Chapter 10

Using GIS to Elicit and Apply Local Knowledge to Ocean Conservation

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Abstract

This chapter describes a protocol for using geospatial analysis tools based on the importance of eliciting and incorporating local expert knowledge and socioeconomic concerns into marine resource management decision-making processes. The GIS tool ("OceanMap") and rapid socioeconomic protocol described in this chapter grew out of past conflicts amongst stakeholders, specifically fishermen, regarding marine protected area planning processes in California, and builds on a pilot project conducted by the Pacific Coast Federation of Fishermen's Associations and Environmental Defense. The pilot project elucidated areas for improvement in the original protocol and GIS tool, resulting in changes and additions described here. Today, Environmental Defense continues to expand and improve the tool to address stakeholder needs, streamline the process of collecting and analyzing information, incorporate additional stakeholders, and accommodate other marine resource management efforts.[1]

Introduction

Many coastal communities are economically and culturally tied to the use of marine resources, both directly (as in fishing) and indirectly (as in recreational diving or nature-watching). Ocean resources are vital to the livelihood of these communities and policy decisions can directly affect individuals' lifestyles and economic well-being. Sound ocean resource management decisions (particularly if they are to be durable) often depend on acceptance by resource users, which in turn depends on perceived and actual social and economic impacts of policy decisions. Yet traditionally, marine conservation management has focused on the biophysical aspect of management first, while considering the socioeconomic aspect second, or not at all. Lack of detailed

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socioeconomic information often hampers ocean conservation efforts both in the policy-making stage and in the implementation and enforcement phases. Recent efforts to implement marine protected areas in California highlight the benefit of integrating socioeconomic aspects of proposed management measures early in the decision-making process, and pilot studies have shown the effectiveness of utilizing geographic information systems (GIS) tools to achieve these goals.

Fully protected marine reserves (areas of the ocean that are off-limits to fishing and other extractive uses) are a relatively new tool for marine resource managers and have attracted both scientific support and political controversy. Much of the controversy is due to the perceived distribution of potential costs and benefits. For example, immediate costs of implementing reserves tend to be borne by the consumptive users of an area, i.e., commercial and recreational fishermen, in the form of restrictions that may adversely affect their income. Conversely, the benefits are often delayed and initially accrue to non-consumptive users (National Research Council, 2001; Carter, 2003), for example, by increasing the appeal of tourism. Marine management measures may also have social consequences by changing the profile and distribution of participation in marine recreational or commercial activities in an area. While federal (National Environmental Policy Act; Magnuson-Stevens Fisheries Conservation and Management Act) and state (California Environmental Quality Act) laws require consideration of socioeconomic costs and benefits of a management decision, such assessments are usually not comprehensive and are often conducted after the planning and public consultation process. Techniques to include local stakeholders in the planning process are needed to ensure consideration of socioeconomic impacts of marine protected areas and reduce conflicts among stakeholders.

Division and conflict between fisheries managers and fishing communities are already apparent (St. Martin, 2001), especially in the context of recent fishery declines (Gilden and Conway, 2002a; Gilden and Conway, 2002b) on the West Coast. Many user groups feel as if their concerns are ignored and their knowledge is underutilized. In order to halt this growing schism, agencies must understand the concerns of affected user groups regarding the costs of management measures. Additionally, incorporating local knowledge could fill important data gaps and be a more appropriate way to address socioeconomic impacts, especially considering the local nature of fisheries on the West Coast, and California's experience with MPA planning and implementation has elucidated the importance of socioeconomic analysis to address these concerns.

Recent projects in California show how GIS offer effective platforms for socioeconomic analysis and incorporation of local knowledge into policy processes. Recognizing the need for local participation in policy planning and implementation, and the ability of geospatial analytical tools to empower user groups, Environmental Defense (an environmental advocacy organization) has developed a GIS-based tool for California's coastal waters, OceanMap, to aid in California marine resource management (Fig. 10.1a; see page XXX). OceanMap comprises numerous data layers that can be added or taken away from view, including geographical information, existing marine protected areas, habitat information, bathymetry, and nautical charts (Fig. 10.1b; see page XXX). OceanMap was specifically designed to facilitate implementation of the California Marine Life Protection Act (MLPA) and grew out of the experience of creating a network of fully protected marine reserves within the state and federal waters of the Channel Islands National Marine Sanctuary (CINMS) off the southern coast of California.

In 2002, Environmental Defense collaborated with the Institute for Fisheries Resources (IFR; the research arm of the Pacific Federation of Fishermen's Associations) on the Local Knowledge Project, a pilot project to develop and test a participatory socioeconomic analysis protocol in the context of the MLPA. The project was designed to elicit fishermen's knowledge, test ways of incorporating their knowledge into the decision-making process, and to test spatially explicit methods for rapid socioeconomic assessments for MPA planning. The project was successful in achieving its goals and in elucidating areas for improvement of OceanMap and the protocol for rapid socioeconomic assessment. This chapter outlines the pilot project, important lessons learned, and the subsequent improvements in the tool. Environmental Defense will continue to use OceanMap and the improved data collection protocol to support MPA planning processes. Additionally, there is growing interest in expanding OceanMap to support MPA planning in other states, as well as other marine resource management efforts.

