a good map of what is on the bottom of the oceans, bays, and estuaries. It is necessary for MPA-related mapping and modeling efforts to cross the land-sea interface to ensure that potential terrestrial impacts are properly understood. For this to happen, there is a need for multidisciplinary staff. A Lake Tahoe, California, GIS map was offered as an example of a publicly available (on-line), high-resolution data set. The coasts along Los Angeles and San Francisco have been mapped with multibeam and LIDAR and were also offered as examples.

(2) Baseline mapping: data requirements to map or model impacts

There is a need for not only good baseline data, but also a time series (i.e., baseline data are not of much use if there are no subsequent surveys with which to compare them). This is a problem because funding is often provided for a one-time data collection, as opposed to a long-term monitoring effort. The funding process needs to be considered as a whole, and there is a need to determine the minimum amount of data needed for it to be useful. The answer is not always in getting higher and higher resolution data, but, rather, the right kind of data at the right resolution. Ideally, a project will be multiresolutional. There is also a need to go beyond the visual or mapping aspects of GIS to explore the spatial interactions between geospatial data layers.

(3) Data analysis and ecological forecasting

Sanctuaries and other MPAs recognize the need for GIS and other technology tools; however, data analysis and modeling possibilities are often not fully explored. Increased staff size has helped meet the increased need for applied technology. There is a need to take GIS beyond its "pretty map-making" abilities and to use it for true analysis. While training is provided relative to these types of analyses, it is often not applied at the site level and, thus, is lost among the majority of staff members. It was suggested that there be a central technical capacity among staff in order to achieve this level of analysis. However, several participants then suggested that the best way to increase analysis would be to contract out this type of work (especially when dealing with high-resolution data), as opposed to creating new positions. Sanctuary staff would then be expected to know what to do with the data once analytical output is delivered. Monterey Bay

NMS was cited as an example of a site with good near shore habitat maps and a high level of interest at the analysis level.

(4) Oceanographic modeling and high-resolution bathymetry
One participant raised the issue that standard GIS packages are often not sufficient or dynamic enough to map currents, tides, and other marine processes. There is a need to explore dynamic modeling packages that have the potential for near real-time capabilities. One participant mentioned the need for good benthic maps at the site level.

(5) Data sharing
Managers and staff need to focus on how to get the data they need and how to make it useful. Staff needs to be made aware of the advantages of sharing data. In turn, upper-level management needs to be educated in terms of the benefits of collaboration and data sharing. Some people are concerned that they will "lose" their data if they share it, or that it will be misused. Due to some of these sensitivity issues, the most popular way to exchange data still seems to be at the staff level. However, data-sharing also needs to take place at the state level. In order to reassure data providers and achieve the necessary comfort level with data sharing, it may be helpful to provide assistance with the creation of legally defensible disclaimers.

Clearinghouses were discussed as a mechanism for data sharing; however, the data available in clearinghouses may not be fully representative of the existing data. It was suggested that clearinghouses contain only a fraction of existing data resources, and that, if incentives were given to data providers, the management and scientific communities might be more likely to exchange data.

Summary Discussion: How do we raise capacity within the management community to use existing tools? How do we design and deliver new tools to maximize their utility for managers and their staffs?
There is a need for specific training in spatial reasoning and spatial logic; staff members need to think more about the process and steps and less about which buttons to push. There is also a need to inform managers about which tools are available to them, beyond ArcGIS. This needs to be company-independent and should include a variety of options, highlighting the advantages and disadvantages of each. Training of any kind should include follow-up sessions or assignments so staff will be more likely to use what they have learned.

More partnerships should be established, but it is often difficult to identify potential partners on a project. Even within NOAA, it is often difficult to know who's who and who does what. This information would be crucial. The possibility of developing stronger partnerships between NOAA and academia should be explored. Participants felt that this relationship holds great potential but is underutilized. Such partnerships could help provide the data analysis that cannot be done in-house. For this to happen there needs to be a connection between the manager, the funding source, and the academic. Face-to-

