SOCIAL CONSIDERATIONS FOR MARINE RESOURCE MANAGEMENT: EVIDENCE FROM BIG CREEK ECOLOGICAL RESERVE

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ABSTRACT

Growing interest in no-take marine protected areas (MPAs) as a complement to traditional fishery management has led to increased attention to biophysical considerations for MPA design, implementation, management, and evaluation. Considerably less attention has been directed, however, toward social, cultural, and economic considerations for MPAs. Information on and understanding of the relationship between MPAs and local fisheries in social, cultural, and economic, as well as biophysical, terms is especially important. At the same time, there is growing interest in collaboration between fishers and scientists to provide more complete and accurate information on fisheries and marine ecosystems. Such collaboration is one element of cooperative (or co-) management of local fisheries, which is gaining recognition as potentially more effective, appropriate, and equitable than traditional, top-down resource management. These two themes—social considerations for MPAs and co-management of local fisheries—are central to a study being conducted at central California's Big Creek Ecological Reserve. This paper provides an overview of the local skiff fishery and the cooperative arrangement at Big Creek; discusses that arrangement as a form of co-management, and as it has played an integral role in the history of the marine reserve; and concludes with observations and emerging questions about the social aspects of establishing and maintaining no-take marine reserves in the context of local fisheries.

INTRODUCTION

Concerns about the shortcomings of traditional fishery management tools and approaches have prompted interest in two alternatives: no-take marine protected areas (MPAs; i.e., marine reserves) and cooperative (or co-) management of local fisheries. The interest in MPAs has led to increased attention to ecological considerations associated with the components of the MPA process, namely their design, implementation, management, and evaluation (see, e.g., Carr and Reed 1993). Much less attention has been directed, however, to social, cultural, and economic considerations for MPAs (Fiske 1992; Wolfenden et al. 1994; Suman 1998). Both sets of considerations are especially germane to the relationship between MPAs and local fisheries because of the diverse ways they affect one another, in sociocultural and economic as well as ecological terms. The interest in co-management has focused largely on its potential for fostering information gains, especially through fishing industry collaboration in the collection of scientific data. This is only one element of full-fledged co-management, however, in which government agencies and resource users share responsibility and authority for resource management (Jentoft 1989; Pinkerton 1989).

At California's Big Creek Ecological Reserve, a small group of local skiff fishers and the manager of the University of California, Santa Cruz (UCSC) Landels-Hill Big Creek (LHBC) Reserve established a cooperative arrangement with two key features: a no-take zone and a fishery-dependent data collection system, *before* the reserve's legal designation in 1994. The Big Creek case is an example of co-management in an MPA context that provides an opportunity for exploring the social, cultural, and economic aspects of these two alternatives or complements to traditional fishery management. This paper explores these themes, based on research the author has been conducting at Big Creek since 1996.[1]

The first two sections briefly discuss fisheries co-management and social considerations associated with MPAs. The third section focuses on the local fishery and the development of co-management at Big Creek. The final section presents emerging questions about the sociocultural and economic aspects of the Big Creek reserve and its co-management that are being pursued as the research continues. I conclude that these questions and considerations are critical not only to the Big Creek situation, but to MPAs and fishery management more generally.

FISHERIES CO-MANAGEMENT AND MPAS

Much of fishery management is based on the assumption that fisheries, as common pool resources

[1]This research has included two studies: a demonstration project, sponsored by UCSC's Monterey Bay Regional Studies (MBRS) Program, conducted in 1996 to explore the cooperative arrangement; and a subsequent three-year (June 1997–May 2000) in-depth study, sponsored by the California Marine Ecological Reserves Research Program (MERRP, Grant no. R/BC-2). The goals of the latter study are to document the fishery adjacent to the reserve, analyze the cooperative arrangement between local fishers and the reserve manager, and evaluate their cooperative data collection system.