Including Local Knowledge in the California MPA Processes

There is a growing body of literature documenting the benefits of incorporating local ecological knowledge (LEK) and socioeconomic concerns into decision-making processes (McCay and Acheson, 1987; Feeny et al., 1990; Ostrom, 1990; Russ and Alcala, 1999; Berkes et al., 2000). LEK refers to the body of knowledge held by a specific group of people about their local ecosystems. The information is often site-specific, and can be a mixture of practical and scientific knowledge (Olsson and Folke, 2001). The Local Knowledge Project was predicated on the benefits of utilizing LEK and also grew out of practical experience with two MPA planning processes in California: the CINMS experience and the first attempt to implement the statewide Marine Life Protection Act in 2002. The MLPA requires the California Department of Fish and Game to implement a network of MPAs in state waters with an improved marine reserve (defined as no-take areas) component.

MPAs in California

Both the CINMS and the first attempt to implement the MLPA were highly contentious processes, with stakeholder groups including commercial and recreational fishing groups, environmental organizations, and resource managers often on opposite sides of the issue. In the CINMS case, a working group comprising scientists, fishermen, environmentalists, and other stakeholders were directed to design a network of marine reserves. Although the working group included a panel on socioeconomics and employed a team of consultants and academics to collect anecdotal and socioeconomic information from fishermen, many stakeholders were dissatisfied. Ultimately, the CINMS did not achieve consensus on one design alternative. Instead, agency staff drafted a number of design alternatives that attempted to meet scientific criteria while minimizing socioeconomic impacts. The Fish and Game Commission adopted the "preferred alternative" for state waters, in which 25% of the CINMS management area will be set aside in marine reserves (Department of Commerce, 2003), and it is now in the federal regulatory process.

The initial attempt to implement the MLPA in 2001 was also rife with controversy. The California Department of Fish and Game (CDFG) formed a Master Plan team to develop Initial Draft Concepts of potential marine reserve sites for public review. The Master Plan Team identified draft MPA candidate sites without stakeholder consultation and presented the maps to the public in a series of meetings along the coast in the summer and fall of 2001. The meetings were extremely charged with intense upheaval among numerous stakeholders, especially fishermen. In both the CINMS and MLPA instances, stakeholders felt as if they were inadequately consulted, that insufficient data were available for comprehensive socioeconomic assessment, and that the fishermen's local ecological knowledge was not appropriately incorporated into the process. The process polarized many fishermen and environmentalists, as the debate focused on trade-offs between conservation goals and economic concerns.

Due to the dissatisfaction and immense distrust created during the initial attempt to implement the MLPA, the Director of the CDFG disbanded the original process and started over. The new process, designed to be more participatory in nature, convened seven Regional Working Groups of representatives from the fishing, diving, scientific, and environmental communities. These stakeholders were charged with proposing sites for marine reserves that would be assessed for ecological benefits by the Master Plan Team and reviewed for socioeconomic impacts. The Master Plan Team was to then synthesize this stakeholder input, scientific analysis, and socioeconomic assessment into a Master Plan for a MPA network for the state, subject to the approval of the California Fish and Game Commission. In January 2004 (two years after its launch), the Regional Working Group process was abandoned due to California's budget crisis. Non-governmental organizations (NGOs) and community groups continued to develop petitions for individual marine reserves and began to construct a "civil society" process (sanctioned by the state, but implemented primarily by stakeholder groups and funded by foundations and other private-sector funders) to synthesize such petitions, assess them against scientific criteria, encourage petitions for reserves that would fill critical gaps in a coherent system of marine reserves, conduct scientific and socioeconomic analyses of individual sites and the proposed system, and present a master plan for approval by the Fish and Game Commission. In the Fall of 2004, the State committed $500,000 to re-start the MLPA process, and appointed a Blue Ribbon Task Force to design and oversee a process to implement a network of reserves, create a pilot project along the Central Coast, and develop a strategy for long-term MLPA funding. The panel has elicited comments from various stakeholders regarding the draft framework for the process and will identify a science advisory team from a pool of nominated candidates. The Task Force is charged with implementing a pilot project in Central California by Fall 2006, and a statewide network of marine reserves by 2011.

The MLPA requires the inclusion of socioeconomic information as laid out in Section 2855 (c) of the Act: "(T)he department and team in carrying out this chapter, shall take into account relevant information from local communities, and shall solicit comments and advice for the master plan from interested parties on issues including [...] (2) socioeconomic and environmental impacts of various alternatives" (California Bill Number AB 993, 1999). MLPA implementation offers an opportunity to capitalize on local knowledge and assess the socioeconomic effects of management decisions, and the Task Force recognizes the need for active involvement of stakeholders and the general public. Restarting the MLPA implementation process creates an opportunity to incorporate local knowledge and socioeconomic analysis early in the planning process. While the Department convened an expert workshop on socioeconomics in the fall of 2002, it is still uncertain how to include such information in MLPA implementation. The Local Knowledge Project, described in the next section, was intended to contribute to the assessment of these complex effects in a participatory way, and to provide a protocol for inclusion of socioeconomic information. Lessons learned from the Local Knowledge Project have further improved the protocol that can be implemented in future versions.

