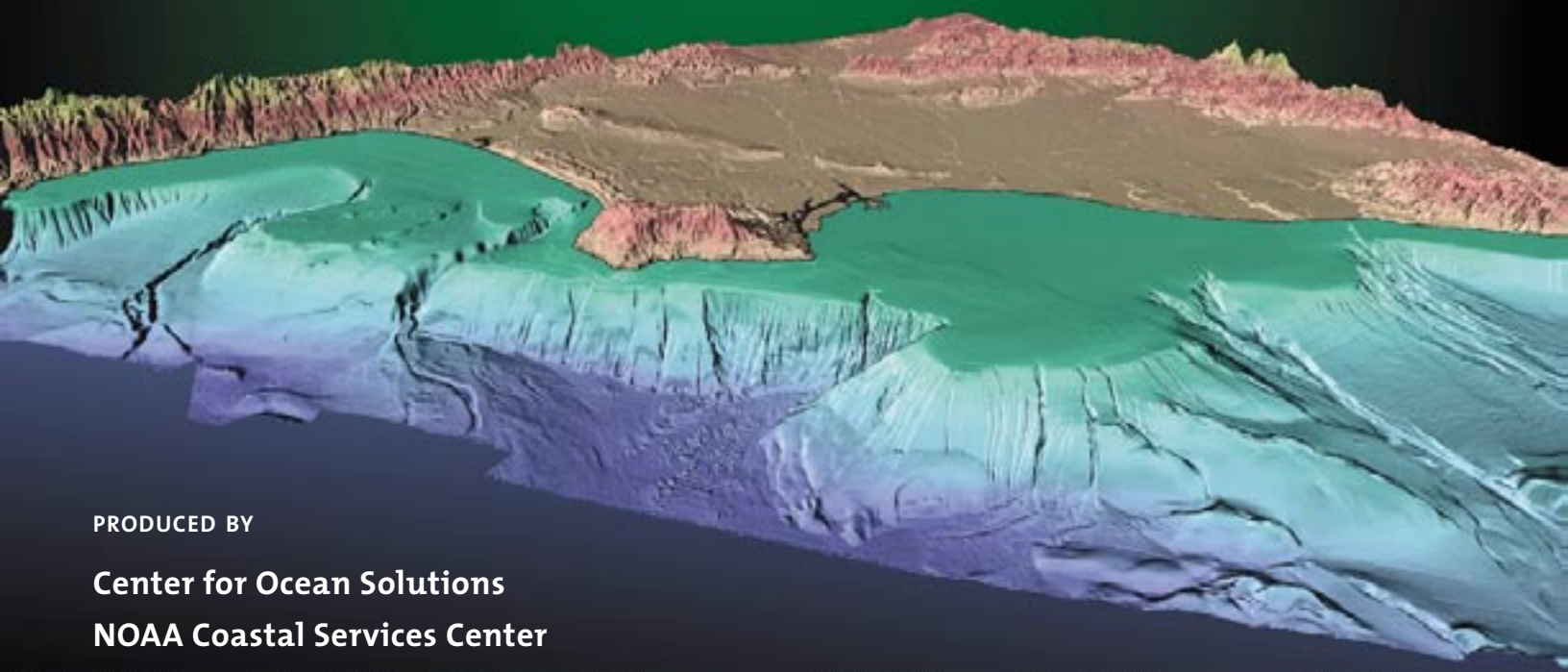
Collaborative Geospatial Information and Tools for California Coastal and Ocean Managers

WORKSHOP REPORT

November 2009



PRODUCED BY

Center for Ocean Solutions
NOAA Coastal Services Center
California Ocean Protection Council
California Ocean Science Trust

FUNDING PROVIDED BY

The Nature Conservancy

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CENTER FOR OCEAN SOLUTIONS

NOAA Coastal Services Center
LINKING PEOPLE, INFORMATION, AND TECHNOLOGY

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CONTENTS

Introduction

THIS REPORT is a compendium of ideas and recommendations on geospatial data management put forward during presentations and discussions at the workshop titled "Collaborative Geospatial Information and Tools for California Coastal and Ocean Managers," held August 17 to 18 at Stanford University in Palo Alto, California. The workshop brought together approximately 75 representatives of state and federal agencies, academic institutions, and nongovernmental organizations, consisting of roughly equal numbers of technical staff members (i.e., GIS specialists), project managers, and upper-level program managers. Nearly half of the participants were employed by the State of California. (See Appendix III for full list of workshop participants.)

The purpose of the workshop was to assess the current and potential capabilities and needs of resource managers to manage and share geospatial data. Geospatial data contains geographic information, such as the location of streets, regulatory boundaries, or habitats, which is typically shown on a map; it can be analyzed and viewed through geographic information system (GIS) software, such as ESRI's ArcGIS, or through open source software, such as Google Maps. California possesses a plethora of geospatial data on both terrestrial and marine resources, as well as human uses on land and in the sea. This information can be very useful for making well-informed permitting and planning decisions about marine resources, identifying existing and potential user conflicts in the marine environment, and allowing more comprehensive planning offshore. However, resource managers, particularly in California, are often either unaware of or do not have adequate access to this information.

The major foci of the workshop were as follows:

1. Identify barriers to managing and sharing geospatial data among agencies and methods to overcome these barriers;
2. Present geospatial decision support tools that state and federal agencies currently use and other tools that could be useful; and
3. Understand how geospatial data can be used to support marine spatial planning efforts at the state and national levels.

The main results of the presentations and break-out group discussions will be presented in this report, along with a set of recommendations for improved geospatial data management in California. These recommendations are summarized below. (See Appendix III for the full list of workshop participants.)

INTRA-AGENCY RECOMMENDATIONS

A. Build agencies' capacity to manage and use geospatial data.

   i. Hire and retain more GIS-trained staff members through a new GIS employee classification exam and more competitive compensation packages.

   ii. Develop an education and training process so that managers can become familiar with using decision support tools (both uses and limitations).

   iii. Dedicate a portion of agency budgets to equipment, data management, and sharing efforts.

   iv. Enhance and maintain technical resources such as bandwidth and software licenses.

B. Facilitate better coordination between agency departments and between agencies' technical and managerial staff.

   i. Dedicate "data diplomats" for intra-agency coordination.

   ii. Solicit support from upper-level managers for data management efforts.

INTER-AGENCY RECOMMENDATIONS

A. Facilitate collaboration between marine and terrestrial agencies.

   i. Coordinate data-sharing efforts with support of the state Geographic Information Officer (GIO).

   ii. Dedicate "data diplomats" for inter-agency coordination.

B. Help agencies share and access data.

   i. Assess data discovery and search tools, such as data portals, search engines, and clearinghouses.

      I. Organized by resource, theme, or agency.

      II. Established by an authoritative source (i.e., the state GIO).

   ii. Develop common data and metadata standards so that data are easily interpreted and measurements can be compared over space and time.

   iii. Craft a common language ("ontology") to make it easier for users to locate and understand relevant data.

   iv. Develop contract language to ensure that agencies maintain data authorship and that data become part of the public domain.

   v. Resolve legal issues relating to confidentiality, open source access, and system security.

C. Coordinate collaboration among state and federal agencies, academics, nongovernmental organizations (NGOs), and industry groups.

   i. Craft interagency data-sharing agreements.

   ii. Employ "data diplomats" to coordinate agencies' data-sharing efforts.

   iii. Establish working groups to set standards, assess appropriate data-sharing tools, and illuminate existing and needed data sets.

   iv. Develop incentives for data-sharing.

   v. Build sustainable sources of funding through public-private partnerships, business interest group investments, or renewable energy portfolios.

STATE LEADERSHIP RECOMMENDATIONS

A. Establish a geospatial information policy for the state that includes a mandate for all agencies to support geospatial data management.

B. Augment agency budgets for additional GIS support staff.

   i. If funding is limited or not available, employ limited-term fellows through federal or private programs.

C. Assess agencies' ownership of and needs for geospatial data and tools.

   i. Clarify agencies' objectives for using geospatial data.

   ii. Identify data sets that agencies need and prioritize actions that make them more accessible.

   iii. Create baseline data sets that can be used by multiple agencies.

   iv. Prioritize the creation of data sets that are easier to assemble and needed by a majority of agencies.

D. Assess geospatial data sets and decision support tools that can be used for multiple ocean uses and areas.

   i. Gather input from agencies, user groups, and the public.

   ii. First identify geospatial data on existing uses; then focus on emerging uses relevant to California.

Setting the Context

SPATIALLY MANAGING THE MARINE ENVIRONMENT IN CALIFORNIA AND THE NATION

Opening comments from Meg Caldwell, Amber Mace, and Rebecca Smyth are summarized to provide the context of the workshop's purpose and goals.

Meg Caldwell, Executive Director of the Center for Ocean Solutions

California's state and federal agencies share significant concerns about managing, sharing, and analyzing geospatial data to fulfill their missions. The primary goal of this workshop is to convene the agency stakeholders for a joint look at their uses of geospatial data. The secondary goal is to examine the state and West Coast policy implications of President Obama's June 2009 Memorandum regarding a national ocean policy and a marine spatial planning (MSP) framework.

STATE PERSPECTIVE

Dr. Amber Mace, California Ocean Science Trust

Responsive and well-coordinated geospatial information policies are critical to the California Ocean Protection Council's (OPC's) ability to function as a leader and facilitator of California's ocean and coastal agencies. In addition to their existing mandates and workloads, state agencies and their federal counterparts face many emerging issues ranging from marine aquaculture to climate change adaptation and offshore energy facility siting. OPC and California Ocean Science Trust (OST) staff members need the workshop participants to help formulate recommendations for improving existing information resources and decision support tools for the benefit of all the interested agencies.

The purpose of the workshop is to help identify concrete, achievable opportunities to leverage the information-related resources and expertise of the agency family. Past attempts to create information infrastructures have focused on ideal solutions that, in practice, could not be implemented with available resources and expertise. Because agencies have diverse needs and goals, OPC will not be looking for perfect, "silver bullet" solutions; rather, OPC's goal is to identify existing tools and assets and think about ways to adapt them to emerging needs.

Geospatial information management and sharing solutions are highly relevant to California's ability to inform a national-scale MSP policy. Although California has no current mandate for MSP, state agencies do have expertise and information that could provide the underpinnings of a more comprehensive ocean planning exercise. Workshop attendees should consider this workshop as an early opportunity to think about MSP from ideal perspectives as well as practical ones.

