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Participatory socioeconomic analysis: drawing on fishermen's knowledge for marine protected area planning in California

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Abstract

The purpose of this pilot study was to test the utility of geospatial analysis tools for eliciting and integrating fishermen's[1] knowledge into marine protected area (MPA) planning processes in California, United States. A participatory design yielded 30 local knowledge interviews that were coded for socioeconomic and biodiversity information. The resulting information is useful in understanding past conflicts around MPA siting proposals and for identifying likely sources of agreement and disagreement. Products include a protocol for rapid socioeconomic assessment; a database of fishermen's knowledge and information; and a geographic information system for further use in California's MPA planning process.

Keywords: Marine protected areas; Local knowledge; GIS; Decision-support; Fishery management

1. Introduction

In California, as elsewhere on the West Coast of the United States, fishing—although a relatively small share of the larger regional economy—is central to the economic and cultural life of local coastal communities. Many people's livelihoods depend upon the ocean, and marine policy decisions directly affect their ability to earn a living and maintain their communities and lifestyles. Traditionally, fishery and marine conservation management have tended to consider the biophysical aspects of any management decision first, and the socioeconomic impacts second. The latter typically occur in the context of regulatory analyses to meet legal requirements. The recent experience in California suggests that it may be far more effective to consider socioeconomic aspects of proposed management measures early on in the decision-making process.

Marine protected areas (MPAs) are a relatively new tool in the repertoire of marine resource managers. They have equally attracted both scientific support and political controversy. Much of the controversy stems from the immediate costs of implementing MPAs, which tend to be borne by the consumptive users of an area, commercial and recreational fishermen. The benefits tend to be delayed and accrue primarily to non-consumptive users [1,2]. The consideration of the costs and benefits of a management decision is the purview of socioeconomic analysis, in particular, regulatory and community impact analyses required by federal (National Environmental Policy Act; Magnuson-Stevens Fisheries Conservation and Management Act) and state laws (California Environmental Quality Act). Typically, these impacts are analyzed in the context of environmental impact statements and other assessments that are conducted prior to the implementation of a management measure, but after the planning and public consultation process. Furthermore, when

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[1] Although seemingly anachronistic, fishers of both genders tend to refer to themselves as fisher*men*. We follow this usage, rather than the more scholarly "fisher" or "fisherperson".

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socioeconomic analysis does occur, it tends to focus on easily measurable economic indicators, such as changes in income or employment, that are typically not available at local scales.

In the case of MPAs, the potential costs and benefits are manifold and often differ between user groups. For example, MPAs may entail restrictions on commercial and recreational fishing, thus adversely affecting personal incomes of fishermen and charter-boat operators. They may also engender positive changes to the regional economy, for example by enhancing the appeal of an area to tourism. In addition to economic impacts, marine management measures may have social consequences, for example by changing the profile and distribution of participation in marine recreational or commercial activities in an area. While socioeconomic impacts can be both positive and negative, they are central to policy processes. Agencies who ignore the concerns of affected user groups about the actual and perceived costs and benefits of management measures run the risk of deepening the schism between fishery managers and fishing communities. Such division is already becoming more apparent [3], especially on the West Coast in the context of recent fishery declines [4,5].

Compounding the danger of delaying socioeconomic analysis is the general inability of agencies to adequately incorporate local knowledge [3], which could fill important data gaps. For example, many socioeconomic analyses consider impacts at the county or regional level, which—given the local nature of the fisheries on the West Coast—may not be the appropriate scale. Smaller, localized scales pose challenges to agencies that tend to be staffed by fishery biologists and policy analysts, and often lack social scientists, staff and resources to design and conduct fieldwork.

In recognition of the aforementioned issues—the potential of local knowledge to supplement socioeconomic analyses, and of geospatial analytical tools to empower user groups—an unusual research alliance formed to accelerate the incorporation of social and economic information into California MPA planning efforts. Environmental Defense (an environmental advocacy organization) and the Institute for Fisheries Resources (IFR; the research arm of the Pacific Coast Federation of Fishermen's Associations (PCFFA), a fishing industry trade organization) collaborated on a pilot project to address these issues by jointly developing and testing a participatory socioeconomic analysis protocol in the context of the California Marine Life Protection Act (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. This is work in progress, as the MLPA process is still unfolding.

2. Bringing local ecological knowledge (LEK) to bear on California MPA processes

The idea for the collaborative project built on the growing body of literature on the benefits of incorporating LEK and economic concerns into decision-making processes. The project also benefited from practical experience with two MPA planning processes in California: the designation of fully protected marine reserves (MPAs where all fishing is banned) within the state and federal waters of the Channel Islands National Marine Sanctuary (CINMS) off the Southern coast of California, and the first attempt to implement the state-wide MLPA in 2002. The MLPA requires the California Department of Fish and Game (CDFG) to implement a network of MPAs in state waters with an improved marine reserve (defined as no-take areas) component.

2.1. Local ecological knowledge

LEK refers to the body of knowledge held by a specific group of people about their local ecosystems. It is often site-specific and can be a mixture of practical and scientific knowledge [6]. Fishermen and fishing communities often possess a high level of knowledge regarding fish populations and marine ecology [7], and so incorporating LEK into policy processes can achieve numerous goals. LEK is separate and different from scientifically generated information, but is still useful, and perhaps necessary, for creating and implementing policy. Local knowledge can be used to corroborate scientific data and to fill in gaps in the scientifically generated data [8]. While local knowledge typically is not subject to the same peer review as scientific knowledge, triangulation with other data sources and comparative techniques can help validate it.

Incorporating local knowledge into the decision-making process and creating community-based resource management systems can have multiple benefits [9–12]. In a study on community-based resource management in the Philippines [13], Russ and Alcala contrasted the success of two separate marine reserves. The reserve that had included resource users in the design and implementation process achieved significantly better enforcement, and increased ecological benefits. Eliciting and using local knowledge in the early stages of the planning process for MPAs may well be an effective way to foster this participation, and empower stakeholders in the governance of marine resources [14]. Our study is premised on the notion that lessons in local knowledge and participation from other countries are applicable in California, where fishery and marine resource management has seen increasing discord between user groups and managers in recent years.

2.2. MPAs in California

In California, recent MPA planning processes are fraught with contentious relationships between stakeholders, especially commercial and recreational fishing groups, environmental organizations, and resource managers. Beginning in 1999, the CINMS—one of 13 such sanctuaries in US waters [15]—underwent one of its periodic management plan reviews. In response to direction from the California Fish and Game Commission and the CINMS, the Sanctuary's Advisory Council formed a working group comprised of scientists, fishermen, environmentalists, and other stakeholders that was charged with the design of a network of marine reserves. This working group, in turn, formed two panels—on natural science and socioeconomics, respectively—that collected and synthesized relevant data and developed tools for analysis. These were then used to develop a series of marine reserve alternatives, and to evaluate their ecological characteristics and economic impacts on the various user groups and surrounding communities [16].

Although they came close after 3 years of negotiation, the working group ultimately did not achieve consensus on one design alternative. Instead, agency staff drafted a set of design alternatives based on the intermediary maps of consensus produced by the working group. The staff attempted to meet scientific criteria recommended by the working group's science advisory panel, while minimizing socioeconomic costs as articulated by the group's socioeconomic panel. Of the design alternatives, the "preferred alternative", i.e. that endorsed by the Sanctuary Advisory Council, provides for 25% of the CINMS management area to be set aside in marine reserves [17]. In October 2002, the Fish and Game Commission adopted the "preferred alternative" for the state water portion and it is currently moving through the regulatory process for the federal portion.