The Local Knowledge Project

The Local Knowledge Project was a pilot project to test a protocol for rapid socioeconomic assessment for use in MPA planning processes. It was based on the need for socioeconomic information in the MLPA implementation process. The project employed GIS with the primary goal of developing methods and data for rapidly assessing potential socioeconomic impacts related to individual marine reserve sites in California state waters. Other design considerations included budgetary and time limitations, and the need for spatially explicit local knowledge data that can easily integrate with scientific information. While the goal of the project was to test a protocol for socioeconomic assessment rather than MPA siting alternatives, many fishermen were interested in using the maps of fishing activity, acceptable closure areas, and critically important economic areas as a platform for further discussion of MPA alternatives.

Methods

The pilot project focused on commercial fishermen and recreational charter boat captains in the north-central region of California (Fig. 10.2), from Pt. Año Nuevo to Point Arena. Five main ports and port groups were identified within this area: Mendocino County (Fort Bragg, Pt. Arena, Albion), Bodega Bay, Bolinas, San Francisco, and Half Moon Bay.

Fishermen were integral to the study, both during the design phase and as participants. Study design included several meetings between project staff and fishermen representatives, "port gatekeepers" associated with the Pacific Coast Federation of Fishermen's Associations (PCFFA). The group collectively developed the research questions to be asked of the participating fishermen and the gatekeepers provided names of about 10 initial fishermen who would be willing to participate in an interview. The rest of the participants (total of 30) were identified through the "snowball sampling" (Huck, 2000) method of having interviewees recommend other fishermen to be interviewed. All participants were recommended based on the length of their fishing career, their depth of knowledge, and their willingness to be interviewed.

Semi-structured, one-on-one interviews with fishermen comprised the core of the project. During a two-month period, field assistants trained in social science interview techniques interviewed 30 fishermen. Typically, the assistants contacted the participants via telephone to explain the project and ask if they would be willing to participate in an interview. All participants were informed that the decision to grant an interview was voluntary and they could relinquish information at their discretion. Response was overwhelmingly positive, with only two fishermen unwilling to grant an interview, citing scheduling conflicts or lack of time. Most fishermen saw this as a rare opportunity to share their knowledge, concerns, and opinions regarding marine reserve siting and MLPA implementation. Once a fisherman agreed to be interviewed, the interviewers traveled to the port and met at a time and location convenient for the fisherman, generally the fisherman's boat or a nearby restaurant.

Guided by a set of specific questions, each interview was a free-flowing conversation. Interviewers allowed the fishermen to discuss a multitude of subjects, but kept the process focused with a set of core questions. This allowed for a comfortable conversation while also achieving quantifiable results that could be recovered and coded in the data entry process for comparison across interviews. The participating