FEDERAL PERSPECTIVE

Becky Smyth, NOAA Coastal Services Center

Opportunities exist to take advantage of policies and resources that are emerging in the new federal administration. Specifically, there is policy-level support for marine decision-making, including MSP, in the White House and among the leaders of the National Oceanic and Atmospheric Administration (NOAA) and the Department of the Interior. Before implementing any new policies, the federal government would need to identify and acquire the necessary tools and assets; it would also need to identify strategies for deploying its resources. The first question for California agencies is how to ready themselves to handle emerging uses and issues such as marine renewable energy, climate change, and marine aquaculture. The next question is whether they can agree on collaborative strategies for applying federal resources in service of a comprehensive vision for governance.

California's marine governance successes ought to be considered by workshop attendees as they collaborate on strategies for developing information assets and tools. The state seafloor mapping project is a great example of state and federal agencies' cooperative and strategic use of resources to achieve common goals. In that case, the agencies established a good working relationship that not only provided high-quality baseline data for multiple governance applications, but also helped the federal government agree to provide additional support when California encountered a fiscal crisis. The West Coast Governors' Agreement on Ocean Health is a second successful example of collaboration. That partnership has provided a forum for joint science and policy decision-making; more importantly, however, it has highlighted the West Coast as an exemplar of marine resource management. Federal agencies have developed a number of information products and decision support tools (such as the California Ocean Uses Atlas, the Multipurpose Marine Cadastre, and the Sanctuary Integrated Monitoring Network) that could be leveraged with state-supported tools such as MarineMap to provide cutting-edge support for marine governance applications.

This session was closed with an observation and two questions for the attendees to answer during the workshop. "A lot of information is out there. How do we get it, and how do we make it useful?"

Geospatial Data Needs and Use: Survey Results

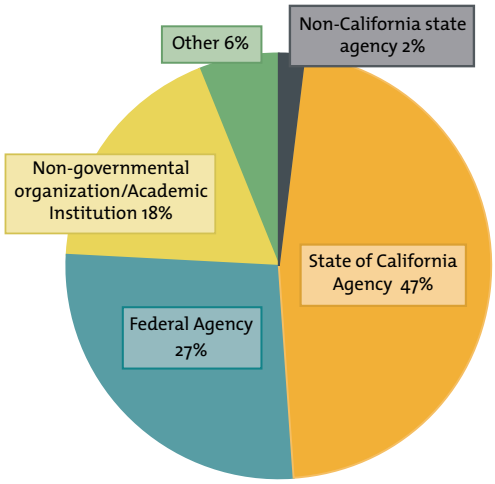
A **PRE-WORKSHOP SURVEY** was distributed to solicit information from workshop invitees and collect baseline data on the capabilities and needs of participating agencies to manage geospatial data. The survey addressed the following topics: data uses and data types, geospatial tool use, including ArcGIS, data-sharing and coordination, and agency priorities with respect to data management. The survey results were used to inform workshop discussions and shape resulting recommendations.

A complete copy of survey results and the figures referred to in this summary can be found in Appendix V of this report.

EMPLOYMENT

A total of 49 participants took the survey in roughly equal groups of upper-level managers (29%), project managers (35%) and specialists in geospatial data and tool use and development (37%). Approximately half of the survey participants were employed by State of California agencies (47%), and a quarter were from federal agencies (27%). The remaining participants were from nongovernmental organizations and academic institutions (18%), non-California state agencies (2%), and "other" entities (6%).

Figure 2: Place of Employment



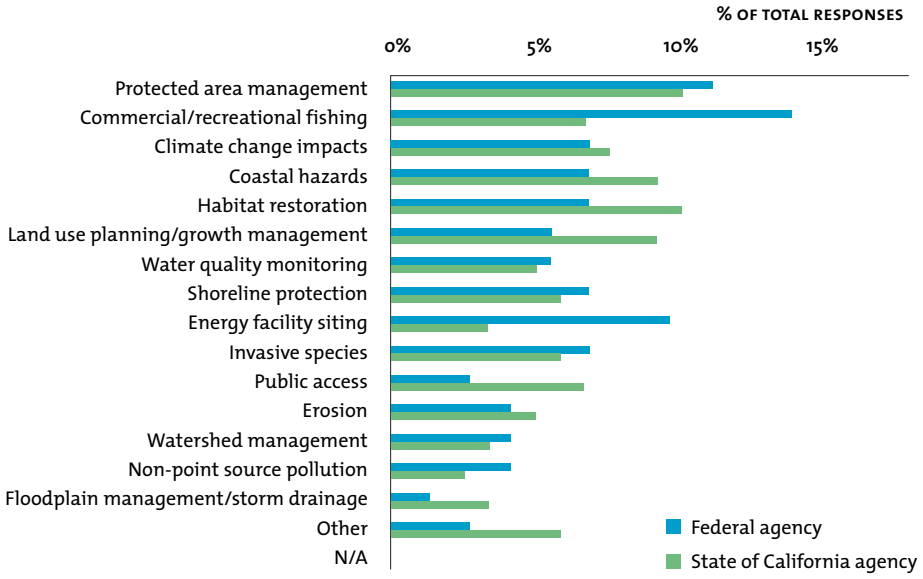
DATA USE

Respondents were asked to indicate the purposes for which they frequently use geospatial data and tools: regulatory activities, long-term planning and development, research, or other purposes. The most frequent response was long-term planning and development, followed by research and regulatory activities (Appendix V, Figure 3). Other purposes of geospatial data and tool use that were not listed in the survey but added by respondents included emergency response, renewable energy siting, and outreach and communication (V, Figure 3).

Depending on their job descriptions, respondents differed in their use of geospatial data and tools for project- or permit-specific decision-making. The vast majority of geospatial specialists used data and tools weekly, whereas project managers and upper-level managers tended to differ, using data and tools on a weekly, monthly, or yearly basis (V, Figure 4). Project managers were more likely to use data and tools weekly, whereas upper-level managers were more likely to rarely or never use geospatial data and tools (V, Figure 4). All respondents employed by the State of California responded that they use geospatial data and tools for project- or permit-specific decision-making at least some of the time; no one from the State of California agencies reported using these tools rarely or never (V, Figure 4). In contrast, for monitoring and compliance decisions, over half of the state agency respondents use geospatial data and tools only a few times a year, rarely, or never (V, Figure 5).

Respondents most frequently use geospatial data to address the following issues: protected area management, commercial/recreational fishing, climate change impacts, coastal hazards and habitat restoration (V, Figure 6). California agency respondents identified their top issue areas as protected area management, habitat restoration, coastal hazards and land use planning/growth management, whereas federal agency respondents prioritized commercial/recreational fishing, protected area management, and energy facility siting as their top issues (V, Figure 6).

Figure 6: Issue areas for geospatial data use (California State vs. Federal Agencies)



DATA TYPES

Respondents identified the following geospatial data types as the most frequently used: bathymetry/topography, coastal aerial imagery, jurisdictional boundaries, marine habitat, and protected/managed areas (V, Figure 7). The top spatial data needs that were seen as important, but are currently lacking or inaccessible, include marine habitat, bathymetry/topography, ocean monitoring, species range or activity, and fisheries data (V, Figure 8).

Figure 7: Spatial Data Use

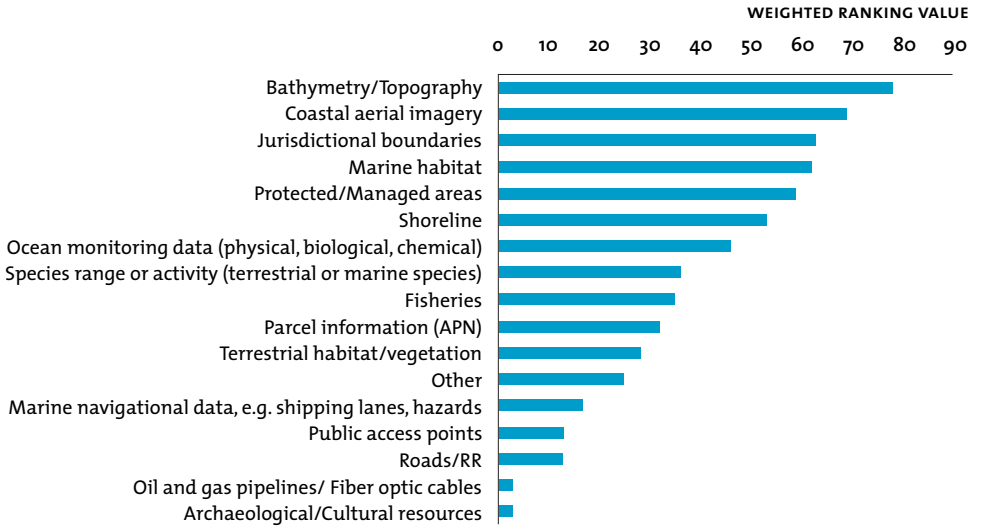
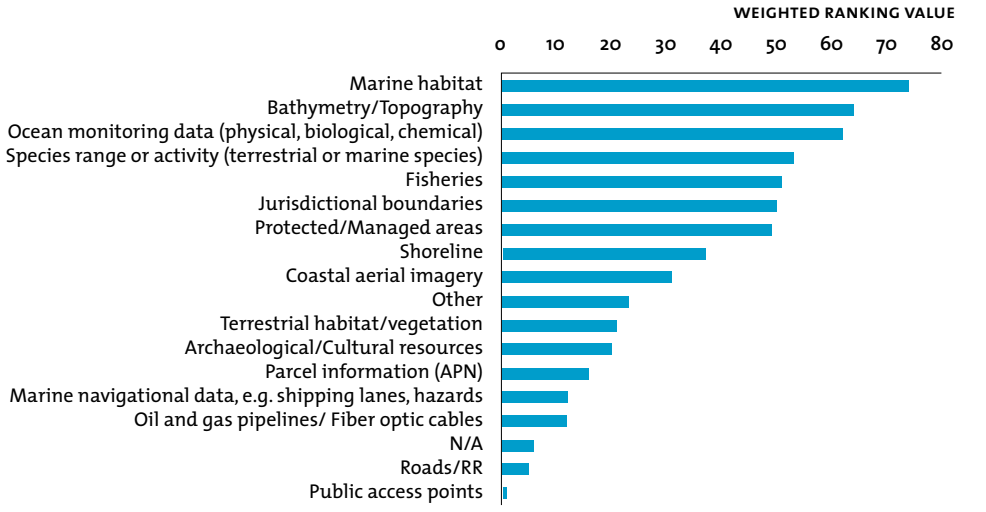