Although a team of consultants and academics collected anecdotal and socioeconomic information from fishermen to inform the process, many stakeholders were dissatisfied. They felt that they were not sufficiently consulted, that insufficient data were available for comprehensive socioeconomic assessments, and that fishermen's LEK was not sufficiently incorporated into the process. Socioeconomic considerations entered relatively late in the siting deliberations, and once completed, the analysis was biased towards consumptive uses and immediate costs [18]. The debate in the Channel Islands became focused on the trade-offs between conservation goals and economic concerns, with many fishermen and environmentalists polarized on opposite sides of the issue.

As one fishermen observed, however, it was in the socioeconomic panel that participants felt their knowledge was at least being taken seriously [19]. This observation, together with another MPA planning process unfolding in California, provided the impetus for this pilot study on a method for engaging socioeconomic concerns early and eliciting LEK.

Along with the CINMS process, the State of California began implementation of the MLPA. Introduced in February 1999 and chaptered in October 1999 [20], the MLPA requires that the California Fish and Game Commission adopt a Marine Life Protection Program. The Program must meet six explicit goals including: protection of biodiversity; conservation of marine life populations; improvement of recreational, educational and study opportunities; protection of marine natural heritage for their intrinsic value; clearly defined objectives based on sound science; and the design and implementation of a network of MPAs, including an "improved marine life reserve component (defined as no-take [i.e., fully protected] reserves)" [21].

The implementation of the MLPA presented an opportunity to use the knowledge of marine resource users better, and to create a successful network of MPAs. Initially, however, the process got off to an inauspicious start. During 2001, in their first attempt to implement the goals of the MLPA, the Department of Fish and Game (CDFG) used a process that did not reflect the importance of effective participation and consultation.

The CDFG formed a Master Plan Team that was responsible for developing initial draft concepts of potential marine reserve sites for public review. The Master Plan Team drafted MPA candidate sites without soliciting input from stakeholders, instead using the distribution of fishing effort and targeted species as proxies for habitat characteristics [21]. Draft maps were then presented to the public in a number of meetings along the coast in the summer and fall of 2001, during which there was intense uproar among many stakeholders, especially fishermen. Much of the contention was focused on the lack of socioeconomic considerations reflected in the draft maps. The process created considerable distrust, leaving many stakeholders dissatisfied, and led the Director of the CDFG to disband the original process and start over [21].

The CDFG has since restructured the consultative process, notably by convening MPA working groups in each of four regions along the coast of California—North, North-Central, South-Central, and South—with a total of seven Regional Working Groups, one for each region, with three additional overlap areas (see Fig. 1). Each Working Group is comprised of about 15 representatives from the fishing, diving, scientific, and environmental communities [21].

The Department held an expert workshop on socioeconomics in the fall of 2002, but is still uncertain how to include socioeconomic information in the implementation of the MLPA. As laid out in Section 2855 (c) of the Act, "the department and team in carrying out this chapter [achieving the goals stated above], shall take

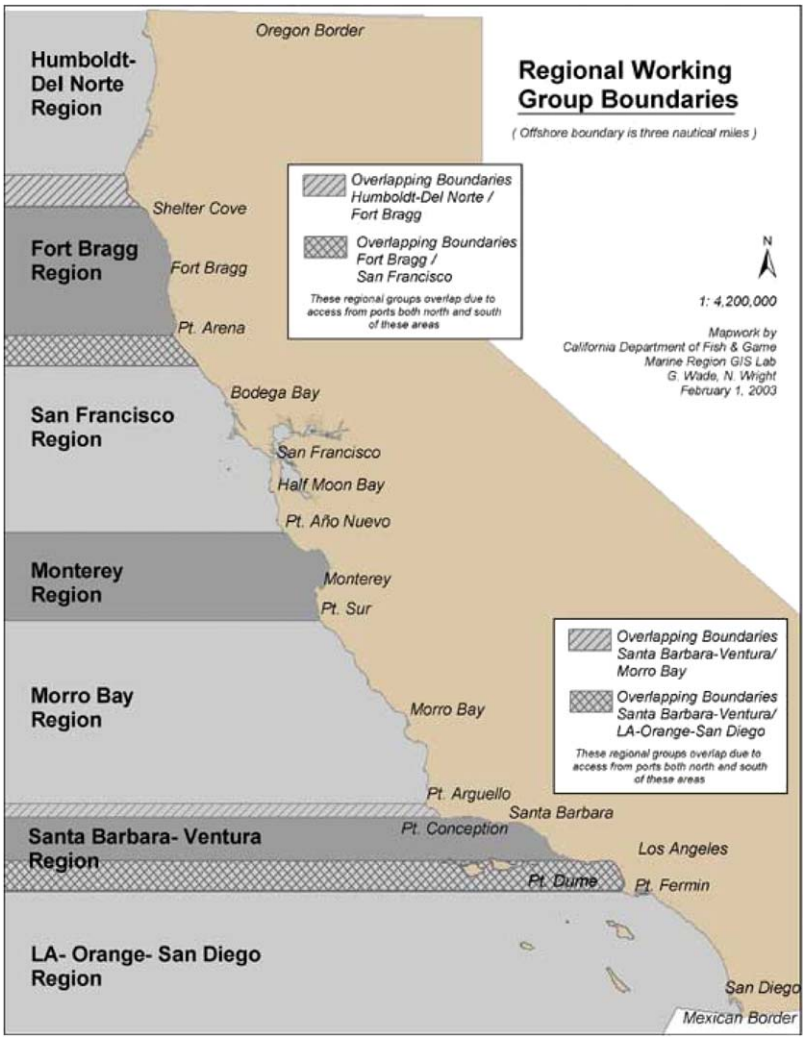

Fig. 1. CDFG regional boundaries map.

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'' [22]. In other words, the ecological, biodiversity, and other goals of the MLPA are to be implemented while taking the socioeconomic effects of various measures (including MPAs) into consideration. Our project was intended to contribute to the assessment of these complex effects, and to provide a framework for consideration in the analysis.[2]

3. Methods

The project focused on the North-Central Region of California—from Pt. Año Nuevo to Point Arena (see Fig. 1). Within this area, we identified five main ports and port groups: Mendocino County (Fort Bragg, Pt. Arena, Albion), Bodega Bay, Bolinas, San Francisco, and Half Moon Bay.

Fishermen were involved in the study both during the design phase and as participants. The design stage of the project included several meetings between project staff and fishing representatives associated with the PCFFA. This group of researchers and port ''gatekeepers'' collectively developed the list of research questions to be asked of interviewees in each port, and the gatekeepers provided some initial names of fishermen who would be willing to participate in an interview for the project. From these initial interviewees, lists were generated of other fishermen who would also be willing to contribute. All 30 interviews conducted for this project were derived using this ''snowball'' sampling method [23].