(CPRs), will inevitably come to ruin unless they are designated as private property or managed closely by the state (Gordon 1954; Olson 1965; Hardin 1968). However, evidence of cooperation among fishers to create and maintain local institutions—shared rules, norms, and strategies—to coordinate their use of CPRs challenges this assumption (Ostrom 1990). Such local CPR institutions may arise and operate independently, or they may be negotiated and coordinated (officially or unofficially) with government resource management, as cooperative (or co-) management. (See, e.g., Jentoft 1989; Pinkerton 1989; Jentoft and McCay 1995; and Sen and Nielsen 1996 for reviews of co-management case studies, including successes and failures.) Forms of co-management range from those in which government consults fishers but retains decision-making authority, to those in which fishers have initiated and participate in many aspects of management, including policy formulation, implementation, enforcement, and evaluation (Kearney 1989).

Fishery co-management is of growing interest to resource managers because it is often more effective in achieving management goals, more acceptable to fishers, and less costly than traditional (i.e., government-centered) management (Jentoft 1989; Pinkerton 1989). In making an explicit link between resource managers and resource users, co-management may overcome many of the limitations and pitfalls of centralized, top-down resource management, resulting in more effective, appropriate, and equitable resource management (McGoodwin 1990).

Among the potential advantages and benefits of co-management are its ability to foster meaningful communication in the decision-making process, improve the knowledge and databases of fisheries management, help reduce the political and equity problems that often arise in resource management, and increase the extent to which users see the management system as legitimate, and hence comply with the rules and regulations (McCay and Jentoft 1996; see also Pomeroy et al. 1995). As a result, government is likely to face reduced challenges to its authority and reduced management costs, while the likelihood of achieving management goals increases (Pinkerton 1989; McGoodwin 1990; McCay and Jentoft 1996).

Of particular interest is co-management's potential for affording information gains at low cost to government. These information gains accrue not only from fishing industry collaboration with researchers in the collection of scientific data, but also from the contribution of fishers' knowledge. This local or traditional ecological knowledge includes fishers' accumulated knowledge of local natural history based on their day-to-day experiences while fishing (Johannes 1989; Neis 1995). It can provide inexpensive and useful information that complements scientific data (Rettig et al. 1989). The integration of scientific and local ecological knowledge makes co-management stronger than either community-based or government management alone (Pomeroy and Berkes 1997). Information provided by user groups about the resource and its use may contribute to a more rational management process, because government agencies are unlikely to foresee all the consequences of regulatory measures (Jentoft and McCay 1995).

Yet the feasibility and success of co-management are contingent upon certain environmental, social, and political conditions.[2] The species and ecosystems involved, the number and heterogeneity of resource users, participants' attitudes toward management, and their ideas about the roles of government managers, scientists, and resource users are among the factors that matter. Co-management redefines the roles of managers, scientists, and resource users. It requires that government agencies and bureaucrats share authority with people they are accustomed to regulating, and that fishers share responsibility for fishery management, rather than continuing to depend on government to make and enforce the rules. Managers, scientists, and resource users alike must engage in "social learning," whereby they come to recognize, respect, and value each other's contributions to fishery management, and trust that each will hold up his end of the bargain (Kearney 1989). Co-management is likely to fail wherever such social learning does not occur.

Hanna (1996) notes that co-management must include effective representation of all stakeholders, and all stakeholders (resource users, managers, scientists, and others) must engage in the process in good faith. Otherwise, it is vulnerable to sabotage by excluded interests or corruption of the process by one or more interests (see also Leaman 1998). Groups involved in co-management may prefer to pressure government authorities rather than assuming responsibility for management functions (Jentoft 1989; Leaman 1998). It has been argued that when fishers participate in decisions that affect their welfare, they are more likely to buy in, and to strengthen the social institutions that encourage others to also abide by the rules (see, e.g., Pinkerton 1989; Fiske 1992). Yet fishers often are reluctant to serve as "informers" or otherwise enforce rules against their peers (Jentoft 1989).