Figure 8: Spatial Data Needs



ARCGIS USE

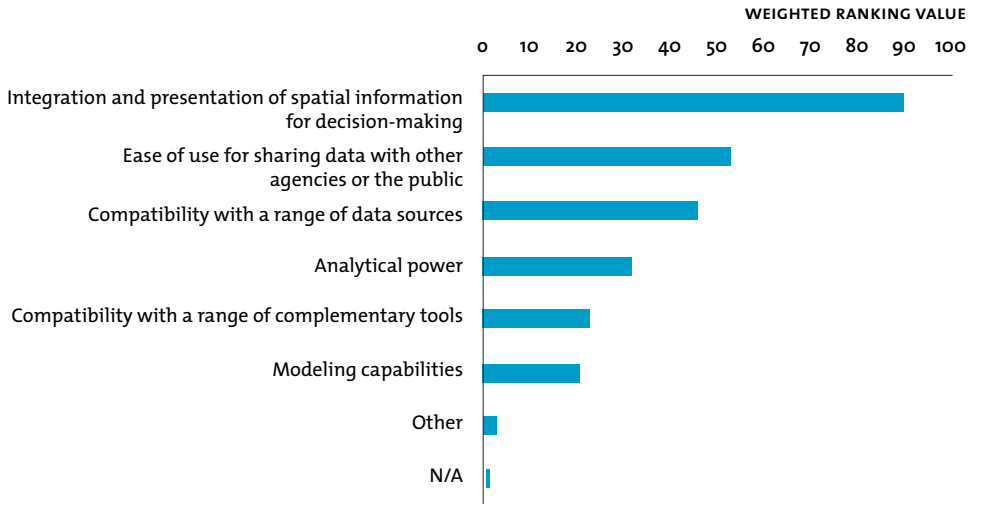
Approximately 80% of the respondents stated that they use ArcGIS to support their professional work, half of whom use ArcGIS 9.3 or an earlier version. The remainder use ArcGIS server, ArcExplorer, or other ArcGIS software (V, Figure 10).

DECISION SUPPORT TOOLS

All respondents stated that they were familiar with Google Earth, and over 90% had used this tool. Approximately half of the respondents were aware of Web-based internal mapping interfaces (IMS) available to them, as well as state coastal atlases, and tools such as MarineMap, NOAA's Multipurpose Marine Cadastre, and the California Ocean Observing System interface. Of these tools, only IMS systems were actually used by the majority of the people who were aware of them, whereas the remaining tools were used by less than half of those who were aware of them (V, Figure 11). Several respondents also provided a list of other data tools that they find useful and a list of tools that would be useful but are currently inaccessible (V, Figure 12).

In another question, respondents indicated that the most helpful function of new or adapted geospatial tools was the integration and presentation of spatial information for decision-making purposes. Also helpful was the ease of use for sharing data and compatibility with a range of data sources (V, Figure 13).

Figure 13: Helpful functions/traits of geospatial tools



DATA-SHARING

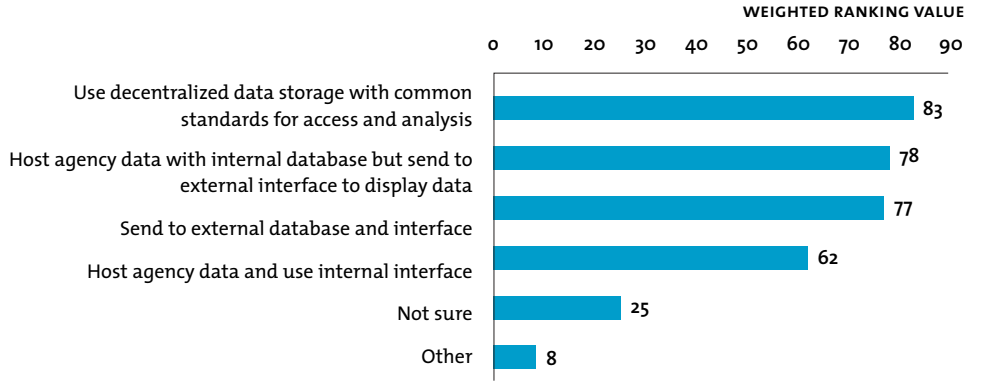
Most of the agency respondents share geospatial data with other agencies (86%). Data are shared between agencies primarily by sending data files directly to the recipient, although many agencies also host data and use internally developed interfaces for data display (V, Figure 16). Explanations from those who do not share data included the need for confidentiality, lack of resources, and lack of data, as well as uncertainty about why their agencies do not share data.

DATA COORDINATION

Respondents were asked to rank barriers to finding and sharing geospatial data. The top barrier listed by respondents was that data sets are unknown or not readily available. All the other barriers mentioned in the survey appeared to be significant issues for respondents, including issues with data confidentiality and problems with the suitability of data scale/resolution (V, Figure 17).

Almost all respondents stated that they would be willing to share data for a coordinated state agency mapping effort (95%), although comments indicated that barriers to data-sharing present considerable obstacles (V, Figure 18). The preferred way to share data with other agencies would be a method of decentralized data storage with common data standards for easy access and retrieval. Respondents were also interested in hosting their own agency data with an internal database and sending the data to an external interface for display, or sending data to both an external database and interface (V, Figure 19).

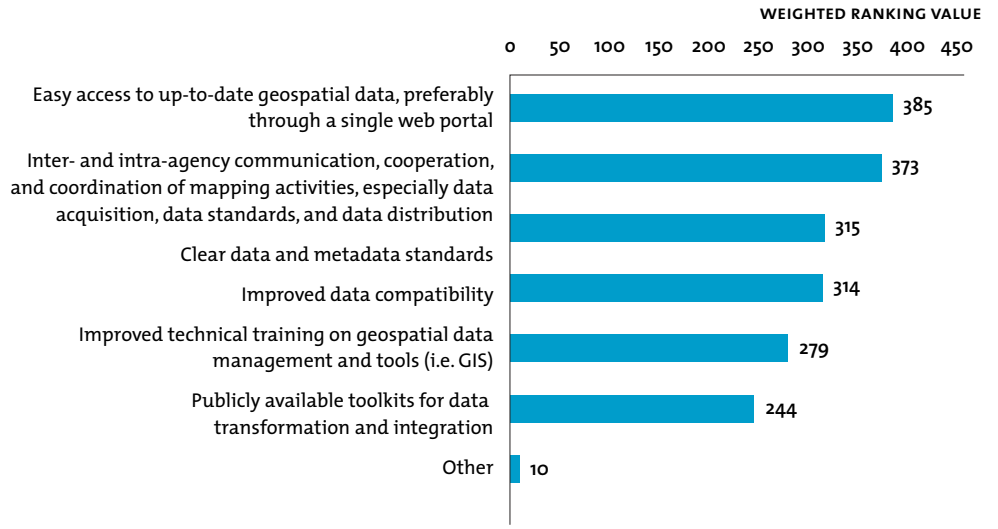
Figure 19: Data Sharing Preferences



AGENCY PRIORITIES

The most common priority for state and federal agencies with respect to data management was easy access to up-to-date geospatial data, preferably through a single Web portal (V, Figure 20). Respondents also indicated a number of other high priorities, including inter- and intra-agency communication, and cooperation and coordination of mapping activities, especially data acquisition, data standards, and data distribution.

Figure 20: Agency Priorities



WORKSHOP AND SURVEY FEEDBACK

Respondents were asked to provide general feedback on survey content. Their comments provided additional information and suggestions for geospatial data use and sharing (V, Figure 21).

During the workshop, participants were encouraged to provide information about additional data that were not mentioned in the survey, but would be helpful for better geospatial decision-making support, as well as ideas for emerging activities in the coast and ocean that could benefit from a spatial management approach.

Respondents identified additional data gaps in the areas of physical oceanography, climate change impacts, time-dependent monitoring, habitat and species data, and human uses such as fishing (V, Figure 22). Agencies could benefit from improved geospatial data and tools for analyzing human uses such as fishing, shipping lanes, ocean energy development, restricted/managed areas, and desalination plants, as well as managing marine debris (V, Figure 23).

Presentations

Workshop participants were given the opportunity to learn about specific geospatial initiatives and tools to increase their knowledge and facilitate collaboration of data management efforts. In the first set of presentations, practitioners described premier data management and collaboration initiatives developed in California or on the West Coast. The second set of presentations looked at geospatial decision support tools that are being used in resource conservation and management around the country.

GEOSPATIAL DATA-SHARING INITIATIVES

Cal Atlas

http://atlas.ca.gov/

The Cal-Atlas online geospatial data clearinghouse aims to facilitate the coordinated and sustainable development, maintenance, licensing, and sharing of geospatial data and Web map services by California government agencies, partners, and stakeholders. California government agencies work with the California GIS Council, regional GIS collaborations, and the broader California GIS community to define the data architecture, systems, standards, agreements, and processes for a fully integrated and effective California Spatial Data Infrastructure.

Oregon Coastal Atlas

http://www.coastalatlas.net/

The Oregon Coastal Atlas is a multi-group project that aims to be a useful resource for the various audiences that make up the management constituency of the Oregon Coastal Zone. The project is a depot for traditional and digital information that can be used to inform decision-making. The Atlas provides background information for different coastal systems, access to interactive mapping, online geospatial analysis tools, and direct download access to various planning and natural resource data sets relating to coastal zone management.

Google Ocean

http://earth.google.com/ocean/

Google Earth is an open source, web-based tool that allows users to view the environment from various perspectives. Google Earth contains a new ocean layer that allows users to visualize bathymetry, ocean temperature, animal tracking data, hypoxic dead zones, ocean expeditions, and other geospatial information. The creators of Google Ocean plan to add three-dimensional visualization features such as shipwrecks and coral reefs. Other layers feature content from over one hundred partners, such as the British Broadcasting Corporation, National Geographic, and the Monterey Bay Aquarium. The creators hope that their tool will make the ocean more visible to the public for educational purposes.