3.1. In situ interviews

At the core of the project was a period of fieldwork during which semi-structured interviews were

[2] As of October 2003, the MLPA process has been reconfigured once again, with working groups suspended due to lack of funding.

conducted. Over a 2-month period, two research assistants interviewed thirty fishermen who had been recommended by the gatekeepers based on the length of their fishing career, their depth of knowledge, and their willingness to be interviewed. Typically, the interviewers contacted the fishermen via telephone to explain the project and the interview process and to ask if they would be willing to participate in an interview. Only two of the contacted fishermen were unwilling to grant an interview, citing scheduling conflicts or lack of time. Once a fisherman agreed to an interview, the interviewers traveled to the port and met the fishermen on his/her boat or at a nearby restaurant. All fishermen were interviewed voluntarily with the understanding that they were not required to relinquish any information if they did not choose to do so. The interviews followed a semi-structured format, resulting in free flowing conversations guided by a set of specific questions. While each interview was unique, this structure allowed the format to be tailored to each interviewee and yielded responses to a set of core research questions that were later recovered in spatial coding. This process resulted in 27 viable interviews.

It is important to note that the interview process was designed to reduce the fishermen's costs associated with participating in the study. One frequent complaint about fishery and marine resource management is that, in order to participate, fishermen have to travel to meetings held in central locations, often at their own expense. Similarly, socioeconomic research designs that rely on group meetings or require fishermen to suspend their fishing activity are problematic. Where mail surveys and other remote techniques have been used, they are usually fraught with low return rates (e.g., 14.6% in the case of a cost-earning survey conducted by the Pacific States Marine Fisheries Commission [24]) or are met with considerable distrust (as in the case of the Marine Recreational Fisheries Statistical Survey conducted by NMFS over the phone). By contrast, our project achieved a 90% return rate (27 viable interviews out of 30 conducted), and allowed the fishermen to contribute knowledge on their own time and in their own space—thus reducing both their actual and opportunity costs of participating in socioeconomic research or fact-finding endeavors.

During each interview, fishermen were asked a series of questions on four core analytical areas: Demographics (home harbor, years fishing experience, species targeted, gear and techniques used), oceanographic information (prevailing local weather and currents, weather-dependent fishing locations, observations about fish distributions based on physical oceanography, critical anchorages and transit passages, effects of ocean regime shifts such as El Niño Southern Oscillation or Pacific Decadal Oscillation), biological information (historically productive or "fished out" areas, known spawning sites, non-threatened or healthy species, threatened species or observed declines, biologically diverse areas, health of the fishery: past and present), and management (opinion of stock assessments, fishery management and environmental concerns, opinion of MLPA process, economically critical areas, acceptable closure candidates).

Using pencils and nautical charts, interviewees identified locations in response to particular questions, where appropriate. Other information was recorded in notes and later transcribed.

3.2. Spatial analysis

Following the interviews, the information was transcribed into a Geographical Information System (GIS) mapping application ("OceanMap") developed by Environmental Defense for the coastal waters of California. OceanMap includes numerous data layers that can be added or taken away from view. The layers include geographical information, existing MPAs, habitat information, bathymetry, and nautical charts.

The interviewees' responses were collected in Excel, coded in reference to the analytical categories, and entered into OceanMap. This allows the information to be represented spatially in an electronic form, and lends itself to thematic and statistical analysis. The collected information, and the OceanMap layers derived from the information, is extremely detailed, including species-specific and season-specific information.

Since this pilot study was conducted in the context of the MLPA and the siting of MPAs, the spatial analysis focused on: (1) Economically Important Areas, (2) Acceptable Closure Candidates, (3) Biologically Diverse Areas, (4) Historically Productive Areas, and (5) Critical Anchorages and Transit Passages. The statistical analysis focused on the congruence of the fishermen's information, and the variance among their answers. We also compared aggregated information derived from the interviews on Acceptable Closure Candidates and Critical Economic Areas with the original Department draft MPA maps (see Fig. 2) to help elucidate potential reasons for opposition to the draft maps.

3.3. Iterative process

Following the interviews, as per agreement between the researchers and the "gatekeepers", we conducted plenary sessions with all participants in a port to review the results from the statistical and spatial analysis. All of the information remained anonymous, but the fishermen were able to see what other fishermen from their own port had revealed during the interview process. This follow-up meeting allowed the fishermen to correct any mistakes made in transcribing the information, approve the maps for use by the researchers in presentations and

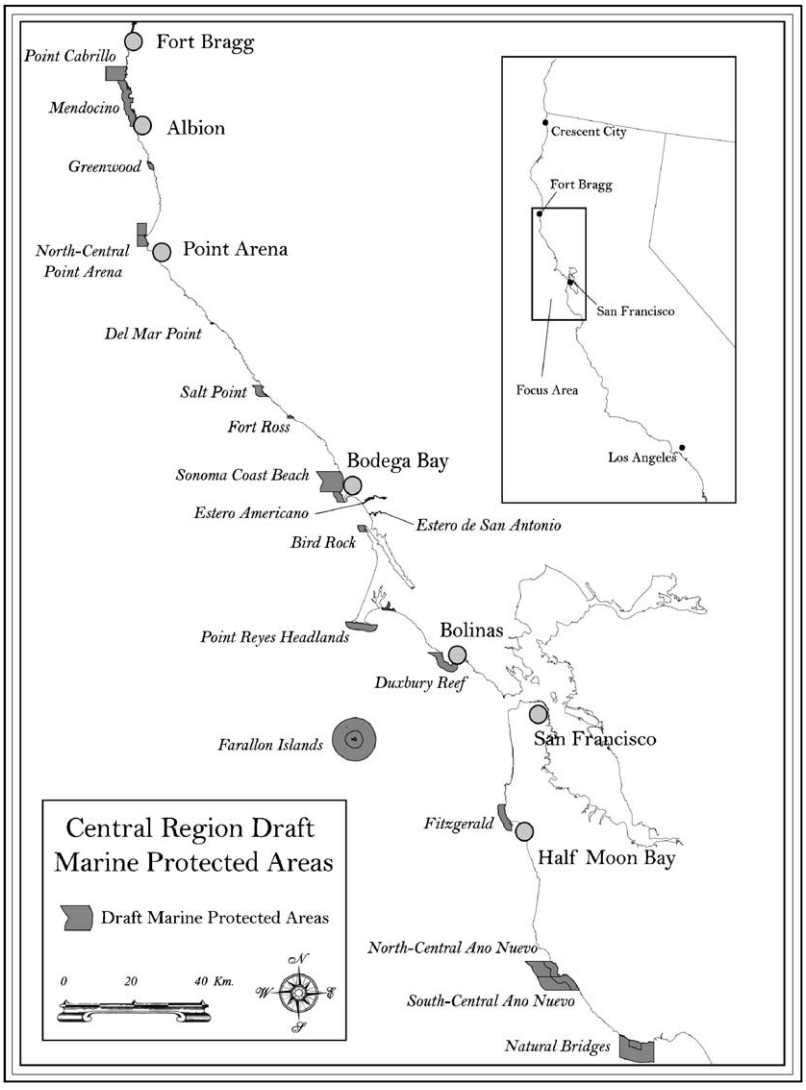

Fig. 2. Draft DFG MPA concepts.

publications, and to discuss the similarities and inconsistencies among the aggregated information. These sessions were vital to the success of our project and often revealed as much information as the initial interviews, in the form of updates and revisions to the initial data. It is important to note that the goal of the project was not to derive a final product or set of maps for each port group, but rather to test the protocols for collecting, analyzing, and presenting locally relevant information.