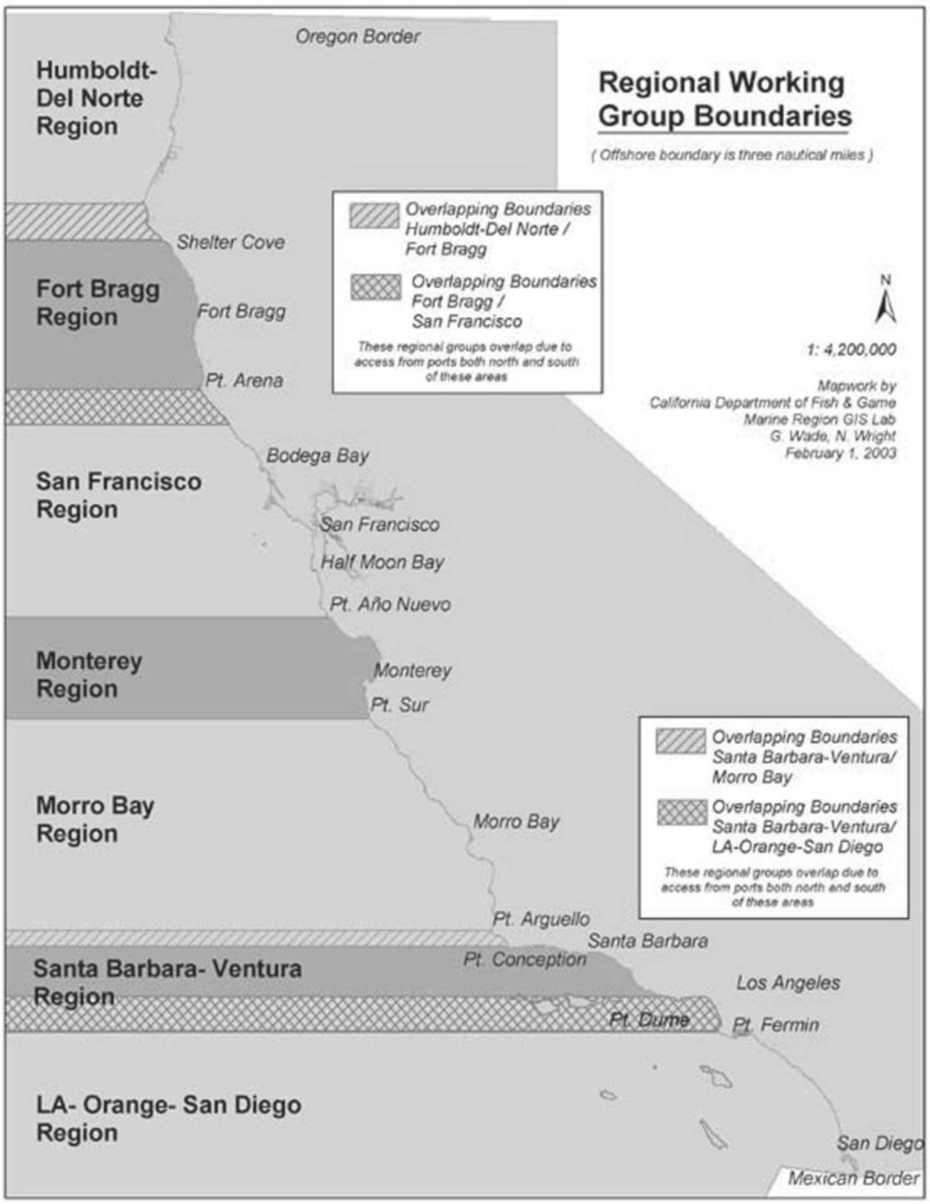

Figure 10.2. Map of MLPA regional boundaries

fishermen were asked a series of questions in four analytical categories: demographics (home harbor, years fishing experience, species targeted, gear and techniques used); oceanographic information (prevailing local weather and current patterns, weather-dependent fishing locations, observations about fish distributions based on physical oceanography, critical anchorages and transit passages, effects of ocean regime shifts such as the El Niño Southern Oscillation or the Pacific Decadal Oscillation); biological information (historically productive or "fished out" areas, known spawning sites, non-threatened or healthy species, threatened species of observed declines, biologically diverse areas, health of the fishery: past and present); and management (opinion of stock assessments, fishery management and environmental concerns, opinions of the MLPA process, economically critical areas, acceptable closure candidates). Interviewers brought nautical charts and fishermen recorded their answers to spatially related questions on these maps. Other information was recorded in notes and later transcribed.

All interviews were conducted at a time and place that was convenient for the fishermen. One complaint about existing socioeconomic analysis processes is the considerable cost they impose upon fishermen. Public meetings held at central location are often the only option for participation in marine resource management, posing high actual and opportunity costs to fishermen. Fishermen must often take time off from fishing to drive several hours to a public meeting, all at their own expense. Other methods for assessment, such as mail surveys, often have low return rates (e.g., 14.6% in the case of a cost-earning survey conducted by the Pacific States Marine Fisheries Commission (Pacific States Marine Fisheries Commission, 2002). The Local Knowledge Project resulted in 27 viable interviews (out of 30 conducted), or a 90% return rate. The fishermen were appreciative of the opportunity to participate and contribute on their own time and in their own space.

Following each interview, the information was coded by analytical category and recorded in Excel. Spatially explicit data were entered as shape files in OceanMap, Environmental Defense's GIS tool for California's coastal waters. A spatial representation of the data is important for data comparison and analysis both within this study and across other studies. Additionally, many of the shape files captured detailed species and seasonal information.

Recognizing the context of the MLPA and the goal to maximize conservation goals while minimizing socioeconomic impacts in MPA siting, the spatial analysis focused on five categories: (1) Critical Economic Areas; (2) Acceptable Closure Candidates; (3) Biologically Diverse Areas; (4) Historically Productive Areas; and (5) Critical Anchorages and Transit Passages. Statistical analysis focused on the congruence of fishermen's information, and the variance among their answers. Additionally, the Critical Economic Areas and Acceptable

Closure Candidates identified by the fishermen were aggregated and compared to the Department's original draft MPA maps. This analysis helped elucidate potential factors in fishermen opposition to the draft maps, such as the proximity of many proposed reserves near fishing ports.

A vital contribution to the success of the Local Knowledge Project was its iterative nature. Following the data collection, entry, and analysis phases, interviewers went back to each port and conducted plenary sessions with all participants from that port to review the statistical and spatial analysis. Information was only shown in aggregate and remained anonymous, but this gave fishermen the opportunity to review the data and correct any mistakes made in transcribing their information. Additionally, the plenary sessions facilitated discussion and understanding amongst the fishermen and often revealed as much information as the initial interviews.

Also central to the success of the project was confidentiality and anonymity. Fishermen's information regarding their fishing sites is proprietary and fishermen are often concerned about revealing information to competitors. Therefore, information collected during the project can be shown in aggregate, but never in fine-grain detail. Furthermore, the plenary sessions were used to gain permission for use of the aggregate data in publications and presentations. Due to the sensitive nature of this material, measures have also been taken to ensure fishermen ownership over the information.