GEOSPATIAL DECISION SUPPORT TOOLS TO ADDRESS KEY MANAGEMENT ISSUES

TNC Ecoregional Assessment

http://www.nature.org

The Nature Conservancy's (TNC's) mission is to conserve the world's biodiversity. With partners, TNC uses ecoregional-scale assessments to identify a set of places that, if protected, would ensure the long-term survival of all native species and communities—not just those that are currently threatened. These "priority conservation areas" are identified at the scale of ecoregions, which are marine or terrestrial regions defined by their distinct climates, geologies, and native plant and animal species. Using a collaborative, science-based approach, TNC assembles the best available data on the distribution of habitats and species and uses the data to determine where biodiversity concentrations are located, where environmental threats are greatest, and where conservation efforts may be most needed and effective. The compilation of spatial data and identification of important places provides a foundation for conservation strategies, but it is also relevant to a variety of other types of spatial planning efforts.

MarineMap

http://www.marinemap.org/

MarineMap is a Web-based decision support tool for open and participatory spatial planning in the marine environment. MarineMap offers a simple, flexible, and powerful means of gathering expertise from resource managers, scientists, stakeholders, and the public in a process of collaborative decision-making. MarineMap now offers users Web-based access to all the data, methods, and analyses that scientists use to evaluate proposals for marine protected areas (MPAs). Without special training or assistance, working in a group setting or at home, MarineMap users can draw, evaluate, and discuss prospective MPAs.

Multipurpose Marine Cadastre

http://www.csc.noaa.gov/mbwg/htm/multipurpose.html

The Multipurpose Marine Cadastre (MMC) is a marine information system for the outer continental shelf and state waters developed by NOAA and the Department of the Interior's Minerals Management Service (MMS). The MMC addresses the increasing demand for information relevant to alternative energy planning by providing direct access to authoritative marine geospatial data from federal and state sources. Data incorporated into the MMC include jurisdictional boundaries, restricted areas, laws, critical habitat locations, and other important features. These data sets are available through a Web portal in several common file formats such as ESRI and KML, and as Web services. Data can be viewed through both ArcIMS and Google Earth applications. The MMC also offers users the option to download data sets from authoritative sources.

Case Studies

GROVER FUGATE AND JOHN WEBER presented two different examples of marine spatial planning (MSP) that are now being used on the east coast of the U.S.; their presentations are summarized below.

THE RHODE ISLAND OCEAN SPECIAL AREA MANAGEMENT PLAN

Grover Fugate, Rhode Island Coastal Resources Management Council

The Rhode Island Coastal Resources Management Council (CRMC) has begun to amend the state's federally approved Coastal Zone Management Program (CZMP) to enable MSP for offshore renewable energy and other uses of the coastal zone and federal waters. Rhode Island has been very concerned with climate change. The state government has decided to invest considerable resources in reducing carbon dioxide emissions by facilitating the development of offshore wind power projects. CRMC will play a major role in development by gathering comprehensive environmental and economic data and incorporating that information into large-scale marine spatial plans.

CRMC has used the Coastal Zone Management Act's Special Area Management Plan (SAMP) provision as a tool for organizing and implementing its energy planning process. Rhode Island has used SAMPs to govern a range of human uses in its coastal zone for nearly three decades. As used by CRMC, SAMPs facilitate "ecosystem based management" by balancing economic development and environmental protection over the long term. The state's Ocean SAMP will allow the state to look at entire areas of the ocean, assess the available resources and development constraints, and plan for appropriate development.

CRMC's planning process depends on high-quality geospatial information and decision support tools. Most importantly, CRMC used maps of seabed bathymetry and seabed geology to predict "construction effort" for siting offshore wind farms. These construction effort predictions could be combined with wind-speed measurements and models in a "technical development index"—a technology-based "metric based on technical challenge to power production potential" that could help the state and developers identify cost-effective sites for wind farms. Rhode Island is gathering additional information about human uses (such as fishing) and key species (such as right whales) that it will use to ensure that the Ocean SAMP leads to environmentally and economically sustainable outcomes.

THE MASSACHUSETTS OCEAN PLAN

John Weber, Massachusetts Office of Coastal Zone Management

The Massachusetts Office of Coastal Zone Management (CZM) and the Massachusetts Executive Office of Energy and Environmental Affairs (EEA) have been developing a comprehensive ocean management plan for Massachusetts state waters. As in Rhode Island, offshore wind power proposals drove Massachusetts to begin a planning process. State senators,

as well as the governor, were concerned that Massachusetts's existing governance framework would leave the state open to numerous development proposals without adequate plans, information, or decision-making tools. They responded to this perceived threat by passing the Massachusetts Oceans Act of 2008 (Oceans Act), which directs the Secretary of Energy and Environmental Affairs to complete a comprehensive ocean management plan by the end of 2009.

The Oceans Act was a multi-dimensional solution designed to account for existing legal authorities, influential human-use constituencies, and a lack of perfect information about Massachusetts state waters. Although the need to plan for renewable energy development initially motivated state decision makers, they decided to engage in a comprehensive planning process that included a wide range of non-energy uses and resources. The major—but politically necessary—exception to this approach was the exclusion of commercial and recreational fisheries. Across the range of uses, species, and habitats, however, the Ocean Plan has been designed to balance the "natural, social, historic, and economic interests of the marine ecosystem." The draft plan identifies two percent of state waters as appropriate for renewable energy development, thirteen percent as development-prohibited areas, and eighty-five percent as "multiple uses" areas subject to spatially-informed environmental review and regulation.

Much of the spatial planning process in Massachusetts has depended on assessments of the compatibility of new uses with existing uses, such as water-dependent marine uses; and with environmental elements, such as unique habitats and areas frequented by whales and seabirds. EEA and CZM have used these compatibility assessments to screen relevant geospatial data, identify areas appropriate for energy development, and map exclusionary criteria used to separate incompatible uses. They have also tried to use geospatial data to assess cumulative impacts and to develop ecological valuation indices. As a result of these efforts, EEA and CZM now have a much better understanding of information and tool needs and gaps. They will use this understanding to build a five-year science framework into the overall Ocean Plan to ensure that the next plan will be more comprehensive.

Breakout Session 1

BRAINSTORMING IDEAS TO OVERCOME BARRIERS TO MANAGING AND SHARING GEOSPATIAL DATA IN CALIFORNIA

Goal

Better understand state agencies' capacities, constraints, and needs for working with geospatial information in the marine environment.

Objectives

1. Identify internal and external barriers and constraints to sharing data.
2. Brainstorm ways to overcome barriers and constraints to sharing data.

Description

Participants were divided into six breakout groups, three groups composed of GIS technical staff members and three groups composed of coastal resource managers. Each group was tasked with developing a list of 1) internal barriers to data-sharing and collaboration and 2) external barriers to data-sharing and collaboration. From each list, participants were then asked to prioritize the top two internal barriers and the top two external barriers. Subsequently, groups were asked to brainstorm solutions for these barriers.

The results presented below are consolidated responses from all six breakout groups. No significant differences in responses were noticed between the GIS technical groups and the coastal resource management groups.

TOP INTERNAL BARRIERS

INTERNAL BARRIERS	SUGGESTED SOLUTIONS
Agencies lack GIS staff members and expertise	■ Revise state job classifications to be relevant to hiring GIS technical staff members ■ Define who needs to be proficient/fluent with GIS software ■ Provide incentives for staff members to learn GIS ■ Make GIS training opportunities available for new and existing staff members ■ Expand software holdings beyond ESRI products to include software that does not require extensive experience or training ■ Develop and use private-public and state-federal partnerships for building and sharing GIS expertise ■ Translate national and state commitments to MSP into resources for supporting GIS staff members

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Managers often lack a clear understanding of geospatial data and decision support tools	■ Create a "data diplomat" to bridge the gap between agency staff members who specialize in working with geospatial data and those who make planning and permit decisions ■ Develop case studies to demonstrate the utility of geospatial data and decision support tools ■ Engage management to work with geospatial technical staff members ■ Develop an education and training process so that managers are aware of decision support tools (both uses and limitations)
Agencies need improved information technology (IT) infrastructure (Web security, policy, software, and technical expertise)	■ Develop a comprehensive IT strategy that accounts for GIS capacity ■ Improve collaboration and communication between technical and management staff members ■ Solicit support from the California Geographic Information Officer (GIO) and upper level management to develop improved IT infrastructure ■ Increase the speed and bandwidth of agencies' IT systems to allow for improved data-sharing ■ Investigate the option of using open source software ■ Investigate the option of using "cloud computing" infrastructure—remote storage and processing similar to that used by major technology firms—to reduce agencies' need for internal hardware investments ■ Build business cases for the reorganization of agencies' data management capacity; identify monetary incentives to show why agencies should invest in improved IT infrastructure ■ Use interagency agreements to build collaborative state-state and state-federal relationships ■ Coordinate lobbying for resources ■ Develop an independent, dedicated money stream for agencies to spend on data management and analysis
Agencies need better-designed, more useful decision support tools	■ Clarify the goals, mission, and audience of decision support tools ■ Develop an education and training process so that managers are aware of the possible uses and limitations of decision support tools ■ Improve communication within agencies to help them identify their on-the-ground needs and find the best tools for the job ■ Increase the flexibility of available tools ■ Develop ways to improve data integration and product development
Agencies lack geospatial data	■ Prioritize data needs and develop a plan that is ready to implement when funding becomes available ■ Standardize sampling protocols ■ Identify funding for new data acquisition ■ Investigate public-private partnerships and alternative collaborative partnerships ■ Document the research questions and projects that use geospatial data to facilitate integration of data across processes from data collection to policy-making

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Agencies lack monetary resources	■ Leverage public-private and state-federal partnerships ■ Prioritize projects and try to speak with a common voice to leverage agencies' resources ■ Develop an independent, dedicated budget for agencies to spend on data analysis and management

TOP EXTERNAL BARRIERS

EXTERNAL BARRIERS	SUGGESTED SOLUTIONS
Agencies have difficulty discovering and accessing available data	■ Possible data-sharing options: • Create networking technology to make it easier for agencies to identify data. Consider search tools, portals, nodes, and other clearinghouse alternatives • Develop a Google-like search engine for geospatial data • Build a clearinghouse listing available data • Share data through Cal-Atlas • Construct queriable metadata catalogs with links to products and tools ■ Data-sharing recommendations: • Agencies must identify their data-sharing capabilities • Web portals and clearinghouses should be organized by resource, theme, or agency • Web portals and clearinghouses should be established by an authoritative source (State of California) • Available data should have complete metadata and follow established metadata standards (e.g., they should identify data stewards and their contact information) • Develop a common language to understand what the data are and what they represent • State portals have boundaries; agencies need to develop regional portals that allow for searching across jurisdictions • Tie metadata to data more firmly so people will get credit and be more willing to share data ■ Develop incentives for data-sharing: • Craft reciprocity agreements • Offer compensation for staff time • Statutory mandate ■ Efforts to improve data-sharing: • Convene workshops and working groups to establish standards, assess appropriate data-sharing tools, and illuminate existing and needed data sets • Bridge gaps between IT and GIS technical staff members. Better communication will lead to improved coordination • Increase the number of partnerships between agencies, academic institutions, nongovernmental organizations, and industry representatives • Develop data-sharing agreements