Confidentiality was critical to the success of the project and all information remained anonymous throughout the entire study. During the group sessions, we asked for the fishermen's permission to share the aggregate information with other ports and/or use it in presentations and publications. The data can be delineated by port, but the fine-grained data remain confidential. This is essential since many fishermen are concerned about revealing their specific fishing spots to potential competitors. Due to the sensitive nature of the subject material, we were also careful to ensure that fishermen maintained ownership of their information. The complete project database and maps are housed at the Institute for Fisheries Research, the research arm of PCFFA. Although we did not collect the data in order to advocate a detailed MPA plan or any other specific management outcome, many of the participating fishermen were interested in using the compiled information as a platform for further discussions and asked for received material pertaining to their port, as well as the summary results for the entire region.

4. Results and discussion

In this section, we present the results from the local knowledge interviews. Our study was not designed to triangulate the fishermen's knowledge with other sources of data and scientific publications. This is,

clearly, a logical extension of the work presented here. For the purposes of this study, we focused on testing a fieldwork and spatial analysis design that may have broader applications for data gathering related to fisheries and marine management.

4.1. Demographics

The interviewed fishermen represent a diverse cross-section of the fishing community in the North-Central region of California. The interview pool consisted of 21 commercial fishermen and 6 recreational boat captains using a variety of gear types to catch a diversity of species. To maintain the integrity of the project, it was important that each fisherman had extensive experience in California fisheries, and, together, the interviewees represented 677 years of experience in the marine environment. Eighty-one percent of interviewees had been fishing for 20 years or longer, 67% had at least 25 years of experience, and 48% had been fishermen for at least 30 years.

The interview pool also represented a range of fisheries typical of the US West Coast. Most fishermen participate in more than one fishery during the year due to seasonal and daily catch limits. In general, fishermen in the study area diversify among fisheries in order to support themselves financially. In order of proportion in our sample, the fisheries prosecuted by the study participants are salmon (81%), crab (52%), rockfish (52%), albacore tuna (33%),[3] California halibut or sand dabs (26%), sea urchins (18%), "baitfish" (7%—including sardine, mackerel and herring), and sea cucumbers (7%).

Participants were fairly evenly distributed along the North-Central region of California: 22% fish out of Mendocino County, 22% out of Bodega Bay, 11% out of Bolinas (a smaller port between San Francisco and Bodega Bay), 19% out of San Francisco and 26% out of Half Moon Bay. These proportions correspond roughly to the ports' share of North-Central California fisheries. The northernmost area, Mendocino County, is sparsely populated and the fishermen are distributed along a large portion of the Coast. We interviewed fishermen in Albion, Pt. Arena, and Fort Bragg. The latter lies in one of the DFG's "overlap areas" (see Fig. 1), and many fishermen from this port utilize portions of the coast within the study area proper.

While not intended as a representative sample, numerous gear types were nonetheless represented in the study. Most fishermen fish for more than one species and therefore use more than one gear type. These percentages represent the fisheries that the interviewees participate in consistently, as opposed to any dormant permits they might have. Many of the interviewed fishermen have used most of the following gear types at one time in their career:

- 41% use pots
- 26% use hook and line
- 22% troll
- 19% dive on compressed air
- 15% use nets, including trawl nets, seine net, and Scottish seine
- 11% longline
- 22% use shallow-water light tackle for recreational charter boats

The study is not comprehensive or completely reflective of the fishing activities off the North-central coast. For example, surf or beach fishermen were not included, and few fishermen who participate in the "live fish" fishery were interviewed. Also, since the study focused on state waters, offshore gear like bottom and midwater trawls are not represented. While some fishermen offered extra information, we did not fully inquire or incorporate information about fishing activities outside of 3 miles from the coast, the boundary of the state's jurisdiction.

4.2. Oceanographic conditions

Oceanographic conditions greatly affect fishermen and fishing practices, making fishing a dangerous way to earn a living. The weather affects when and where fishermen can go out, and oceanographic conditions affect the location and abundance of fish. The weather pattern off California is characterized by winds predominantly from the Northwest or North-Northwest in the summer, and from the Southeast during the winter.

All fishermen agreed on the importance of protecting critical anchorages and transit passages during the siting of MPAs. Due to the dangerous, ever-changing nature of the ocean environment, fishermen must be able to access shelter in the protected coves and inlets along the coast. The fishermen have been concerned that the MLPA will affect anchorage sites and transit passages. Although the CDFG has indicated that anchorages will not be affected by any MPAs implemented under the MLPA, the fishermen felt it was important to capture critical anchorages in the study. From North to South, these are Arena Cove, Fish Rocks, Stewarts Pt., Fisk Mill Cove, Fort Ross Cove, Russian Gulch, Bodega Bay, Drakes Bay, Bolinas Bay, Shelter Cove, Pigeon Pt., Pt. Año Nuevo, and the South Farallon Island; they are shown in Fig. 3.

The fishermen we interviewed firmly believe that the most important factor determining the rise and decline

[3] Since the study focused on state waters out to three miles, tuna are not pertinent to our analysis. We decided, however, not to constrain the interviews to just state waters, since most fishermen regularly fish in state and federal waters.

of fish stocks are natural cycles and changing oceanographic conditions, such as fluctuations in weather, currents, and temperature. In discussions regarding fish abundance, fishermen cited small seasonal fluctuations, as well as larger scale fluctuations such as the El Niño Southern Oscillation (ENSO). Many fishermen reported that the entire food chain is affected during El Niño years and believe ENSO to be "nature's cleansing." Many of the lower trophic level organisms die off, leaving higher trophic level fish thinner and less abundant. Additionally, fish move further north to find cooler water, and catches of all fish decrease dramatically. Following El Niño years, fishermen note the dramatic increase in fish, and fish catches. Salmon, in particular, tend to rebound extremely well.

Fishermen also discussed the effects of longer-term ocean regime shifts, such as the Pacific Decadal Oscillation. After several decades of a warmer water regime, fishermen (and many scientists) suggest that we are now entering a cooler water regime. Off the West Coast, cooler water generally corresponds with higher ocean productivity and numerous fishermen agree that the ocean has been more vibrant and full of life over the past few years. In general, the fishermen interviewed agree that natural cycles are more important determinants of ocean health and abundance than human consumption and fishing pressure. Based on this perspective, many fishermen disagree with the need for MPAs to enhance fish populations, or indeed the ability for MPAs to help rebuild fish stocks. There are other factors that influence fishermen's disagreement with the need or appropriateness of MPAs, but larger scale ocean regime shifts was one of the most commonly cited reasons. Interestingly, many of the fishermen's observations of the effects of regime shifts on fisheries match the scientific literature quite well [25,26]; however, their interpretations of the causes of declines in fish abundance are in general at variance with the literature and