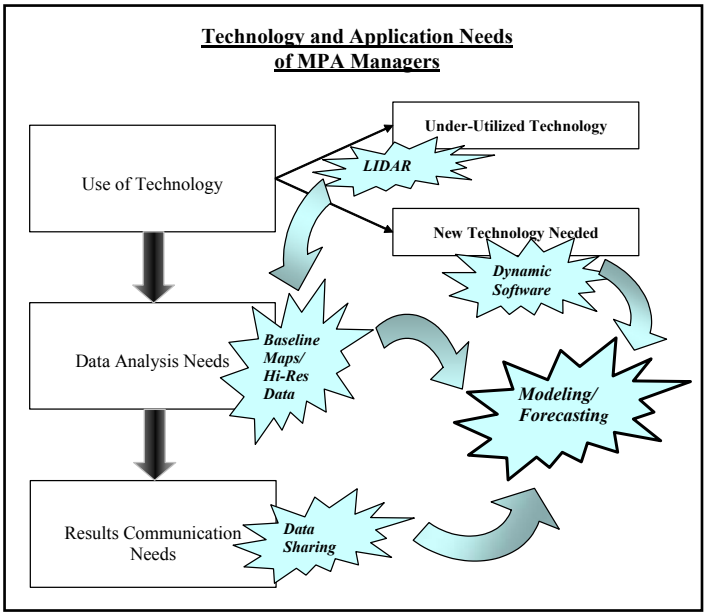

Figure 2

face interactions should be maximized to improve communication.

To improve data sharing, case studies could be written to document the positive experiences that agencies and organizations have had with data sharing. In the Florida Keys, for example, most of the projects are government-funded and have had widely available data with good sharing experiences. The Florida water quality protection program involved successful cooperation among 21 principal investigators and was also mentioned as a possible case study. In addition, a participant suggested that data sharing would improve if it were made a condition of funding. If funding entities stated explicitly that data must be made publicly available in order to receive the award, more groups would be encouraged to distribute their data.

Closing Remarks

The information gathered during the SIM will inform the MPA technology needs assessment. A draft of the assessment will be completed by the end of the summer.

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Appendix E
NERR Needs Assessment (2002) Executive Summary

Addressing Habitat Issues with Remote Sensing in the
National Estuarine Research Reserve System
Needs Assessment Final Report
October 2002

In the summer of 2002, the National Oceanic and Atmospheric Administration (NOAA) Estuarine Reserves Division and Coastal Services Center conducted a remote sensing and geographic information system (GIS) needs assessment of the reserve system to identify the common issues, capacity needs, and data used in the system. The information was collected through hour-long conference calls with staff at each reserve and the needs assessment team. Prior to the calls, reserves were asked to identify three priority issues within their respective reserves that they felt could be addressed with remote sensing and GIS.

Priority Issues
The needs assessment collected information on three priority issues that could be addressed with remote sensing and GIS. These issues were generally categorized as data, analysis, or management needs, but sometimes fell into several categories or none at all. The most common data need was upland land cover, followed by information on benthic or subtidal habitats. Topographic and bathymetric data, as well as information on water quality issues such as turbidity, were also common needs throughout the reserves. The analysis category contained issues that required ancillary data collection. A common need expressed was the need for measuring change for different land uses or covers that could be used to examine historical changes, monitor erosion, or assess impacts on managed areas. The management category was the most diverse of the three. It included common issues such as restoration, acquisition, policy and planning, and education and research. There are a number of management issues that could be informed by using remote sensing and GIS data, including permitting for docks, controlling storm water runoff, conducting risk assessments, and deciding where to focus restoration efforts.

Other Results
Many reserves recognize the value of remote sensing and GIS; however, most of them are limited in their capacity to go beyond their current uses and need additional staff and training. Many reserves lack a dedicated GIS staff person, but some have developed partnerships to fulfill their needs. The reserve system is a diverse collection of sites with few having the capacity to conduct in-depth analysis of spatial data. Many of the reserves have access to a variety of data sources (e.g., state data clearinghouses) but often find that those sources are not high-resolution.

Results Overview
The assessment identified several common themes among the reserves. First, several reserves do use remote sensing and GIS, but they limit their use to certain activities, such as creating maps of different data layers. They could expand their use of these technologies to various other projects, especially spatial analysis. Second, most reserves do not have sufficient personnel. They need additional staff or training to utilize GIS and remote sensing capabilities fully. Finally, each reserve's expanded use of remote sensing and GIS could benefit the entire system as reserves apply specific uses to larger, system-wide projects and programs.