SOCIAL AND ECONOMIC CONSIDERATIONS

Social and economic information is critical to effective fishery management in general (Orbach 1978; Clay and McGoodwin 1994; Buck 1995). Management de-

[2]Ostrom (1990) has specified eight elements of design for local, self-governing CPR institutions: clearly defined boundaries, good-fitting rules, collective choice arrangements, monitoring and enforcement, graduated sanctions, conflict resolution mechanisms, minimal recognition of rights to organize, and nested enterprises. Pinkerton (1989) offers hypotheses on the preconditions favorable to co-management, conditions supportive of it, and the types of groups that are preadapted for effective co-management.

cisions that are informed by understanding of people's practices, values, and beliefs are more acceptable and successful, and less disruptive (Hanna and Smith 1994). It is essential to consider social, cultural, economic, and political factors, as well as biophysical factors, in the establishment and management of MPAs (Fiske 1992; Pomeroy et al. 1998; Suman 1998; Thomson 1998). These factors include peoples' values, attitudes, beliefs, and behaviors, both individually and collectively; the ways they value and use marine resources; and the social, economic, and political organization of resource use (Fiske 1992).

The permeability of MPA boundaries means that conditions (and changes) within a reserve will influence those outside its boundaries, and that activities and conditions outside an MPA will influence conditions (and outcomes) within it. It is therefore especially important to consider the social and economic impacts of, and peoples' perceptions, attitudes, expectations, and behavior regarding, MPAs in the context of local fisheries. Relevant questions to be asked include:

1. What is the nature and extent of fishing activity in and near the proposed MPA site?
2. Do fishers support or oppose the proposed MPA? Why, or why not?
3. What social and economic effects might be expected from establishing this MPA? How are these effects distributed? Are there alternative sites or designs that might lessen the negative effects or increase the positive effects on resource users?
4. How might the nature and extent of fishing activity change with MPA designation? Is there a concentration of fishing activity at the MPA perimeter? Is there crowding on the fishing grounds that remain open, and is this a source of conflict?
5. How would these changes affect resource conditions and outcomes—in ecological, social, and economic terms—within and outside the MPA?

Information on and understanding of these aspects of MPAs can be used to minimize their negative effects and maximize their positive effects. Failure to consider them can lead to the failure of MPAs to achieve their ecological, social, and economic goals (Fiske 1992; Pomeroy et al. 1998).

THE BIG CREEK CASE

The Setting

Big Creek is located on California's Big Sur coast about 85 km south of Monterey and 163 km north of Morro Bay (fig. 1). It is the site of both the 3,848 acre terrestrial Landels-Hill Big Creek (LHBC) Reserve man-

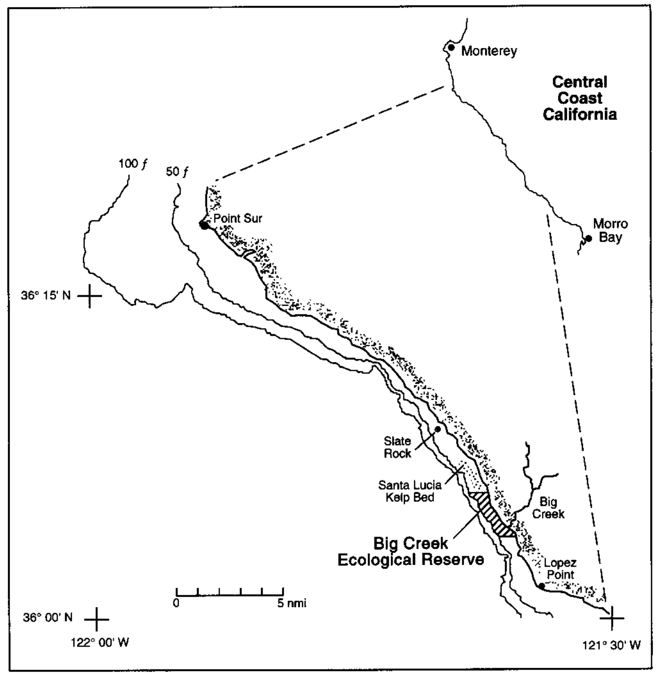

Figure 1. Big Creek MRPA Ecological Reserve and sites associated with the fishery and the Hook-and-Line Kelp Bed Survey.

aged by UCSC, and the 1,680 acre (6.86 km^2) Big Creek Ecological Reserve, co-managed by the California Department of Fish and Game (CDFG) and the LHBC reserve manager, a UCSC employee.