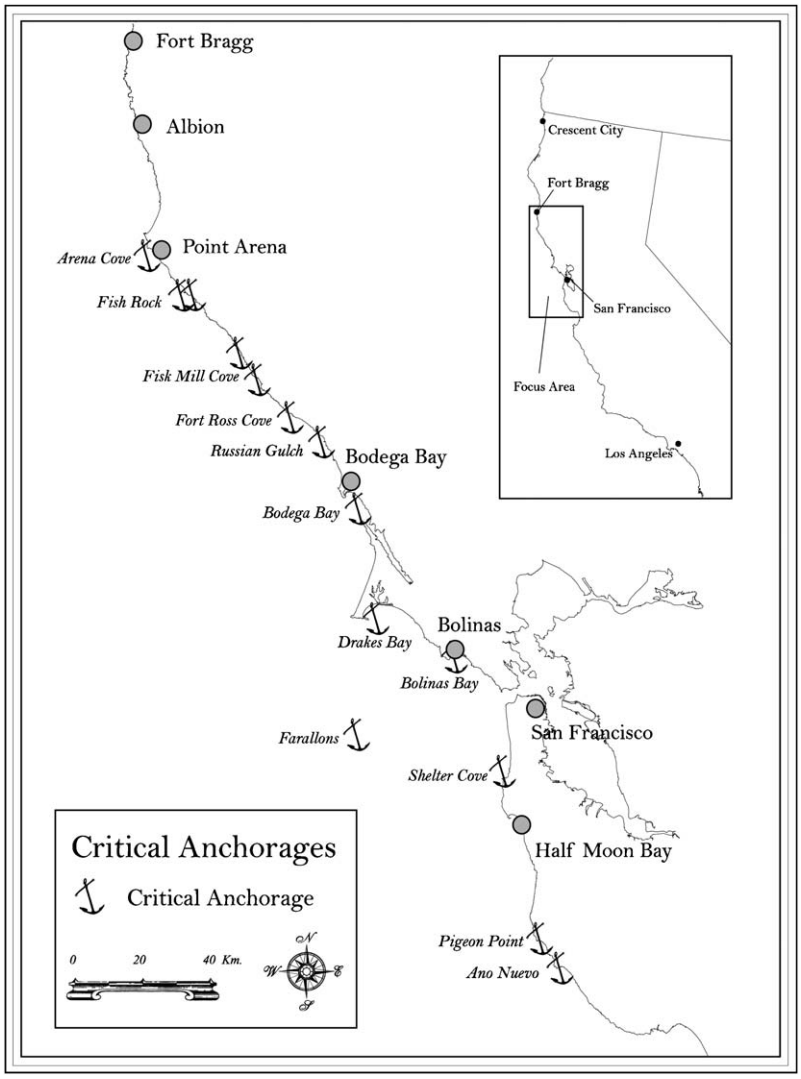

Fig. 3. Critical anchorages.

with observed trends in existing marine reserves, where exploited fish populations are larger than in fished areas [27–32]. It would be interesting and valuable for scientists and fishermen to collaborate in a future extension of this project and compare their data and perceptions.

Physical oceanography and habitat structure are important determinants of fish location as different fish species prefer different habitat types, therefore tending to congregate in specific areas. Fishermen can often successfully fish for specific species based on the habitat of a region. Furthermore, some specific locations along the coast tend to retain more larvae and have higher fish abundance. For example, many fishermen indicated that larvae build up off Point Reyes due to the current pattern and physical structures present. Additionally, many salmon and tuna fishermen can locate fish based on slight temperature changes referred to as "slicks" or "rips," as fish tend to congregate along the temperature gradients.

4.3. Biological information

4.3.1. Health of stocks

During the interviews, fishermen were asked to identify species that were "non-threatened" or in good health, as well as which species they considered to be "threatened" or that had declined over the length of their careers. The following statistics represent a compilation of the interviewees' answers. It is important to note that these were open-ended questions and that most fishermen answered in the context of the fisheries in which they participate.

Some patterns emerge when comparing responses aggregated across the entire interview pool, to stratifications of it by participation in a fishery or by assessment category of a stock. For example, of all the fishermen interviewed for this project, 37% characterized the crab fishery as healthy and sustainable, whereas 44% of those participating in the fishery thought so. The summary of fishery assessments from a 2001 status report by the CDFG is included for comparison.

Comparing columns B and C, Table 1 suggests that, for all species but salmon, fishermen participating in a particular fishery have a more optimistic assessment of the health of the associated stocks than the interview pool as a whole. This also holds for the assessment of some rockfish stocks as "in decline", which is felt by fewer of the fishermen participating in that fishery (70%) than of the interview pool over all (81%). There are several possible explanations for this pattern. First, most fishermen answered the questions within the context of their own fishery and frequently couched their responses in terms of fisheries they know best from personal experience by explicitly stating their hesitancy to talk about fisheries in which they do not participate. Secondly, fishermen may tend to be more optimistic about the fisheries in which they participate if they have "migrated" from a fishery exhibiting a worse trend or if they are relatively young or recent participants. This may be an indication of the "shifting baseline" phenomenon because more recent entrants to a fishery may assess the stock status relative to their experience of the fishery rather than the underlying trend [34]. Thirdly, in the case of rockfish, fishermen have been able to move into newer and more lucrative markets—notably for live rockfish—based on formerly unexploited species. Since fishing

Table 1
Summary of biological information about stocks

(A) Stock/ fishery	(B) Proportion of interview pool and their assessment of respective stocks	(C) Proportion of participants in a fishery, and their assessment of it	(D) Fishery status as assessed by CDFG [33]
Salmon	78%—Very good health	74%—Healthy	Healthy[a]
Crab	37%—Healthy and sustainable	44%—sustainable	Healthy
Rockfish	33%—Certain species healthy; 81%—Shelf and/or nearshore species in serious decline	54%—healthy; 70%—in decline	Many in poor health (to the extent known), some overfished
Albacore tuna	30%—Improving	67%—good health	Relatively healthy
Urchin		80%—healthy	In decline
Halibut		67%—healthy	In decline
Sanddab		100%—sustainable	In good condition

[a] The fishery for salmon is prosecuted on a mixture of stocks, both wild and hatchery produced, making it difficult to assess. It is generally considered healthy, despite the threatened or endangered status of several wild spawning populations.

income is a function of price and quantity, the fishermen's perception of the relative health of a fishery may partly be a function of the income they receive.

With the exception of urchins and halibut, both of which the CDFG assessed as in decline in 2001, the fishermen's assessment matches the state managers' assessment of stocks. Our project was not designed to be a comprehensive comparison of fishermen's knowledge to "official" science, and there is nothing in the interviews that could be analyzed to explain the origins of the (dis)similarities of the assessments. This would, however, be an interesting avenue for further inquiry. The "very good" health of the California salmon fishery is attributed to the changing ocean cycles, as well as the improvements in watershed health, and the successful hatchery system. Interestingly, none of the fishermen mentioned the 90% reduction in fleet size since the 1980s as a factor contributing to this trend [33].

The status of rockfish, in our study as in the fishery over all, is confounded by the fact that it is a multispecies fishery, many stocks of which are not assessed. Some of the more than 80 federally managed groundfish species, approximately 54 of which occur off California, are overfished while others still continue to thrive. Correspondingly, Table 1 reveals some interesting nuances: a third of the fishermen (33%) identified at least some stocks as healthy, but most of them (81%) said that shelf rockfish, nearshore rockfish, or some combination thereof, are seriously threatened and have declined significantly in the last several decades. There was almost uniform agreement that trawling is extremely detrimental to rockfish populations, even among trawlers themselves. None of the interviewed trawlers target rockfish, and they all agreed that past trawling techniques have contributed to rockfish population declines. Specifically, most interviewed fishermen cite the extensive use of "roller gear" (trawls fitted with rollers that make it possible to fish higher relief substrates—where many rockfish species live—without tearing or hanging up) as an important factor contributing to rockfish declines.[4] Furthermore, some fishermen criticized managers for not only allowing roller gear, but also subsidizing its use in the past.