Project Performance and Benefits

Information collected during the interviews was extensive and revealed an intricate use pattern over the oceanscape. Fishermen shared years of experience and first-hand knowledge that is invaluable, including for example, observations on oceanographic conditions, biological phenomena, and the effect of management decisions on ocean resources and their livelihoods. For a complete discussion of the results, see Scholz et al. (2004).

Overall, the project successfully achieved many of the goals set forth at its commencement (i.e., protocol for rapid socioeconomic assessment, and spatially explicit database of fishermen's ecological knowledge and socioeconomic concerns) and included numerous benefits over traditional methods of collecting and analyzing socioeconomic information. Importantly, the project was well received by most participants, many of whom expressed appreciation for the opportunity to share their knowledge and opinion. The project was relatively quick and inexpensive to conduct, is easily replicated, and achieved a high rate of return.

Through the pilot project, we created a spatially explicit database of fishermen's ecological information and socioeconomic concerns that can be easily integrated with biological information and used to inform future decision-making, and most importantly, successfully developed a protocol for rapid socioeconomic assessment for MPA planning processes.

Lessons Learned

The pilot project confirmed many of our preconceptions regarding the need for better processes for socioeconomic analysis and the ability of GIS-based tools to achieve these results. Engaging fishermen in conversations about the marine environment and MPA planning was invaluable in numerous ways: The process revealed information about the ocean, uncovered possible areas of compromise and common ground, and the project highlighted ways to improve OceanMap and the use of GIS tools for socioeconomic analysis.

In the context of this project, once engaged, fishermen were eager to share their knowledge and viewpoints about the ocean environment, fisheries biology, and marine resource management. In many cases, their observations of the marine environment correlate well with the scientific literature. Building upon this shared understanding can be invaluable to corroborate data and create policy applications that are supported by all stakeholders.

Fishermen generally disagree with scientists regarding the need for fully protected marine reserves (henceforth, "reserves"), where no fishing is allowed. While many scientists see reserves as a vital tool to manage marine resources and cite numerous studies showing that biomass, diversity, and fecundity are greatly enhanced in reserves (Castilla and Bustamante, 1989; Russ and Alcala 1996; Wantiez et al., 1997; Russ and Alcala, 1998; Halpern, 2003), fishermen often claim there is no scientific proof that reserves will benefit the fishery. Often missed is the fact that scientists and fishermen are frequently talking at cross-purposes, with scientists discussing benefits within reserves and benefits to fisheries in the form of insurance against management errors; while fishermen focus on fisheries yield enhancement (for which there is little evidence to date, due to the paucity of studies and lack of reserves of sufficient size to enhance fishery yield). Fishermen explain that existing strict regulations already make it nearly impossible to earn a living and additional restrictions will further jeopardize their future. Analysis revealed fishermen's extensive use of the marine environment, and according to participants, virtually every portion of state waters is important for catching a specific species or during a specific fishing season. Understanding the use patterns in state waters illustrates the challenge of creating reserves while limiting socioeconomic impacts. However, we found that despite their vehement opposition to the need for reserves, in light of impending legislation, most fishermen are willing to engage in conversation about reserve policy implementation, and many feel that the socioeconomic analysis is the only vehicle for their opinions.

The Local Knowledge Project highlighted shortcomings in both OceanMap and the protocol for socioeconomic assessment. Some attributes were anticipated while others were surprising. The scope of the project was too limited to conduct rigorous analysis or draw specific conclusions, which was expected based on the goals of the project. For example, some user groups were under-represented or omitted. This was intentional in the case of other marine resource users such as consumptive and recreational divers and surfers, but in addition, some types of fishermen, including surf fishermen and live rock fishermen, were left out. This is one problem with the snowball sampling method—as is unequal representation of gear types and species fished—and will be corrected in future iterations by ensuring that port gatekeepers also represent all fishermen groups that use the study area. Inclusion of all user groups and affected stakeholders is essential for comprehensive socioeconomic analysis of management implementation and policy decisions, and will be implemented in future phases of the project. Furthermore, the ability to draw conclusions from collected data is positively correlated with increased sample size; so, if this approach is used to formally assess socioeconomic impacts, sample size must be much larger.

While fishermen's shape files, as entered in OceanMap, contain species-specific and season-specific information, the resulting data analysis lacked detail. A significant amount of information could not be easily transcribed from notes to shape files because of constraints and limitations of the data entry protocol and OceanMap. For example, the only way to include information such as fishermen's name, homeport, and targeted species was to embed it in the title of a shape file. Additionally, some portions of the fishermen's information was coded and transcribed in Excel, while other portions were entered into OceanMap. Querying the data became a difficult and time-consuming process that could benefit from streamlining. Researchers also learned the importance of eliciting and representing all data in the greatest detail possible, by, for example, asking fishermen to specify the species to which they are referring when answering questions and recording that in OceanMap.