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California agencies lack an explicit data-sharing policy	■ The state GIO needs to articulate a policy for geospatial data-sharing across agencies • Clarify objectives for geospatial data use • Identify the likely users of geospatial data • Prioritize data that are most useful to share • Use a holistic approach across agencies for dealing with data-sharing issues and barriers ■ Participate in the California Mapping Coordinating Committee* meetings
Data aren't always available at the correct resolution, scale, or standard	■ Develop a regionally applicable policy on mapping standards and best practices (West Coast-wide) ■ Initiate an effort to look at agencies' data collection methods to figure out how to aggregate and use more detailed and confidential data ■ Find sustainable sources of funding, such as public-private partnerships, business interest group investments, and renewable energy portfolios
Agencies need better Web services	■ Leverage public-private or state-federal partnerships ■ Reward the development of Web services ■ Coordinate agencies' use of Web services ■ Develop guidelines and best practices for publishing Web services

* The California Mapping Coordinating Committee (CMCC) is an informal group of GIS professionals in California state government. Membership is open to any interested State of California employee. This group serves as a technical and coordinating group to better understand the state's GIS needs and priorities.

ADDITIONAL INTERNAL BARRIERS

- Agencies host their in-house data in various formats. They need to digitize data that exist in paper format.
- Geospatial data often vary with respect to time frames, formats, scales, and resolutions. Agencies need to develop standards and best practices to make data more compatible across platforms.
- Agencies lack common metadata standards.
- Agencies lack sufficient capacity to store data and may use antiquated data storage systems.
- Agencies lack means of assuring data quality.
- Agencies use insufficient, outdated software.
- Existing GIS staff members don't have enough time to process all the data that managers need.
- Agency staff members often work with large volumes of data (historical and present).

ADDITIONAL EXTERNAL BARRIERS

- Agencies lack complete and up-to-date metadata.
- Data sets often do not comply with metadata standards.
- Confidential data—proprietary and sensitive data—pose problems for sharing.
- Not all agencies and staff members have access to GIS and similar software.
- Legal requirements for sharing information with the public can inhibit data-sharing.
- Agencies lack a common approach to sharing and receiving data. Data exist in formats that are not easy to bring into GIS software.
- Managers don't always know what information they need, or what information is available, to support the decision-making process.
- Data set file sizes can be too large to access or upload.
- Large volumes of data—historical and present—can be hard to work with.
- Agency staff members may fear sharing their data because of uncertainties about data quality.
- Intellectual property laws and agreements—especially relevant in the academic world and with government grants—inhibit data-sharing. Academics often have faster publication rates.

Breakout Session 2:

ACTION ITEMS FOR STATE LEADERSHIP IN THE DEVELOPMENT OF MARINE AND COASTAL GEOSPATIAL INFORMATION AND DECISION SUPPORT TOOLS

Summary of Breakout Session 2

Goal

Identify action items for state leadership in the development of marine and coastal geospatial information and decision support tools.

Objectives

Identify opportunities for agencies to work together on the following:

1. An information-sharing infrastructure that can be used to facilitate communication across agencies;
2. A set of decision support tools that can leverage the assets of multiple agencies by facilitating sharing and communication.

Description

The facilitators synthesized the findings of the Day 1 breakout sessions and presentations into six problem statements or issue areas for collaborative problem-solving during the Day 2 breakout sessions.

General Problem Statement: Overarching institutional barriers to data-sharing and tools development:
Group 1: How can managers and GIS staff members work together to make data more discoverable and accessible?

Group 2: How can statewide IT policy support data management and sharing by building capacity?

General Problem Statement: Management issues currently facing California agencies as a group:
Group 3: Marine protected areas

Group 4: Water quality*

General Problem Statement: Management issues likely to face California agencies in the near future:
Group 5: Offshore aquaculture

Group 6: Renewable energy development

*Attendees self-sorted into breakout groups according to their interests in these topics. The water quality issue failed to attract sufficient interest to warrant a stand-alone group, so it disbanded and its members moved into the remaining breakout groups.

GROUP 1: DATA DISCOVERABILITY AND ACCESSIBILITY

The facilitator presented two questions to the group at the beginning of the breakout session. First, should the state adopt common data formats and standards for marine- and coastal-relevant data? If so, what data formats and standards are appropriate? Second, how should agencies evaluate whether to use clearinghouses, Web services, or portals to provide geospatial data and data services?

The group identified two standards-related concerns that could act as barriers to adopting a common data standards framework. First, the wide diversity of information stakeholders, applications, and existing standards makes it very difficult to find a solution for all users. Second, even where users adopt a common format, data and metadata can still go "stale" when they are not updated regularly. A common format, alone, cannot force agencies to manage their data adequately. The group worried that a state attempt to force a "silver bullet" solution on the data stakeholder community would yield rules that were inflexible and unresponsive to stakeholder needs.

The group also identified storage- and ownership-related concerns that would act as barriers to using a common data repository. First, data stakeholders fear having to "flatten" their data to meet repository requirements. Group members recalled data sets that became unusable after being reformatted for compliance with strict repository rules. Second, the use of large repositories may suggest to some users that data therein are reputable, even when the stored data sets are obsolete or of limited use. Group members stated that holding data stakeholders responsible for the quality of their data is more important than being able to find all data in one place.

Finally, the group members agreed on two general needs. First, stakeholders need solutions that make reputable, authoritative data sets easier to find. Second, stakeholders need to know where and how data have been collected in order to use multiple data sets accurately and precisely.

These concerns and needs led to the following recommendations.

PROBLEM STATEMENT/ISSUE	RECOMMENDATIONS TO OPC AND THE STATE OF CALIFORNIA
How can managers and GIS staff members work together to make data more discoverable and accessible?	1. View the dearth of information infrastructure for ocean applications as an opportunity to develop a cohesive framework 2. Work with the California geographic information officer (GIO) to do the following: a. Identify consistent data themes or "buckets" for coastal and marine applications b. Develop a structure for cataloging metadata so that authoritative data sets are easily discoverable among agency and public users c. Identify examples of, and adapt where appropriate, policies for multi-agency data and metadata management, such as the Federal Office of Management and Budget's Circular No. A-16 d. Ensure that the GIO's agenda continues to address geospatial data and decision support tools for marine and coastal applications 3. Avoid temptations to seek "silver bullet" data standards or build monolithic data repositories 4. Use the CMCC as a forum for exploring information-sharing problems and identifying opportunities for collaborating with the GIO. Encourage agencies with marine and coastal management responsibilities to use CMCC continually

GROUP 2: STATEWIDE INFORMATION POLICY

The group discussion focused on the bigger issue of geospatial information policy and data stewardship, rather than on IT policy in a strict sense. Group members tried to identify ways to institutionalize a culture of data stewardship among state agencies.

The group identified state policies for agency recruitment and staff recognition as important foci for improvement. They pointed to the mismatch in job requirements stated under the current classification system for entry-level analysts and how these do not address the need for GIS trained staff members in most agencies. One member observed that the current GIS job classification system provides good entry-level salaries, but does not incentivize GIS specialists to seek leadership positions. As a result, people without GIS or data-related backgrounds end up with disproportionate influence over information infrastructure development.

The group also identified multiple ways that agencies' relationships with academia and independent contractors make it difficult to develop agency expertise and institutional knowledge over the long term. First, agencies' relationships with academic researchers are often characterized by academics' reluctance to share data obtained via grants or permits until the academics have published papers analyzing the data. The state currently has few legal methods for ensuring that data obtained under academic partnerships make it into the public domain. Second, agencies' use of independent contractors can help bridge information and skills gaps in the short term. In the long term, however, dependence on independent contractors prevents agencies from obtaining core data sets and developing institutional knowledge. Finally, agencies lack a common business case for requiring standard contract language, metadata standards, and other best practices in dealing with geospatial information management with their partners. Without such a common template, agencies have more difficulty identifying and building a cohesive framework that could benefit everyone. This could be an opportunity where the state GIO could effectively assist agencies in their data management and coordination efforts.

These concerns and needs led to the following recommendations.

PROBLEM STATEMENT/ISSUE	RECOMMENDATIONS TO OPC AND THE STATE OF CALIFORNIA
How can statewide IT policy support geospatial data management and sharing?	1. Adopt a long-term strategy of building and maintaining agency capacity and reducing dependence on independent contractors a. With the State Personnel Board and the Department of Personnel Administration, revise the classification and exam system to recruit well-trained GIS staff members b. Plan around agencies' needs to maintain institutional knowledge c. Use independent contractors when necessary for short-term projects, but ensure that agency staff members can understand and use the resulting work products 2. Incentivize agencies to take responsibility for managing and sharing data a. Reward and incentivize responsibility and collaboration by recording authorship in metadata b. Use permits, grants, and memoranda of agreement/understanding to ensure data enter the public domain c. Identify appropriate metrics for meeting agencies' data needs d. Incentivize consistent measurements and metadata entry e. Develop business cases for better data management and sharing 3. Institutionalize data management and sharing for marine and coastal applications at the state level a. Ask the GIO to serve a facilitation or "midwife" role by leading collaborative efforts, championing capacity-building efforts, and engaging agencies with marine and coastal jurisdictions b. Ensure that budgets and contracts treat data management and sharing as core project and organizational components rather than as peripheral concerns; consider allocating 10% of any budget to data management c. Use standard contract language to require metadata d. Use forums such as CMCC to incentivize and inform collaboration

GROUP 3: MARINE PROTECTED AREAS

Who needs access to geospatial data? The group members approached this question from a number of different perspectives:

- MPA designers, i.e., people who need to put lines on maps. This group includes federal and state agencies as well as stakeholders, who are the ultimate designers. NOAA NMS and the CCC are important members of this category.
- MPA evaluators. This group involves the state and federal agencies included in the "designers" group, but also include the California DFG, academics, stakeholders, and policy makers.
- MPA users, i.e., the communities who are involved in allowable uses, whether extractive or not.
- Managers and Wardens. This group includes agents of particular agencies including DFG, DPR, NOAA NMS, NWR, and USCG.
- Modelers, including agency scientists or academic scientists.
- Policy makers, such as the California Fish and Game Commission.