4.3.2. Critical habitat

Participants agreed that bays and estuaries, as well as kelp forests, are very important for spawning and need to be protected. Fishermen found it difficult to pinpoint a few specific spawning areas due to the variation among species, as well as seasonal considerations. For example, rockfish depend on rocky areas, but the depth varies with each species. Sanddabs spawn on soft bottom during the summertime, and urchin spawn virtually everywhere during the spring. Fishermen also noted variance in spawning times and areas along different parts of the coast.

Fishermen identified areas of high biological diversity that are closely linked to known spawning areas. Fishermen indicated that rocky kelp areas have high biological diversity, as well as reefs and other structures. As shown in Fig. 4, the portion of coast off Mendocino County was often noted for its high biological diversity, especially the Sea Ranch area, and the region from Fisk Mill Cove to Fort Ross Cove. Other areas noted for high biodiversity include: Pt. Arena wash rock, Bodega Head, Point Reyes, Duxbury Reef, Cordell Bank, the area from Pescadero to Pt. Ano Nuevo, and estuaries.

Interviewees were also asked to identify areas that had been historically productive, but may now be "fished out." Such areas—combining good habitat but economically unattractive to fishermen—could potentially make good candidates for MPAs because they represent low opportunity costs of implementation. Sixty percent of fishermen said there were no fished out areas along this portion of coast. Several interviewees, however, did indicate a few areas that are not as productive in terms of fish yields as they once were, and that could potentially benefit from protection. These are summarized together with the biodiversity areas in Fig. 4.

4.4. Management

Fishermen are highly influenced by management decisions, and management is a popular topic of conversation. Most fishermen think that fishery management is currently flawed, and that California fisheries would be better off if agencies such as the CDFG had less influence over the fisheries. Many fishermen also blame the current plight of California marine fisheries on the mismanagement of trawlers during the 1970s and 1980s (see Section 4.3.1).

Eighty-five percent of interviewees believe that stock assessments are inaccurate, ranging from "flawed" to "completely ludicrous." Fishermen cite numerous reasons for their poor opinion of stock assessments; for example, exclusion of fishermen and their expertise in the process, infrequency of surveys, and poor choice of sampling locations. Many fishermen feel that stock assessments will never improve enough to be used as an accurate fisheries management tool, but suggestions for improvement include: more comprehensive methods such as annual assessments rather than tri-annual and better sampling locations; using more fishermen's knowledge by having trained biologist observers onboard fishing vessels and using better landing data, such as catch-per-unit-effort data. Many of the fishermen interviewed felt that the rockfish populations, if left unfished for a small period of time, would rebound

[4] Note that our study did not include fishermen who use roller gear.

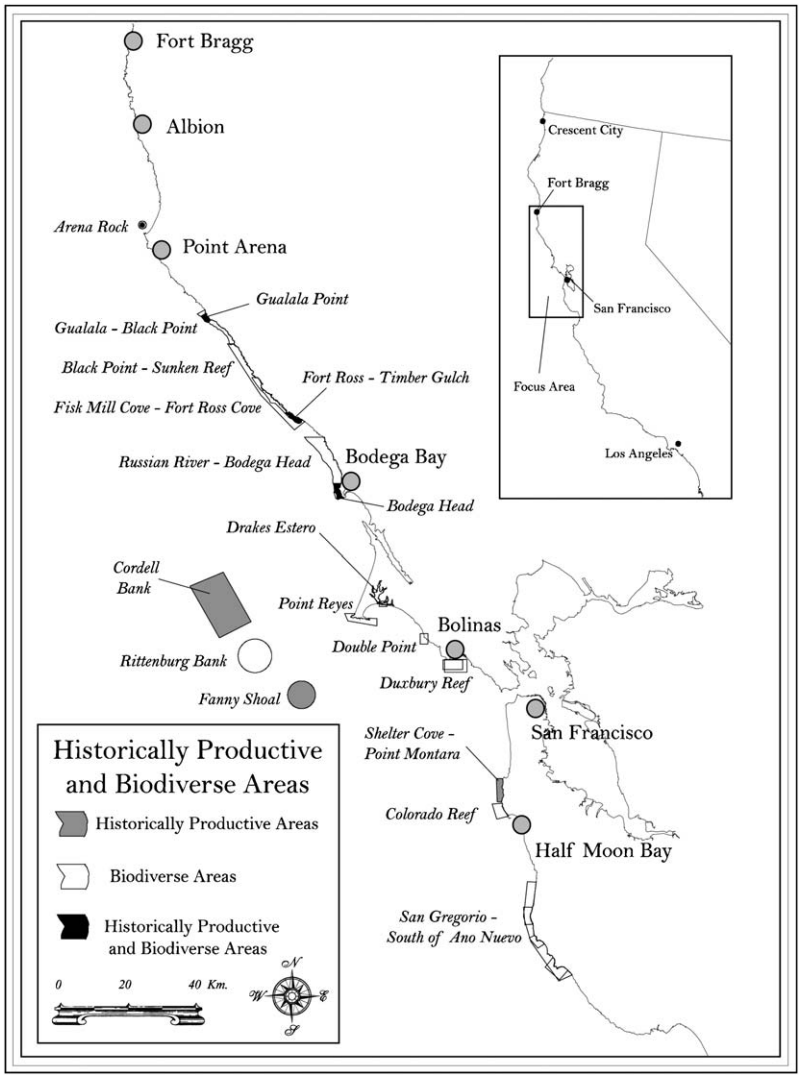

Fig. 4. Historically productive and biodiverse areas.

rapidly. This sentiment is in stark contrast to the federal stock assessments, which for the overfished stocks estimate required rebuilding periods on the order of decades [35]. Controversies over the merit and accuracy of stock assessments are at the center of disagreements between fishermen and managers [36,37], and our findings certainly reflect the culture of distrust of the science that drives fishery management.

Eight-two percent of interviewees believe that marine pollution in some form is a problem. Pollution types cited include sewage outfall, floating trash, sedimentation associated with development and logging, bilge dumping, agricultural runoff, and heavy metal buildup. There was consensus among the fishermen interviewed that pollution is primarily focused around urban areas, such as the San Francisco Bay, and other more densely populated coastal areas. Fishermen most often noted effects from sewage treatment plants, such as an anoxic zone near the Pacifica plant, as well as evidence of effects on kelp and seafood health from carcinogenic chemicals in the sewage outfall.

The ultimate goal of this project was to discuss the MLPA with the fishermen, include their knowledge in the management process, and identify areas of critical economic importance as well as those that the fishermen think would be acceptable closure candidates. The project was premised on the notion that implementation of the MLPA will involve some form of fully protected marine reserves, and participants were asked to frame their responses based on this premise.

Perhaps not surprisingly, almost all the fishermen interviewed were staunchly opposed to marine reserves. They argued that they are already over-regulated, and many cited the recent shelf closures in federal waters as an example of how greatly reduced their fishing opportunities have already become. Fishermen said that they use multiple parts of the nearshore environment over a year or over their career, and there are few, if any,

areas that they could give up for protection without some negative impact on their income. Many fishermen asserted that they need all areas of the nearshore environment because they fish multiple species that live in different areas, and fish are always moving. In other words, they need multiple areas for "insurance." Furthermore, despite some scientific evidence that marine reserves enhance fishery yields through spillover [38,39], fishermen are still waiting for conclusive evidence that marine reserves will directly benefit fisheries before they approve of closing portions of the ocean to fishing.