Related to insufficient detail, the project also lacked sufficient quantitative data and analysis. The interviewing technique and questions elicited a wide range of answers with limited standardization, creating a challenge for coding and comparison. There was no weighting mechanism to capture the relative importance of fishermen's data. For example, a total of 10 shape files identified by one fisherman as Critical Economic Areas had the same importance as one shape file identified by a different fisherman, particularly evident in analyzing the congruence of these areas. Additionally, analysis did not discriminate between, for example, crab fishermen and salmon fishermen referring to salmon habitat. Lack of weighting mechanisms and techniques to derive relative importance of various answers limited the usefulness of the collected information and analysis. It is essential that future projects using this methodology to collect information to support policy processes incorporate more quantitative data and analysis.

Other challenges included how the project was perceived. There were some negative misconceptions of the project goals and techniques by fishermen who were not included in the study. Misunderstandings between project staff and project participants also occurred. The proprietary nature of fishermen's information exacerbates any miscommunication and highlights the need for clear communication from the beginning through the end. While most participants supported the project, some interviewees and other outside fishermen would have been more comfortable conducting the socioeconomic analysis themselves. Follow-up discussions resulted in ideas that can help strengthen future analysis.

GIS Tool Improvements and Future Directions

Local knowledge gained through the project described above not only informed marine management, but has also aided the design of innovative GIS-based tools and methods for socioeconomic analysis. Taking into account lessons learned from the Local Knowledge Project, we have redesigned both OceanMap and the protocol for socioeconomic data collection and analysis. The result is a more powerful, user-friendly tool that has generated interest among numerous marine stakeholders, and plans for additional studies to directly support MPA planning efforts in California.

Improvement of OceanMap and Study Protocol

Experience with the pilot project revealed numerous areas for improvement of our protocol and use of OceanMap. Focusing on fishermen, the first step was to expand the list of questions, making the study more comprehensive and quantitative in design. The revised protocol focuses on understanding and documenting fishermen's use patterns of state waters in a spatially explicit manner. The ultimate goal will be to compare fishermen's uses of the marine environment with scientific and jurisdictional information to identify areas that meet conservation goals, while minimizing socioeconomic impacts. In addition, we developed interview questions and protocols for other marine users including: consumptive and recreational SCUBA and free divers; surfers; kayakers; sailors; and shop owners who provide services for such users. These protocols were tested in summer 2004 with another iteration of the Local Knowledge Project and will be revised based on the results of the study.

FISHERMEN PROTOCOL

Changes to the interview questions reflect the new goal to compare information and identify areas for conservation with a minimal socioeconomic impact. First, we devised questions to be more quantifiable in nature. For example, fishermen will be asked to estimate the percentage of take-home income earned from fishing, broken down by species, to act as one metric for determining the relative importance of fisherman-identified Critical Economic Areas when conducting data analysis. Additionally, fishermen will only be asked to identify Critical Economic Areas (CEAs) and not Acceptable Closure Candidates (ACCs), as was included in the pilot study. The decision to include ACCs as an interview question is politically sensitive and depends upon the audience and the stage of the decision-making process. Groups of stakeholders that are using OceanMap internally may find it useful to identify ACCs, whereas meetings conducted across stakeholder groups will likely find it contentious to include ACCs early in the discussion, but may benefit by identifying them in later stages of negotiation. In the context of the Local Knowledge Project, fishermen were often hesitant to suggest any area for closure. By only inquiring about CEAs in the next phase of the project, we will create a data layer of fishing patterns in state waters that can inform marine management decisions while still being politically sensitive. All CEAs will be coded by species and weighted for importance by each fisherman. Interviewers will explain that each fisherman receives 100 total "points" to assign to their CEAs, to indicate relative importance amongst the areas they identify. For instance, one fisherman may identify one area and assign all 100 points to that area; while a second fisherman may identify 20 areas assigning 5 points to each one; and a third may identify six areas assigning 50 points to one area and 10 points to the remaining five areas. These two measures, weighting within and across fishermen's answers, will be recorded with each shape file and will act as proxies for relative importance of quantitative data. Additionally, OceanMap now has the ability to capture the scale at which a shape file was drawn, providing a broad ranking system of information. Shape files drawn at a smaller scale are more specific and contain more information. This can be accounted for in the analysis phase by attributing a multiplier to the scale of the shape file. These three weighting mechanisms will allow more quantitative and accurate analysis of fishermen's information and can be built into the analysis phase to create a more comprehensive spatial representation of use patterns and their socioeconomic importance.

The revamped OceanMap has significantly streamlined data entry and can now act as a centralized database for most information collected during the interview. OceanMap functions have been programmed for commercial and recreational fishermen and include six categories of shape files: Critical Economic Areas, Biologically Diverse Areas, Historically Productive Areas, Spawning Areas, Critical Anchorages,