The nearshore reefs and kelp beds at Big Creek and along the larger Big Sur coast provide important habitat for several commercially and recreationally valuable finfish species: *Sebastes* spp., e.g., vermilion (*S. miniatus*), kelp (*S. atrovirens*), black-and-yellow (*S. chrysomelas*), blue (*S. mystinus*), gopher (*S. carnatus*), copper (*S. caurinus*), olive (*S. serranoides*), and black (*S. melanops*) rockfish; cabezon (*Scorpaenithys marmoratus*); and lingcod (*Ophiodon elongatus*) (Paddack 1996). Although rough conditions and the limited number of safe launch sites along the Big Sur coast have tended to discourage fishing, Big Sur has been the site of a small, local, commercial hook-and-line fishery for these species since the late 1970s (Georgette 1981). Fishers launch 10–12-foot aluminum skiffs from the beach into the surf, and motor to shallow and midwater sites to fish. After a day of fishing, they land their catch and transport it to regional markets (e.g., Monterey, Morro Bay, Oakland).

A limited amount of commercial and recreational fishing activity originating in the Monterey and Morro Bay areas has also occurred in the area, despite Big Sur's remoteness from their established ports and fishery infrastructure (Mason 1995; see also CDFG 1993). Over the past two decades, commercial fishers have used a variety of net, trap, and line gears to target rockfish and other

TABLE 1
Gear Used by Commercial Fishers, and Target Species for the Big Sur Area

Gear	Target species
Round haul nets	California market squid
Pots	Dungeness crab, spot prawn
Trawls	Rockfish, lingcod, cabezon, spot prawn, English and petrale sole
Hook and line[a]	Rockfish, lingcod, cabezon
Gill and trammel nets[b]	Rockfish, lingcod, cabezon

[a]Since 1997, longlines used within one mile of the California coast from Point Conception to Point Mugu have been limited to a maximum of 150 hooks per boat, and 15 hooks per line.
[b]Since 1 January 1994, gill and trammel nets have been banned from California's nearshore waters.

species such as sardine, squid, dungeness crab, spot prawn, and various flatfishes (table 1). Table 2 shows the number of vessels, volume, and ex-vessel value of all 1981–98 landings reported to have been caught in this region, and in CDFG block 547, within which the Big Creek reserve lies. Commercial landings from the Big Sur region (CDFG blocks 526–613) have fluctuated widely, ranging from 43.7 million pounds with an ex-vessel value of $11.1 million in 1981 to 1.6 million pounds with an ex-vessel value of $376,000 in 1988 (based on Pacific Fisheries Information Network—PacFIN—data). Commercial landings reported from CDFG block 547 reached a brief (and anomalous) high of 124,000 pounds, with an ex-vessel value of $58,200 in 1988, but have generally been much lower, especially since the phasing out of nearshore gill nets in the early 1990s (PacFIN data).

The Final Environmental Impact Report for the Marine Resources Protection Act (MRPA) Ecological Reserves noted that "only a small amount of commercial fishing takes place within [block 547] because of its distance from major ports or landing sites. . . . Some trawl activity has been reported in the larger vicinity of Big Creek, but the reserve's rocky substrate has precluded such activity" (CDFG 1993). The report also notes little sport fishing in the vicinity of the reserve, largely because of the site's remoteness and rough conditions for fishing. Because of the already existing LHBC Reserve, there is no direct public land access. For 1988 through 1992, CDFG's Central California Sport Fish Survey and Analysis Unit reported no sport fishing activity within a 10-mile radius of Big Creek (CDFG 1993).

Several economic and regulatory changes are reflected in the commercial landings data, including the emergence of the live-fish market in 1993, the phasing out of gill and trammel nets starting in 1991 until they were banned in nearshore waters in 1994, and the establishment of the Big Creek Ecological Reserve the same year.