There is also a general distrust of scientists and environmentalists among the interviewees. Fishermen feel that their ideas and views have not been considered in the past, and that they have little input regarding the management of their livelihood. Additionally, fishermen hesitated to discuss the siting of marine reserves, because they feel that scientists and environmentalists will misuse or misinterpret their information. As stated above, 85% of interviewed fishermen feel that stock assessments are flawed, that their information has not been well used for management, and more importantly, that they could contribute more accurate and detailed information to improve the situation, but that the agencies have not been very receptive. As a result of past interactions, there is a lot of frustration and distrust. This historical context helps illuminate the fishermen's skepticism of management or conservation tools such as marine reserves.

Despite their opposition, many fishermen did acknowledge that new marine reserves are likely to be implemented under the MLPA. With this understanding, most interviewees were willing to discuss siting considerations for marine reserves. During the interview process, we asked the fishermen to identify two different categories of areas on nautical charts: critical economic areas, i.e., those that they rely most on for their livelihood and would thus be least likely to give up, and acceptable closure candidates—areas that the fishermen would be willing to consider for protection using some form of marine reserves. These may be areas that the fishermen never or rarely fishes, or whose biological values outweigh their economic significance.

Given the sensitive nature of this information, the fishermen requested that these maps not be disseminated for fear that they be misconstrued as a siting proposal or consensus statement. We therefore discuss the results solely in narrative form. There are some areas that multiple fishermen agree upon. For example, roughly one third of the fishermen interviewed identified an area known as Sea Ranch off the Mendocino Coast as an acceptable closure candidate. There was, however, also disagreement. In comparing the fishermen's responses on both critical economic areas and acceptable closure candidates, we found a 17% overlap between these opposing categories. Much of this overlap is due to the variation in targeted species. Since each species requires a unique set of oceanographic and habitat conditions, one fisherman's "bread and butter" area is another's closure candidate. Hence, a rockfish fisherman may suggest sandy areas for closure, which are preferred by halibut fishermen, who in turn might suggest rocky habitat for closure.

We also compared the fishermen-identified areas to the initial set of CDFG draft maps. Significantly, there is both a 42% overlap between critical economic areas and the MPAs proposed in the draft maps, and a 30% overlap between acceptable closure candidates and the initial draft maps. The first result explains the considerable controversy and public outcry surrounding the release of the initial draft maps in 2001. By using logbook data that record fishermen's catches by area, and using targeted species as habitat proxies [22], the department had inadvertently chosen some of the economically most important areas off the coast for closure. Effectively, based on the implied habitat associations, the higher the catch reported for a particular block for species that, for example, are associated with rocky habitat, the more likely that area would be proposed for closure in the draft maps. Catch per unit area is high in blocks with high catch, and is also an indicator of the economic importance of an area. On the other hand, the second result suggests that there is some potential for fishermen and managers to engage in a constructive dialogue in MPA planning processes. Based on the results from our study, it would appear that there is at least some shared understanding about areas that are worthwhile to protect.

4.5. *Results for selected areas of the California coast*

In this section, we summarize the results for the study region, from North to South:

Arena Rock, off Pt. Arena in Mendocino County, was characterized as an area of high biological diversity. Fishermen identified it both as a critical economic area and an acceptable closure candidate. This is significant because most of the fishermen interviewed stay fairly close to their home ports and did not comment on areas outside their own fishing zones. Hence, the dual assessment is likely due to the diversity of fishermen in the study and the fact that they each utilize different habitats.

The area known as Sea Ranch, from Gualala Point to Black Point, was identified as an acceptable closure candidate by one third of the participants. It was also identified as having high biological diversity and is thought to have been a historically productive area.

The fishermen we interviewed did not focus their fishing effort on the area from Black Point to Bodega Head. They did emphasize the numerous important

anchorages in this stretch, which is also considered to be biologically diverse.

Bodega Head south to Point Reyes is another area that contains overlap between critical economic areas and acceptable closure candidates. The Pt. Reyes bluff is already closed to 85 feet (about 14 fathoms) [40], but many fishermen recommended the closure be extended to 30 fathoms. There is considerable disagreement regarding the area from Pt Reyes bluff to the Golden Gate. The estuaries and Duxbury Reef were noted as having high historical productivity and high biological diversity, but the responses indicate that the area is both acceptable as a closure candidate and is economically critical.

Thirty percent of interviewed fishermen agree that the Farallon Islands are critical economic areas. Fishermen most often noted the importance of the South Island as both a critical economic area and an important anchorage. Conversely, 15% of interviewed fishermen identified a small portion of the Farallon Islands as an acceptable closure candidate, and the Farallons were also noted for historical productivity.

The area south of the San Francisco Bay did not engender many comments regarding their economic importance or closure potential. Shelter Cove is a critical anchorage site, and the area just south was identified as being historically productive.

Recreational fishermen use much of the nearshore waters, from Half Moon Bay down to Pt. Ano Nuevo; this area is vital to their business. Other fishermen we interviewed out of Half Moon Bay fish outside of state waters.

The area north of Pescadero to Pt. Ano Nuevo is thought by fishermen to be extremely biodiverse, and is an especially important fishing area. Fifty percent of the recreational fishermen (11% of our total sample) we interviewed suggested that an area just south of Pt. Año Nuevo might be an acceptable closure candidate.

5. Conclusions

This project focused on methods for collecting local knowledge and standardizing it in ways that lend themselves to integration into policy processes. We found that a participatory study design and in situ interviews yielded a nearly 100% response rate and provided a rich source of information on biological and socioeconomic considerations pertinent to MPA planning in California. The project deliberately was not intended to compare this local information with all the available data sources. Rather, it is intended to suggest a procedure for eliciting and interpreting local knowledge as a practical source of information for marine planning processes. Triangulation with other data and validation would form part of a comprehensive analysis for planning purposes.

We anticipate that both the information collected in the course of this study, as well as the methods and protocol used for obtaining it, will be a useful contribution to the MLPA process. Products include (1) a protocol for rapid socioeconomic assessment, (2) a database of fishermen's knowledge and information, and (3) a geographic information system (GIS) of fishermen's ecological information and socioeconomic concerns for further use in the MLPA process. The project could be improved with further iterations, as well as with a larger pool of participants and extensions to other user groups. The maps produced to date do not reflect a consensus among the fishermen, nor was that the goal of the project. We originally thought, however, that these maps could be a tool for the fishermen to bring their knowledge into the MLPA process. This goal remains as the project moves forward. We are currently planning follow-up and additional interviews to expand the sample size, and create more detailed and meaningful information.

In general, fishermen are opposed to marine reserves and they perceive that every portion of the coast is used by one type of fishermen or another, making it economically critical to somebody. Participation in the study certainly did not influence the interviewees' opinions regarding the necessity of marine reserves, and most interviewees still staunchly oppose them. They did, however, comment on the ease of the interview process and its potential for people outside the fishing community to benefit from the knowledge they have gained over their fishing careers. Many fishermen expressed interest in using the aggregate information in the MLPA process. The project has other benefits—namely, it is inexpensive, effective, and replicable. Additionally, the information is compatible with other data gathering activities, especially as GIS is becoming more prevalent in marine resource analysis.