Figure 10.3. OceanMap pull-down menu screen for Critical Economic Areas

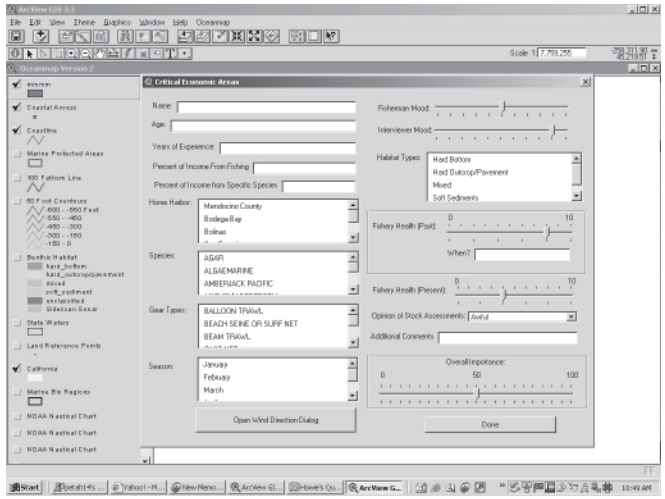

Table 10.1. OceanMap database of shape files and fishermen attribute information

	A	*B*	*C*	*D*	*E*	*F*
Fisherman Name	X	X	X	X	X	X
Home Harbor	X	X	X	X		
Species	X	X	X	X		X
Gear type	X					
Wind Direction	X		X	X		
Season	X	X		X	X	
Age	X					
Years Experience	X					
% income from fishing	X					
% income from species	X					
Fisherman mood	X					
Interviewer mood	X					
Habitat types	X					
Fishery Health (past)	X					
Fishery Health (present)	X					
Weighted importance of area	X					
Effect of regime shifts		X				
Pollution type						X
Pollution frequency						X
Pollution effects						X
Additional Comments	X	X	X	X	X	X

Column A = Critical Economic Areas; Column B = Biologically Diverse Areas; Column C = Historically Productive Areas; Column D = Spawning Areas; Column E = Critical Anchorages; Column F = Pollution and Polluted Areas. The user is guided through OceanMap with various pull-down menus, designed to build information into the program. All data are tied to shape files, categorized above, via customized pull-down menus (Fig. 10.3), designed specifically for that category of spatial information. For instance, inputting a fisherman-identified CEA requires choosing standardized options for numerous attributes including Home Harbor, Gear Type, Targeted Species, Wind Direction, Effects of El Niño, and Weighted Overall importance of area. The other categories of shape files have their own specified list of attributes displayed in the pull-down menus (Table 10.1). Associating this information with spatially-explicit shape files will ensure collection of complete information; create more detailed and useful data; and ease data organization, querying and analysis.

DIVER PROTOCOL

Recreational and consumptive SCUBA and free divers are another important group of marine resource users. We have also created interview protocols for these stakeholders and have built out the OceanMap program, in the same manner as for fishermen, to incorporate diver information. Customized pull-down menus have been created for both consumptive divers and recreational divers. While there are some differences between the protocol and pull-down menus for divers and fishermen, we intentionally designed the project to be comparable across user groups, and therefore the components for divers are largely the same as for fishermen.

For both recreational and consumptive divers, we programmed functions for six categories of shape files: Favored Dive Sites, Biologically Diverse Areas, Historically Productive Areas, Spawning Areas, Critical Anchorages, and Polluted Areas. Note that these are exactly the same as those for fishermen, except instead of Critical Economic Areas, divers have the category Favored Dive Sites, or user-identified areas that are most important for divers to have access for their activity and enjoyment. Identical to the fishermen shape files, users are guided through a series of pull-down menus where they specify different categories of information, which are tied directly to shape files by the OceanMap program. For a list of attributes that are displayed in the pull-down menus, see Table 10.2. As mentioned above, these are largely similar to the fishermen menus for comparison purposes, but include modifications such as average dive time, and size of dive area.

Importantly, Favored Dive Site also includes the weighting mechanism described in the previous section for the fishermen. Divers are asked to indicate the importance of each area by giving it a point value, with a total of 100 points for all of their areas combined. OceanMap also captures the scale at which the shape is drawn. The combination of these weighting mechanisms will be important for analyzing data within user groups, as well as across user groups. In

Table 10.2. OceanMap database of shape files and diver attribute information

	A	*B*	*C*	*D*	*E*	*F*	*G*
Diver Name	X	X	X	X	X	X	X
Home Harbor	X	X	X	X	X		X
Species Observed	X	X	X	X	X		X
Wind Direction	X	X	X	X	X		
Season	X	X	X	X	X	X	
Years Experience	X	X					
Species Targeted	X						
Harvesting Method	X						
% income from consumptive diving	X						
% income from specific species	X						
Interviewer mood	X	X					
Habitat types	X	X					
Species Health (past)	X	X					
Species Health (present)	X	X					
Average Dive time	X	X					
Average Size of Dive Area	X	X					
Access Method	X	X					
Weighted importance of area	X	X					
Effect of regime shifts			X				
Pollution type							X
Pollution frequency							X
Pollution effects							X
Additional Comments	X	X	X	X	X	X	X

Column A = Favored Dive Sites (Consumptive divers; Column B = Favored Dive Sites (Recreational Diver); Column C = Biologically Diverse Areas; Column D = Historically Productive Areas; Column E = Spawning Areas; Column F = Critical Anchorages; Column G = Pollution

particular, the scale feature will be helpful to compare fisherman and diver information, which are likely to be vastly different in size.