For the live-fish market, fishers use pots (or traps), sticks, and other hook-and-line gears to catch species such as grass, gopher, and black-and-yellow rockfish; cabezon; and lingcod in waters up to 15 fathoms deep. (Sticks are 4-foot PVC pipes with four to six hooks attached to a line tied along the length of the pipe. The stick is attached to a float by a length of rope, and is deployed in nearshore kelp beds and rocky reef areas.) Live rockfish bring a price 5 to 10 times that for dead fish ($.50 to $10 per pound; McKee-Lewis 1997), with relatively small in-

TABLE 2
Number of Vessels, Volume, and Value of Commercial Fishery Landings for CDFG Blocks 526–613 (Big Sur) and 547 (Which Includes Big Creek), 1981–98

	CDFG blocks 526–613			CDFG block 547		
Year	No. of vessels	Volume (1,000 lbs.)	Value ($1,000)	No. of vessels	Volume (1,000 lbs.)	Value ($1,000)
1981	1,150	43,673.9	11,124.3	15	41.6	18.5
1982	997	35,294.2	7,771.7	18	54.0	20.9
1983	820	17,633.7	5,627.6	14	25.1	12.2
1984	686	16,478.4	5,563.0	3	16.0	5.8
1985	711	17,925.5	7,547.9	7	33.5	9.0
1986	750	22,930.1	7,455.9	1	0.4	0.2
1987	551	14,535.1	3,791.1	3	59.6	26.2
1988	58	1,618.1	376.4	13	124.0	58.2
1989	67	3,291.7	558.0	5	16.7	7.9
1990	45	5,149.0	509.7	1	0.0	0.0
1991	132	2,561.1	710.1	2	0.1	0.2
1992	134	5,802.4	909.9	2	3.4	5.1
1993	162	5,830.5	1,247.3	11	3.2	3.4
1994	432	17,038.1	4,487.5	12	3.6	3.2
1995	536	15,417.0	4,736.2	12	4.9	6.0
1996	584	26,690.7	5,908.0	11	7.2	18.0
1997	539	25,347.3	6,955.0	27	16.3	45.1
1998	341	4,465.1	2,916.4	11	11.3	34.3

Source: PacFIN data.

vestments in additional equipment and effort to keep the fish alive between capture and market. Over the past five years, many Big Sur skiff fishers have shifted from traditional hook and line gear to sticks in order to fish for the live-fish market, especially as prices and demand for dead fish have remained stagnant or declined.

Big Creek Ecological Reserve

Big Creek Ecological Reserve is one of four no-take MPAs (marine reserves) established in 1994 pursuant to the 1990 MRPA. It stands out among the MRPA reserves not only for its high-quality rockfish habitat (Yoklavich et al. 1997), but also, importantly, for the support of local, small-scale commercial fishers, which facilitated its legal designation (Pomeroy and Beck, in press).

The fishers' support for the marine reserve grew out of a pre-existing cooperative arrangement between themselves and the manager of the LHBC Reserve. The primary elements of the arrangement were the establishment and monitoring of an informal no-take zone adjacent to the terrestrial reserve, and fishers' collection of extensive fishery-dependent data on their nearby fishery, in exchange for the opportunity to launch their skiffs from Big Creek. Both of these features emerged locally with little input from government authorities.

The origins of the arrangement date back to the early 1980s, when a small group of local skiff fishers first began to coordinate their fishing activities. They divided the area of the Big Sur coast that they fished into three sections, and agreed to rotate their effort, so that they fished each section for only four months, leaving it to "rest" during the remaining eight months of the year.[3] In October 1988, two of these fishers (on behalf of some eight individuals) asked the LHBC Reserve manager for permission to launch their boats from Big Creek in order to more easily reach preferred fishing spots to the north. The reserve manager consented in exchange for the agreement that those who launched from Big Creek would observe a no-take zone in the kelp beds adjacent to the terrestrial reserve out to 1,000 m (3,280 feet).