Given the history of distrust and contention in marine management, it is important to consider socioeconomic concerns early on in any policy process. The high degree of overlap between the CDFG's draft MPAs and the fishermen's critical economic areas exemplifies the danger of ignoring socioeconomic concerns. That is not to say that socioeconomics should trump conservation concerns. Rather, accommodating socioeconomic concerns while adhering to ecological standards or criteria forms the crux of the policy process. As this project has demonstrated, the process of incorporating local knowledge into decision-making may have an important dual function: in addition to yielding pertinent information, looking at the MPA siting question through the lens of the fishermen's socioeconomic concerns may help identify less contentious siting alternatives. As the considerable overlap between

closure candidates and the CDFG draft maps suggests, there may exist areas that are or have been biologically productive and are relatively "cheaper" to give up. This presents a challenge, but the participatory approach to socioeconomic analysis described here is one tool that may warrant further exploration.

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References

[1] National Research Council (NRC), Marine protected areas: tools for sustaining ocean ecosystems. Washington, DC: National Academy Press; 2001.
[2] Carter DW. Protected areas in marine resource management: another look at the economics and research issues. Ocean & Coastal Management 2003;46:439–56.
[3] St. Martin K. Making Space for Community Resource Management in Fisheries. Annals of the Association of American Geographers 2001;91(1):122–42.
[4] Gilden J, Conway F. An investment in trust: communication in the commercial fishing and fisheries management communities. Corvallis: Oregon Sea Grant; 2002.
[5] Gilden J, Conway F. Fishing community attitudes toward socioeconomic research and data collection by fisheries managers—supplement to an investment in trust. Corvallis: Oregon Sea Grant Extension; 2002.
[6] Olsson P, Folke C. Local ecological knowledge and institutional dynamics for ecosystem management: a study of Lake Racken Watershed, Sweden. Ecosystems 2001;4:85–104.
[7] King M, Faasili U. Community-based management of subsistence fisheries in Samoa. Fisheries Management and Ecology 1999;6:133–44.
[8] Wilson JA, Kleban P. Practical implications of chaos in fisheries. Maritime Anthropological Studies 1992;5:67–75.
[9] McCay BM, Acheson JM, editors. The question of the commons: the culture and ecology of communal resources. Tucson: University of Arizona Press; 1987.
[10] Berkes F, Colding J, Folke C. Rediscovery of traditional ecological knowledge as adaptive management. Ecological Applications 2000;10:1251–62.
[11] Feeney D, Berkes F, McCay BJ, Acheson JM. The tragedy of the commons—22 years later. Human Ecology 1990;18:1–19.
[12] Ostrom E. Governing the commons: the evolution of institutions for collective action. Cambridge: Cambridge University Press; 1990.
[13] Russ GR, Alcala AC. Management histories of Sumilon and Apo Marine Reserves, Philippines, and their influence on national marine resource policy. Coral Reefs 1999;18:307–19.
[14] Soma K. How to involve stakeholders in fisheries management: a country case study in Trinidad and Tobago. Marine Policy 2003; 27:47–58.
[15] http://sanctuaries.noaa.gov/
[16] Ugoretz J. Final environmental document: marine protected areas in the National Oceanic and Atmospheric Administration's Channel Islands National Marine Sanctuary. Sacramento, California Department of Fish and Game, 2002. 〈http://www.dfg.ca.gov/mrd/ci_ceqa/〉
[17] Department of Commerce. Announcement of intent to initiate the process to consider marine reserves in the Channel Islands National Marine Sanctuary; intent to prepare a Draft environmental impact statement. Federal Register 2003;68: 27989–90.
[18] Scholz AJ, Fujita R. Supplementary report: social and economic implications of a Channel Islands Marine Reserve Network. Environmental Defense, August 2001.
[19] Chris Miller, personal communication to Astrid Scholz, March 2002.
[20] California Department of Fish and Game. 2001. Marine Life Protection Act Background. January 2003. 〈http:// www.dfg.ca.gov/mrd/mlpa/index.html〉
[21] California Department of Fish and Game. 2001. Marine Life Protection Act Working Group Process. January 2003. 〈http://www.dfg.ca.gov/mrd/mlpa/working_group.html〉
[22] California Bill Number AB 993, as introduced by Assembly Member Shelley, February 25, 1999.
[23] Huck SW. Reading statistics and research 3rd ed. New York: Addison Wesley, Longman; 2000. p. 126.
[24] Pacific States Marine Fisheries Commission. May 16, 2002. West Coast Catcher Boat Study. January 2003. 〈http://www.psmfc.org/efin/docs/catcherboat.pdf〉
[25] Cushing DH, Dickson RR. The biological responses in the sea to climatic changes. Advances in Marine Biology 1976;14: 1–112.
[26] Steele JH. Regime shifts in marine ecosystems. Ecological Applications 1998;8:33–6.
[27] Halpern BS, Warner RR. Marine reserves have rapid and lasting effects. Ecology Letters 2002;5:361–6. Found online 〈http://www.piscoweb.org/who/grads/bhalpern.html.〉
[28] Halpern BS. The impact of marine reserves: do reserves work and does reserve size matter? Ecological Applications (Supplement: The Science of Marine Reserves) 13(1):S117–37.
[29] Castilla JC, Bustamante RH. Human exclusion from rocky intertidal of Las Cruces, central Chile: effects on *Durvillaea Antarctica* (Phaeophyta, Durvilleales). Marine Ecology Progress Series 1989;50:203–14.
[30] Russ G, Alcala A. Marine reserves in fisheries management. Aquatic Conservation: Marine and Freshwater Ecosystems 1996;4:233–54.
[31] Wantiez L, Thollot P, Kulbicki M. Effects of marine reserves on coral reef fish communities from five islands in New Caledonia. Coral Reefs 1997;16:215–24.
[32] Russ G, Alcala A. Natural fishing experiments in marine reserves 1983–93: community and trophic responses. Coral Reefs 1998;17:383–97.
[33] Leet WS, Dewees CM, Klingbeil R, Larson E, editors. California's living marine resources: a status report. Berkeley: University of California Agriculture and Natural Resources, 2001.
[34] Pauly D. Anecdotes and the shifting baseline syndrome in fisheries. Trends in Ecology and Evolution 1995;10(10):430.
[35] PFMC, Status of the Pacific Coast groundfish fishery through 2001 and acceptable biological catches for 2002: stock assessment and fishery evaluation. Portland, OR: Pacific Fishery Management Council; 2002.

[36] Smith TD. Scaling fisheries: the science of measuring the effects of fishing, 1855–1955. Cambridge: Cambridge University Press; 1994.
[37] Finlayson AC. Fishing for Truth: A sociological analysis of northern cod stock assessments from 1977 to 1990. St. John's: Memorial University of Newfoundland; 1994.
[38] Johnson DR, Funicelli NA, Bohnsack JA. Effectiveness of an existing estuarine, no-take fish sanctuary within the Kennedy Space Center, Florida. North American Journal of Fisheries Management 1999;19:436–53.
[39] Roberts CM, Bohnsack JA, Gell F, Hawkins JP, Goodridge R. Effects of marine reserves on adjacent fisheries. Science 2001;294: 1920–3.
[40] California Department of Fish and Game. 2002. Descriptions and evaluations of existing California marine protected areas. January 2003. 〈http://www.dfg.ca/gov/mrd/mlpa/analysis_northcentral.html#pointreyes〉