Marine Resource Stakeholders as Loci for Data Collection

The Local Knowledge Project has generated interest in socioeconomic analysis and marine reserve siting among numerous user groups, specifically in using the OceanMap tool. Many fishermen who participated in the pilot project requested copies of maps to use for fishermen-driven MPA planning efforts, and would like to see further data collection. Recreational diver representatives have seen demonstrations of OceanMap and have contributed their own data.

Environmental Defense has distributed numerous copies of OceanMap to interested parties for review and individual use.

OceanMap is designed to accommodate a variety of approaches for socioeconomic assessment. Environmental Defense can conduct research independently, partner with other organizations to collect data, or train interested stakeholder groups or organizations in the protocol and the use of OceanMap and let the groups collect data themselves.

OceanMap has additional built-in functions that allow stakeholder groups to work independently of GIS experts to easily perform initial data analysis. For instance, users can aggregate spatial information with the click of a button to quickly find congruence within the stakeholder data, thereby creating a map of their detailed spatial representation of their socioeconomic information. More advanced data analysis, such as comparing information across user groups, is also possible, but will likely occur after user groups have compiled their information into data layers. Environmental Defense can help groups synthesize and analyze OceanMap data initially, but will seek a "neutral party," perhaps an academic or government institution, to serve as the repository of data collected by OceanMap users. The flexibility and ease of OceanMap make it a powerful tool for reaching out to all stakeholders and conducting accurate and timely socioeconomic assessment that can easily be integrated with other types of information. Its application can facilitate the analysis and inclusion of socioeconomic data inimplement the Marine Life Protection Act and other marine management initiatives.

Over the summer of 2004, Environmental Defense, in partnership with Ecotrust and the Central California national marine sanctuaries, conducted the second iteration of the Local Knowledge Project, utilizing and testing the changes made in OceanMap. Participants included commercial and recreational fishermen, consumptive and non-consumptive SCUBA and free divers, kayakers, sailors, surfers, and shop owners. The results of the study will be published in a peer-reviewed journal, but have once again proven the effectiveness of OceanMap. We continue to refine interview protocols for each user group, expand the stakeholder-specific pull-down menus and methods for integrated data entry, and make other improvements to OceanMap.

Integration with other Spatially-Explicit Information and Expansion Beyond California MPA Planning

OceanMap is a tool that allows spatial representation of disparate forms of marine-related data. One of the greatest benefits of the tool is its capacity to integrate numerous datasets, represented as individual layers of information, into one centralized location. Comparison and analysis of complex datasets is possible and relatively easy to accomplish. OceanMap already contains numerous data layers and will continue to assimilate information as it becomes available. The end result will be a rich database that can be used to derive MPA siting alternatives based on specified goals and objectives.

If coupled with simulated annealing software, OceanMap could serve as a decision-support tool, generating sets of reserve siting scenarios that all meet scientific criteria (e.g., for individual reserve size, total network size, habitat representivity, etc.). These siting scenarios could then be compared with socioeconomic data to choose scenarios that minimize costs to user groups.

OceanMap can also facilitate interaction between stakeholder groups. For instance, fishermen and scientists can view each other's information in a standardized format and identify areas of common agreement. Local knowledge is generally not subject to the same peer review as scientific information, but comparison of fishermen's information with other data sources would help validate it. Meetings between fishermen and scientists to achieve these objectives would be a logical extension of the project.

The protocol developed through the Local Knowledge Project and the capabilities of OceanMap can be generalized to other applications. These tools are flexible enough to support numerous marine policy implementation decisions and are not limited to MPA planning efforts. Groups working to derive marine decision support tools in other regions and states have expressed interest in the OceanMap model. The OceanMap design is replicable and, depending on available data, can be applied to any marine environment.

Conclusion

MPA planning is a complex and sometimes contentious process, with numerous stakeholders and data needs. Experience in California illustrates that early inclusion of socioeconomic information improves planning and implementation phases of the decision-making processes. Tools designed to facilitate inclusion of socioeconomic information in a spatially explicit manner and integration of different kinds of information are needed.

The Local Knowledge Project focused on developing a protocol for collecting local knowledge and standardizing it for integration into policy processes. The initial study yielded numerous products including: (1) a protocol for rapid socioeconomic assessment; (2) a database of fishermen's knowledge and information; and (3) a GIS of fishermen's ecological information and socioeconomic concerns for further use in the MLPA process (Scholz et al., 2004). Through this study, OceanMap was proven effective in representing spatial information and augmenting the MPA planning process.

Based on lessons learned during the pilot study and feedback from marine resource stakeholders, OceanMap has been further developed into a more comprehensive and powerful tool. The protocol for collecting socioeconomic information has also been improved for broader application, and with continued use and feedback, OceanMap development will persist. As this project has demonstrated, GIS-based tools are effective means of empowering user groups and representing information spatially. Such tools can greatly facilitate the collection and analysis of socioeconomic information, which is essential for sound policy making and durable marine management successes.

Notes

1. Parties interested in learning more about “OceanMap,” or obtaining a copy should contact Peter Black at Environmental Defense. “OceanMap” currently runs on Microsoft 2000 or higher and with ESRI’s Arcview 3.3.

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