The following season (1989–90), the reserve manager, a CDFG biologist, and the two fishers discussed the possibility of research collaboration to sample rockfish inside and outside the no-take area. The idea of a research fishery appealed to the reserve manager, who sought to justify, but also to limit, fishers' launching from Big Creek. Following these discussions, the reserve manager designed the Big Sur Hook-and-Line Kelp Bed Survey (the HLS) in consultation with the Big Creek fishers. (CDFG's rockfish sampling program at Big Creek and at Mill Creek, located about 10 miles south of Big Creek, also resulted from these discussions, but the studies are independent of one another.)

TABLE 3
Design of the Big Sur Hook-and-Line Kelp Bed Survey

Two studies
Twin Kelpbed (80 sortie limit)
Slate Rock (40 sortie limit)
Procedure
Sampling
First 5 fish caught at experimental site within 30 minutes
First 5 fish caught at preferred fishing site
Data collection and recording
Fisher name
Date
Location(s), depth fished, time to catch 5 fish
Fishing conditions (cloud cover, precipitation, temperature, currents, sea state)
Species, weight, length

The HLS includes the "Twin Kelpbed" and "Slate Rock" studies, each with a control and an experimental site (table 3).[4] On each "sortie" (launch) from Big Creek, fishers collect two five-fish samples, one from the control site and one from their preferred (i.e., experimental) site. After a day of fishing, they return to Big Creek to unload their catch, measure, and weigh their fish, and record the survey data at a recording station maintained by the reserve manager.

The passage of the MRPA in 1990 provided an opportunity to gain legal recognition and enduring and broader protection for the Big Creek no-take zone. Designation as an MRPA reserve would insure its continued and more institutionalized protection, but it also posed a potential threat to the cooperative arrangement, in part because it would prohibit passage through the reserve, unless permitted for research.[5] The reserve manager worked proactively with local fishers, landowners, and the state to promote the reserve's designation while insuring that some local control—including that associated with the Big Creek arrangement—was retained. He garnered broad local support for the reserve, beginning critically with that of the Big Creek fishers. An

[3]The number of fishers involved in the arrangements referred to here and at Big Creek specifically has ranged from about 6 to 10, varying over time as individuals' interest in the fishery and other commitments have changed. Although these fishers tended to rotate their activities among the three areas (each associated with a particular Big Sur launch site) as noted, other fishers, both local and from more distant ports such as Monterey and Morro Bay, operate independently of this group of skiff fishers.

[4]The Twin Kelpbed study's control site is adjacent to the reserve and is characterized as "lightly fished," whereas the Slate Rock study's control site is farther from the reserve, and considered to be "medium fished." In both studies, fishers' preferred fishing sites constitute the experimental sites, and are assumed to be "heavily fished." This design allows comparison of fish species, lengths, and weights among sites where fishing pressure is assumed (by the design) to increase with distance from the reserve. The results of the experiment may be confounded, however, by the lack of control over other fishing activities near the reserve and the prior condition of the sites.

[5]In contrast to most of California's other MPAs (which number more than 100; McArdle 1997), these reserves protect all species within their boundaries, and use is "restricted to scientific research relating to the management and enhancement of marine resources" (California Fish and Game Code 630.5).

August 1991 letter from one of them on behalf of himself and the others states: "We offer our support not only in seeking the establishment of Big Creek Reserve as a Marine Ecological Refuge, but on a continuous basis, if in fact Big Creek Reserve wins the designation."

When it was established on 1 January 1994, the Big Creek Ecological Reserve retained the prior, informal no-take zone's northern and southern boundaries and extended its seaward boundary 179 m (586 feet; CDFG 1993). More important, it gave limited recognition to the existing institutional arrangement, and formalized co-management at Big Creek. Provisions in the California Fish and Game Code specify the LHBC Reserve manager's authority to approve research at Big Creek and recognize the priority of research initiated prior to legal designation—such as the HLS; 14 Sec. 630.5 Sec. (b)(2)(A); see also Sec. 630.5 (a)(2)—and a 1994 memorandum of understanding between CDFG and UCSC outlines the co-management arrangement for the Big Creek Ecological Reserve.