For what purposes or decisions will these stakeholders use geospatial information? The group listed types of uses but also engaged in significant discussion about the ways data could be used. The list includes:

- Putting lines on a map
- Monitoring
- Establishing regulations and boundaries
- Providing habitat and ecological forecasting
- Making decisions about marine reserve designations

The group next turned to the types of data that would be needed for these uses of data. The group admitted that siting MPAs requires a wide range of data types—not all of which could be listed in one breakout session. Still, they identified the following types of data/information:

- Human uses data
- Socioeconomic information, which is now very sparse
- Physical and biological data, including models and synthetic data
- Physical data, such as large-scale current data, that have not yet been incorporated into many decision support tools
- Climate change-related information, including forecasts
- "Change in general," such as changes in sediment flows
- Water quality information

Group members acknowledged that information quality changes with location. For instance, information becomes sparser as distance from the shore increases. There are large gaps in information about federal waters.

The group further discussed needs in the context of particular user groups or applications. For instance, managers and wardens need better ways to access information about regulations and boundaries. The range of current delivery methods, which currently includes static maps, MarineMap, and simple coordinates, could be expanded. Ocean visitors need better education tools, while people involved in the siting process need the state to invest more time and resources in capturing socioeconomic data and climate change modeling data. Some critical use data can be sensitive or confidential because of its commercial implications and therefore hard to obtain; the state GIO or the OPC need to find incentives to "get the critical data out there."

The group then talked about the baselines and goals that should inform the design of MPA monitoring frameworks. First, they said, state and federal MPAs—designated at different times and under different statutes—have different baseline conditions and different goals, which makes it difficult for the management community to develop common standards and objectives that apply to all MPAs. In addition, these differences make it hard to build an efficient long-term monitoring framework across MPAs. Group members noted that decision support tools may be usefully employed to facilitate integration of data and data services and allow greater efficiency for future monitoring. Second, the group discussed whether it is necessary to determine desired endpoints. "Things change," said some members, so defining end points ahead of time is not necessarily appropriate. Finally, some group members noted that the real goal of establishing MPAs is to manage "what people do in the box"; therefore, the most important information is information about an MPA's success in altering human behavior. From this perspective, a monitoring framework should focus on uses and compliance.

What incentives can facilitate collaboration among agencies and stakeholders? The group identified three major incentives.

- Proper technology for sharing information. In particular, the group suggested funding a consultant to work with agencies on developing data-sharing tools.
- Building trust for sharing data sets. A process or forum that facilitates discussion and collaboration among state agencies, federal agencies, and other stakeholders about their common interests in data could be very useful.
- Science. The group briefly identified collaboration "through the science door" as one path to increased collaboration.

What are key functions for decision support tools? The group identified functional needs as well as overarching questions and concerns about decision support tools. Functional needs include the following:

- Data exploration through visualization. Customized visualization products can serve both technically challenged users and more advanced users who need additional information.
- A dashboard of common-interest indicators.

- Products that are customized for state agencies' uses. Wave energy siting and MPA siting exercises, for instance, may use similar inputs but different metrics.
- Integration of human use patterns.
- Integration of water quality information.
- Connections to multiple information sources and decision support tools.
- Facilitation of communication between tool users, data collectors, and interpreters.

The group also discussed the need to define decision support tools' intended uses. At some point, they said, users and designers need to answer more detailed questions about the functions that tools would be designed to perform. Will an agency use a decision support tool to model data, or to analyze existing data and synthesize the results? Will agencies and stakeholders need decision support tools for monitoring, assessment, education, or outreach, or a combination of all of these functions? Ultimately, said many, tool design will boil down to decisions about the location and content of management measures.

Finally, the group noted the need to gather more information about decision support tools. "We need the tools to understand the tools," said some. Agencies and stakeholders would benefit from an inventory of available tools that includes their identities, functions, and locations. Agencies could also use the assistance of specialists or consultants to walk them through the process of identifying tools that are most appropriate to their needs.

All of these concerns and needs led to the recommendations listed below.

PROBLEM STATEMENT/ISSUE	RECOMMENDATIONS TO OPC AND THE STATE OF CALIFORNIA
Marine protected areas (current issue for management). Specific questions considered by the group include the following: • Who needs geospatial data? • For what purposes or decisions will stakeholders use geospatial information? • What incentives can facilitate collaboration among agencies and stakeholders? • What are key functions for decision support tools?	1. Meeting agencies' needs a. Prioritize the development of baseline data and allocate resources accordingly b. Support the development of improved education tools c. Identify and acquire data sets and tools needed to determine whether MPAs achieve their goals and objectives 2. Facilitating interagency collaboration a. Support outreach and education activities that can build trust in data collection, use, and inventory methods; consider making data publicly available b. Identify and support interagency working groups that are focused on common themes c. Provide funding to hire software developers or consultants who can help agencies develop proper tools for sharing information d. Find ways to increase trust and transparency in data-sharing processes 3. Identifying key functions for decision support tools a. Identify functions or methods of exploring data through visualization tools, such that agencies and developers can design customized products b. Build flexibility into decision support tools so that they are not project-specific c. Build a better understanding of available tools, including tools' uses and the technical support available for users d. Build capacity across agencies for tool use that increases understanding and use

GROUP 5: AQUACULTURE

Discussion A

Who needs geospatial data with respect to finfish aquaculture? Group members identified the following agencies.

- Federal agencies: MMS, NOAA, USCG, USGS, USACE
- State agencies: DFG, FGC, SWRCB, RWQCBs, CCC, SLC

For what purposes or decisions do finfish stakeholders need geospatial information? Group members identified the following uses:

- Siting and permitting
- Sub-leasing
- Endangered species issues
- Invasive species
- Disease control
- Forecasting for future conditions such as harmful algal blooms

What types of data do these stakeholders need? Group members identified the following:

- Currents
- MPA designations
- Navigation data
- Wind and wave data
- Oil spill models
- Water quality
- Compatibility with different uses
- Lease maps
- Water depth
- Wetland restoration projects
- Pipeline and cable locations
- Synthetic information, such as the impacts of aquaculture facilities on existing habitat and the cumulative impacts of multiple aquaculture facilities

Discussion B

Who needs geospatial data with respect to shellfish aquaculture?

- Federal agencies: USACE, MMS, USCG, NOAA, NPS, USGS
- State agencies: DFG, Fish and Game Commission, CCC, SLC, SWRCB, RWQCBs

For what purposes or decisions do shellfish stakeholders need geospatial information? Group members identified the following uses:

- Siting and permitting
- Lease mapping
- Sub-leasing
- Forecasting for future conditions such as harmful algal blooms
- Endangered species issues
- Invasive species
- Disease

What types of data do these stakeholders need? Group members identified the following:

- MPA designations
- Substrate
- Navigation data
- Environmentally Sensitive Habitat Areas
- Wind and wave data
- Water quality
- Tsunami data
- Sea level rise
- Oil spill models
- Compatibility with different uses
- Water depth
- Wetland restoration projects
- Pipeline and cable locations
- Information on the ecological impacts of shellfish aquaculture facilities
- Cumulative impacts of multiple aquaculture facilities

General Discussion

What are key functions for decision support tools? The group agreed that the primary use of a decision support tool would be to support a state siting policy for aquaculture facilities.

The group discussed a number of issues that are facing agencies, in addition to answering the questions posed by the facilitator. The state has not sited an aquaculture facility for many years but is now completing a Programmatic Environmental Impact Report (EIR) pursuant to state SB 201 (2006). Aquaculture developers, with the help of relevant agencies, will need to account for various existing uses, such as shipping lanes and oil and gas developments, to obtain leases from the State Lands Commission. They will also need to account for invasive species and water pollution close to facilities. However, no one was sure if agencies were already contributing spatial data for joint work on these issues. They wondered if OPC would be able to facilitate data collaboration between agencies.

All of these concerns and needs led to the recommendations listed below.

PROBLEM STATEMENT/ISSUE	RECOMMENDATIONS TO OPC AND THE STATE OF CALIFORNIA
Aquaculture (emerging issue for management). Specific questions addressed by the group include the following: • Who needs geospatial data? • For what purposes or decisions will stakeholders use geospatial information? • What types of data do these stakeholders need? • The group answered these questions twice: once for finfish (Discussion A), and once for shellfish (Discussion B).	1. Facilitate a more rational, streamlined aquaculture-siting policy by developing explicit guidelines and criteria and by making the siting process less bottom-up; consider using the upcoming Programmatic EIR to accomplish this goal 2. Reconsider policies that allow aquaculture site development anywhere outside of marine protected areas 3. Develop a state siting policy that accounts for impact models and studies; ensure that the multi-stakeholder, multi-agency Aquaculture Development Committee uses this information to make decisions 4. Encourage the Aquaculture Development Committee to develop databases that can be used to identify sites and facilitate permitting 5. Determine a lead agency for federal siting and regulation activities 6. Consider adapting MarineMap for use in siting decisions 7. Use a broad suite of data types to assess aquaculture facility sites; identify data gaps 8. Coordinate aquaculture siting with the siting of other uses, such as renewable energy

GROUP 6: RENEWABLE ENERGY SITING

Who needs geospatial data? The group agreed that this question, with respect to renewable energy planning and siting purposes, can be answered from a number of angles. Planning and regulatory agencies and divisions need geospatial data, as do private-sector developers and nongovernmental organizations. Some members pointed out that the category of "data producers" overlaps with the category of "data users" in many cases. In the context of renewable energy, the following stakeholders will likely need geospatial data:

- Federal regulatory agencies: MMS, FERC, NOAA, NMFS, ACE, FWS, U.S. EPA, USCG, Tribes
- State regulatory agencies: CCC, SLC, DFG, CalEPA, CPUC
- Local governments with certified local coastal plans and jurisdiction over offshore areas
- Federal planning agencies: NPS, NOAA, BLM, MMS
- State planning agencies: CCC, SCC, OPC
- Stakeholders: NGOs, coastal landowners, energy/utility companies, fishing interests, other marine resource users

For what purposes or decisions will these stakeholders use geospatial information? From a general utility standpoint, one group member stated that users need this information for "well-informed decisions that minimize impacts to the environment and maximize opportunities for green technology." Others agreed that agencies need access to high quality data to make well-informed, cost-effective decisions. Group members also noted a wide range of planning- and permitting-related data uses, including the following:

- Strategic planning, including regional planning
- Environmental reviews mandated by NEPA, CEQA, and similar laws, including cumulative impact assessments and mitigation determinations
- Socioeconomic needs and impacts analyses
- Risk and hazard assessments
- Project-related feasibility, efficacy, and technology-needs assessments
- Trade-off determinations
- Stakeholder involvement

What incentives can facilitate collaboration among agencies? This question was not in the facilitators' original list, but the group spent significant time addressing it. Two major issues were inter-agency communication and leadership.

The group members spent significant time on the issue of communication between agencies and governance initiatives. The group agreed that renewable energy issues—knowledge-management issues, in particular—require robust regional communication networks and tools. While particular agencies have good track records for communication and data-sharing, agencies as a group need better opportunities for collaborating regularly. The promise of needed and useful information in a trustworthy forum would be a good incentive for agencies across the board to participate.

The group members also agreed on the need for top-level leadership at state, regional, and national levels. Members identified the California OPC and GIO as relevant players but focused more on the need for leadership and resources from the West Coast Governors' Agreement, federal agencies, and Congress. One member suggested that a "bottom-up" approach could be more successful than a "top-down" mandate to cooperate. Others, however, identified needs for top-level leadership in the following areas:

- Providing financial support and incentives for collaboration
- Maintaining connections between agencies and stakeholders though workshops and forums
- Identifying and sharing solutions to increase efficiencies across the board
- Facilitating successful partnerships and helping to formalize them into more permanent institutions

What are key functions for decision support tools? At the urging of one group member, the group's discussion around this question shifted to a different but related question: "what do we need decision support tools to do?" Other group members acknowledged that this latter question is important whether an agency is performing planning or regulatory functions. They noted a number of needs, many of which would be relevant regardless of a particular tool's design; other needs, they noted, may be hard to build into a decision support tool. Various members identified the following needs:

- The ability to develop and visualize alternative scenarios for cumulative impacts and ecosystem services analyses
- The ability to capture spatial and temporal models
- Identification of more- and less-sensitive areas for development
- Support for decision makers who lack "scientist-level" knowledge
- Legal support for decisions that are challenged in court—particularly for decisions that are challenged on "adequacy of evidence" grounds

All of these concerns and needs led to the recommendations listed below.

PROBLEM STATEMENT/ISSUE	RECOMMENDATIONS TO OPC AND THE STATE OF CALIFORNIA
Renewable energy siting (emerging issue for management). Specific questions considered by the group include the following: • Who needs geospatial data? • For what purposes or decisions will stakeholders use geospatial information? • What incentives can facilitate collaboration among agencies? • What are key functions for decision support tools?	1. Facilitate inter-agency communication by leading regular forums where information officers and data managers can share information, compare lessons learned, and identify more efficient solutions 2. Coordinate state agencies' advocacy and requests for funding at the regional and national levels 3. If/when developing decision support tools, focus on improving scenario analysis, capturing decision-making processes, and supporting agency credibility 4. Help develop a "committee road map" for cooperative siting and permitting

Workshop Conclusions and Recommendations

DURING THE breakout sessions and large group discussions of the two-day workshop, participants collectively realized a number of conclusions and suggested several key recommendations for the State of California to pursue. These conclusions and recommendations can be broken down into three categories: intra-agency solutions, inter-agency solutions, and state leadership in geospatial information policy.

I. Intra-Agency Solutions

Participants' ideas for improved geospatial data-sharing and management within state agencies focused on the need for improved capacity-building and inter-departmental coordination. Many participants stated that state agencies' current capacities to manage geospatial data are hindered by a lack of well-trained staff. The current employee classification system for hiring technical staff members is not appropriate for GIS positions and does not accurately reflect the skills desired by agencies. For example, a single classification applies to both coastal program analyst (CPA) and GIS analyst positions, although the training and job requirements for each position are quite different. To solve this problem, the Department of Personnel Administration (DPA) should work to create a separate job classification for GIS support staff members that reflects agencies' general needs for geospatial data analysis. The new job classification should recognize the differences between geospatial information systems (GIS) and information technology (IT) skill sets.

Moreover, agencies need to hire and retain technically (i.e., GIS) proficient personnel. Many state agencies have difficulty retaining employees in technical positions, particularly at higher managerial levels that may not be competitive with other high-level technical jobs. In response, DPA should also work to make pay scales and compensation packages more competitive in order to retain well-qualified technical employees.

Participants noted that education and training are key to improving understanding and use of geospatial decision support tools among the broader agency staff, particularly among managers. Once an agency or the state chooses to adopt a decision support tool, it should then implement a process to train existing and new staff members on the capabilities (and limitations) of the tool, as well as provide ongoing support for updating and trouble-shooting.

Many agencies also lack adequate IT resources, such as computing hardware, data-transfer bandwidth, and software licenses, that would allow them to perform and support data management and analysis more effectively. Improving these resources may require significant up-front capital investments but decreasing costs over time for maintenance and upgrades. To fund technology investments and increase GIS capacities, each agency could dedicate a portion of its annual budget to the purchase and maintenance of geospatial equipment. The State of California, for its part, could promote interagency data-sharing and collaboration by ensuring that agency budgets are sufficient to cover technology investments. The state could

also require agencies to build into their project contracts a budget item for data management tasks such as data acquisition, cleanup, and standardization. The state could save additional money across agencies by improving data-sharing between agencies to allow multiple users to access the same data sets.

Finally, several participants suggested that each agency could hire or designate a "data diplomat" who would facilitate internal data management and promote collaboration. The data diplomat would be responsible for improving communication within agencies and departments (such as the marine and terrestrial regions of the Department of Fish and Game), and among technical and management staff members (to ensure staff needs are appropriately met). The diplomat could communicate the needs of technical and program staff members to upper level management and solicit support for necessary resources and data management initiatives both within and between agencies. The position would also coordinate internal and external data-sharing efforts, including assisting in the creation of common data standards and tools for improved access to data sets.

Recommendations:

A. Build agencies' capacity to manage and use geospatial data.
   i. Hire and retain more GIS-trained staff members through a new GIS employee classification exam and more competitive compensation packages.
   ii. Develop an education and training process so that managers can become familiar with using decision support tools (both uses and limitations).
   iii. Dedicate a portion of agency budgets to equipment, data management, and sharing efforts.
   iv. Enhance and maintain technical resources such as bandwidth and software licenses.

B. Facilitate better coordination between agency departments and between agencies' technical and managerial staff.
   i. Dedicate "data diplomats" for intra-agency coordination.
   ii. Solicit support from upper-level managers for data management efforts.

II. Inter-Agency Solutions

Participants also focused on state agencies' need to work toward collaboration with each other, particularly across the "marine-terrestrial divide." As noted above, the various state resource management and regulatory agencies possess an abundance of geospatial data. However, there has been limited effort to date to coordinate these data among agencies, especially when agencies have jurisdictions in separate spaces. To help coordinate and improve data access and sharing as well as digital mapping services among these different agencies, the state's Chief Information Officer recently appointed a state Geographic Information Officer (GIO). The GIO has begun a collaborative initiative with various state agencies to organize and share data sets for land-based needs, mainly emergency response. However, marine and coastal data, and the agencies responsible for the data, have largely

been absent from this collaboration. In response, many workshop participants recommended that California's coastal and marine resource agencies work with the GIO to ensure that their priorities are known and to help publish data that may be useful to others. Data diplomats could serve as liaisons to the GIO to help implement this action for individual agencies. In addition to interacting with the GIO, agencies should set up working groups to illuminate existing and needed data sets, set common data standards, and assess appropriate data-sharing tools.

The workshop participants noted several available options for information tools with search and discovery functionalities to assist agencies in accessing, sharing, and viewing geospatial data. For instance, managers could use a clearinghouse, or bibliography of data and sources, to identify and retrieve available geospatial information. Workshop participants from the California Environmental Resources Evaluation System (CERES) stressed the importance of including marine data in the Cal-Atlas database, a clearinghouse of state agency geospatial information developed by CERES. Currently, Cal-Atlas contains a dearth of marine and coastal data, but if agencies inserted relevant data, it could be used as a resource for coastal managers in the future. Other options include Web-based technologies, such as portals, that make it easy for users to find and view geospatial data on the Web. Google Earth, which has incorporated aspects of open-source Web technologies, is one such tool. A similar option would be a shared interface (likely based on GIS) that would allow authorized agency users not only to view, but to download data from various agencies for analysis within their own internal systems. A shared interface could be combined with a clearinghouse or other data listing service so that users could easily identify and cite their information sources. A third option would be to develop a search tool, similar to general use Internet search engines, with capability to search various agency databases for common language that identifies data sets and sources. This option would work best with the development of an "ontology" that would define attributes, and relations between attributes, to allow the search engine to recognize and retrieve the most relevant data. Each of these options carries its own positive and negative qualities according to its desired functionality, as well as its intended audience, whether it is for the public, state employees, or for other specific viewers.

Participants further suggested that new data search and discovery tools be constructed around specific resources, themes, or agencies. This kind of targeting would allow for more streamlined development and increased flexibility. New discovery and search tools should be supported by an authoritative source, such as the state GIO.

The workshop participants also highlighted one unanimous recommendation for development of data discovery tools: a single common geospatial database for all agencies is not appropriate because it would quickly become obsolete and, due to the large number of data sets, could be cumbersome to navigate and maintain.

For each of these search and discovery options, participants highlighted the need for common data standards, particularly for metadata, which is information that describes a

data set. Metadata can include a description of the data itself, as well as information about its source, owner, and creation. Standardizing data and metadata allows for easier searching and retrieval of relevant data sets and minimizes confusion over the ownership or purpose of the data. Most agencies formally adhere to Federal Geographic Data Committee (FGDC) metadata standards when compiling their geospatial data sets. However, the workshop participants recommended that the state require that all agencies keep metadata under FGDC or a similar standard. Participants also reinforced the importance of ensuring that agencies use metadata to record original authorship, since data-sharing initiatives will not be as effective if ownership is not credited to the data's author(s), particularly within the academic community. The participants suggested that agency contracts include language that requires agencies and their partners to identify and secure original author information in metadata. Finally, some recommended that all future agency contracts contain language requiring that data sets gained through government-sponsored research belong to the public domain. (Some agencies already require such language.)

To create a collection of baseline geospatial data sets for use among various agencies, the researchers, managers, and relevant users should also agree to spatial and temporal standards and protocols to which research should adhere. These stakeholders rarely coordinate their research efforts under a larger vision, with the result that large data gaps persist for many geographic areas and many data themes. By working with academic and private institutions on designing research to produce large-scale baseline data, state agencies can minimize these gaps and create a more comprehensive understanding of our coastal and marine ecosystems and the human activities that impact them. Additionally, by agreeing on standard measurements and outputs for data gathering, managers could reduce the amount of time they must spend converting and comparing data sets of different dimensions and facilitate the use of data in diverse geospatial information systems.

The participants also raised concerns about legal constraints on data-sharing. Certain legal and software issues, such as confidentiality and nondisclosure agreements, security protocols, and firewalls, are bound to arise with greater frequency when agencies try to share data more consistently. Many regulatory agencies possess private information necessary for permitting purposes. This information must be blocked and secured from unauthorized users if agencies' databases are opened to data-sharing and search tools, particularly with open source software. Security is also an issue for all agencies from an operating efficiency perspective, since breaches of database security can result in significant lost time and money for all involved and may result in lawsuits. Agencies often install firewalls to protect their data systems from these problems, but firewalls themselves could constitute barriers to multi-agency search tools. To help agencies resolve these data security issues, the state could explore the creation of a common legal framework allowing sharing of certain data sets between agencies, consistent with confidentiality and privacy needs. The state could also help agencies invest in software—or hardware—based security measures, such as internal and external agency authorization classifications, to maintain privacy.

Workshop participants stressed the need for improved collaboration and investment in partnerships among state and federal agencies, academic researchers, nongovernmental organizations, and industry leaders. To increase their abilities to collaborate, state agencies should build on partnerships that are already in place with federal agencies such as NOAA, the Minerals Management Service (MMS) and the U.S. Fish and Wildlife Service (FWS). They should also take advantage of facilitation organizations such as the NOAA Coastal Services Center (CSC), which helps federal, state, and local resource managers better understand their capacities, constraints, and needs and identify opportunities for working with geospatial information in the marine environment. They should also work more closely with the California Ocean Science Trust, which facilitates the delivery of useful scientific information to resource managers and decision-makers. Agencies should take advantage of connections formed through regional initiatives, such as the West Coast Governors' Agreement between California, Oregon, and Washington, that were created to help their members share information and resources to address pressing ocean and coastal issues. In addition to these partnerships, California should establish relationships with other states that have already begun to invest in geospatial information systems and decision support tools for improved marine resource management, such as Massachusetts and Rhode Island.

Beyond coordination between government agencies, participants noted the successful examples of partnerships among agencies, academic researchers, and NGOs. They particularly commended the Ocean Observing System (OOS) interfaces and MarineMap, a marine reserve designation tool designed by researchers at the University of California, Santa Barbara, The Nature Conservancy, and the California Department of Fish and Game. Using these examples as models of successful partnerships, the state could identify and build new relationships with data-rich entities, such as universities, NGOs, and industry leaders. Strong data-sharing agreements formalizing these multi-organizational partnerships would facilitate the flow of current and future research findings and relevant baseline data, and could also eliminate redundancy in effort among the partners.

Appropriate incentives may be necessary to promote data-sharing between and among public and private entities. Incentives could include support for additional staff time or resources, reciprocity with existing and future data sets, more efficient permitting of proposed projects, or a mandate from the state or federal government to participate. Participants noted that this is more likely to work if sustainable sources of money are set aside for data-sharing. Ideas ranged from creating an energy portfolio using funding earned through taxes on energy developers to establishing public-private partnerships and soliciting business interest group investments.

Recommendations:

A. Facilitate collaboration between marine and terrestrial agencies.

   i. Coordinate data-sharing efforts with support of the state Geographic Information Officer (GIO).

   ii. Dedicate "data diplomats" for inter-agency coordination.

B. Help agencies share and access data.

   i. Assess data discovery and search tools, such as data portals, search engines, and clearinghouses, for different purposes.

      I. Organized by resource, theme, or agency.

      II. Established by an authoritative source (i.e., state GIO).

   ii. Develop common data and metadata standards so that data are easily interpreted and measurements can be compared over space and time.

   iii. Craft a common language ("ontology") to make it easier for users to locate and understand relevant data.

   iv. Develop contract language to ensure that agencies maintain data authorship and ensure that the data become part of the public domain.

   v. Resolve legal issues relating to confidentiality, open source access, and system security.

C. Coordinate collaboration among state and federal agencies, academics, NGOs, and industry groups.

   i. Craft and use interagency data-sharing agreements.

   ii. Employ "data diplomats" to coordinate agencies' data-sharing efforts.

   iii. Establish working groups to set standards, assess appropriate data-sharing tools, and illuminate existing and needed data sets.

   iv. Develop incentives for data-sharing.

   v. Build sustainable sources of funding through public-private partnerships, business interest group investments, or renewable energy portfolios.

III. State Leadership

Stating the need for a "mandate from the top" to build support for geospatial data management for all agencies, participants highlighted the opportunity for state-level leadership in the creation of a geospatial data policy for California. The state GIO is ideally situated to fill a policy-formulating role given his charge to coordinate geospatial information and mapping services within the state. Given that there are contradictions between different agency data management rules, the GIO should take the lead in coordinating agency dialogue and crafting a common policy based on the needs of agencies. As mentioned above, the GIO has already begun this dialogue with agencies possessing terrestrial geospatial data; however, to date, the GIO's work with marine and coastal agencies has been limited. The workshop participants suggested that the OPC work with the GIO to formulate an effective geospatial information policy that prioritizes data management, facilitates the integration of terrestrial and marine data, and coordinates data sources for improved access to essential information for permitting and planning.

To be effective, a statewide policy must support and promote geospatial data management as a priority for California's resource management agencies. Legislation may be

required to spur action forward, although any proposed reform should account for agencies' concerns that they will have difficulty meeting new mandates, in addition to their existing demands, with limited budgets and resources. Funding will be necessary to augment existing agency resources, including GIS support staff and technology, to meet the needs of increasing geospatial data management requirements mandated by state policy. In addition to seeking government funding, agencies could employ the suggestion, made above, to allocate a minimum amount of contract budgets for data management purposes. Some participants suggested that if government funding is limited or unavailable, the state could employ limited-term fellows through the NOAA Coastal Fellowship or Sea Grant programs to undertake some of the data management and coordination work. Ideally, fellows could collaborate with their counterparts in other states and agencies to share regional data, develop common data standards, and compare tools and lessons learned.

To better understand the state's needs for geospatial information and decision support tools, the GIO could perform an assessment, using targeted surveys, interviews, or other means, of agencies' assets and anticipated needs. Once these assets and needs are identified, the GIO should prioritize the collection and interpretation of existing data that would be most useful to multiple agencies and then identify baseline data needed for future planning purposes. The GIO should focus initial efforts on filling the easier data gaps; agencies can then gather more difficult-to-obtain data next. The GIO should prioritize the sharing of existing data sets that are necessary to the missions of many agencies but are not yet widely accessible. The GIO should give secondary priority to creating new data that several agencies need for mission-critical decisions. Final priority should be given to creating data that are expensive or of value to only one or two agencies. To ensure that the data sets are widely available and useful, the GIO should solicit input on the formats and standards most useful to agencies for their future research and planning efforts.

In understanding agencies' geospatial information assets and needs, the state can begin to identify information relevant to regulating human uses of the ocean, such as shipping, fishing, aquaculture, energy development, and marine protected areas. These uses would likely also need to be balanced in a marine spatial planning (MSP) effort. To help define existing and potential uses, the state can seek input from agencies that already site, regulate, and monitor coastal and marine resources and human activities, including the Department of Fish and Game, the State Lands Commission, the California Coastal Commission, and the Department of Parks and Recreation. Using geospatial information acquired through permits, applications, visitor records, and surveys, these agencies can help identify existing human uses and potential emerging uses of the ocean and coast. The state can also engage with the recent federal MSP initiative. By working to assess and balance human uses in state waters now, the GIO and agencies will be properly prepared with relevant, up-to-date geospatial information to address proposals for offshore development and assist federal agencies to ensure that development priorities for state and federal waters align.

Recommendations:

A. Establish a Geospatial Information Policy for the state that includes a mandate for all agencies to support geospatial data management.

B. Augment agency budgets for GIS support staff.

   i. If funding is limited or not available, employ limited-term fellows through federal or private programs.

C. Assess agencies' ownership of and needs for geospatial data and tools.

   i. Clarify agencies' objectives for using geospatial data.

   ii. Identify data sets that agencies need and prioritize actions that make them more accessible.

   iii. Create baseline data sets that can be used by multiple agencies.

   iv. Prioritize the creation of data sets that are easier to assemble and needed by a majority of agencies.

D. Assess geospatial data sets and decision support tools that can be used for multiple ocean uses and areas.

   i. Gather input from agencies, user groups, and the public.

   ii. First identify geospatial data on existing uses; then focus on emerging uses relevant to California.

Related Events

The Ocean Protection Council held a public meeting September 17, 2009, to discuss the potential for MSP and the need for collaborative interagency data-sharing in California. The council unanimously passed a resolution at the meeting to support the improved coordination and management of geospatial information for state agencies (see Appendix VI). The resolution is intended to assist agencies in increasing their capacities for managing and sharing geospatial data that will allow the state to improve resource management and protection efforts and address current and future user conflicts in the ocean. The OPC also resolved to research and develop MSP principles and objectives specific to California. The OPC resolution follows up on the conclusions and recommendations made at the August workshop, as well as recent interviews conducted by OPC and NOAA Coastal Services Center staff with state agencies having coastal and marine jurisdiction.

The national interagency Ocean Policy Task Force, created by President Obama in June 2009, is also working to develop recommendations for implementing a framework for MSP in federal waters by the end of 2009. In September, the Task Force submitted interim recommendations for a national ocean policy that includes support for MSP as well as an ecosystem-based management approach to ocean policy, regional management initiatives, and enhanced coordination and collaboration with state, tribal, and local authorities. The full report can be viewed at:
www.whitehouse.gov/assets/documents/09_17_09_Interim_Report_of_Task_Force_FINAL2.pdf.

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