Analysis of these institutional developments at Big Creek led to three conclusions (Pomeroy and Beck, in press). First, the cooperative arrangement had been instrumental to the legal designation of the Big Creek reserve. Second, although the HLS holds promise as a source of fishery-dependent data that might be used (in combination with fishery-independent data) to monitor and evaluate the MPA, adjacent fisheries, and the relation between them, it has largely been ignored or dismissed by resource managers and scientists in the region, some of whom question the reliability and validity of the data. Third, the cooperative arrangement at Big Creek has not been adequately considered for its relevance to MPA management and broader resource management.

Although certain aspects of the situation—the fishery's small scale and relative isolation, the involvement of a small number of fishers whose fishing practices are relatively homogeneous, their history of cooperation and ongoing social ties, and the fact that they receive something of immediate value to them (access to the Big Creek launch site) in exchange for their observance of the no-take zone and data collection—may limit generalizations from any lessons learned at Big Creek. However, we have begun to identify other, similar arrangements already in place (Wright, pers. comm.), suggesting some opportunity for the Big Creek case to contribute to enhanced resource management.

QUESTIONS GUIDING FURTHER RESEARCH

Our findings led to a proposal to California's Marine Ecological Reserves Research Program (MERRP) to evaluate, optimize (as needed), and explore the replicability of the HLS and the larger Big Creek arrangement. We recently completed year one of the three-year MERRP study, during which we interviewed Big Creek fishers and others to develop a more complete understanding of the historical, sociocultural, and economic aspects of the local fishery and the cooperative arrangement; systematically observed boating and fishing activity along the Big Sur coast and HLS data collection; began to evaluate and analyze the HLS data; and began to analyze PacFIN data on rockfish landings in the region.

As the MERRP study progresses, we are seeking answers to several questions about co-management and the marine reserve at Big Creek. A first set of questions focuses on the Big Creek arrangement: Just how "cooperative" is it? Fishery co-management arrangements vary in terms of the activities that government and fishers are involved in, the nature and extent of communication among the people involved, and the types of information that they do and do not share. At Big Creek, co-management involves three sets of actors: the Big Creek fishers; the reserve manager; and state resource managers and scientists. At present, the reserve manager plays a central role as liaison between the other two groups, and direct interaction—and cooperation—between fishers and resource managers and scientists remains limited. This, in turn, has limited the opportunities for the social learning that is at once critical to and a benefit of co-management.

A second set of questions pertains to the HLS, and the reliability, validity, and utility of its data. What are the sources of bias in the HLS? What is the relation between markets (prices) and HLS practices and outcomes? How might these biases be addressed to make the HLS more useful? When multiple people collect data, evaluating and analyzing the data require understanding the different ways people interpret the research protocol and collect their data. Another source of bias stems from the fact that this is fishery-dependent data, and therefore reflects the species targeted, the locations fished, and the gear and techniques used by participating fishers. These are a function of, and change in response to, environmental, regulatory, and market conditions, as well as fishers' personal circumstances. For example, Big Creek fishers used to target larger fish, but market conditions (the live-fish market) have prompted a shift to targeting smaller (1–4-pound) fish, and a shift from filet fish (e.g., blue rockfish) to species valued by the live market (e.g., grass, gopher, and black-and-yellow rockfish; cabezon). Such conditions and changes within them must and can be accounted for in evaluating and interpreting the HLS data.

The third set of questions focuses on other aspects of the cooperative arrangement—such as fishers' local ecological knowledge—that might be useful to efforts to understand reserve-fishery interactions at Big Creek. Several of the Big Creek fishers have fished the Big Sur coast since the 1970s, and have observed changes in the availability and quality of different species, in biophysical conditions, and in the nature and extent of fishing activity in the region. This knowledge is not the product of scientifically structured sampling, but rather the result of frequent, year-round, spatially focused observation carried out over the long term. It is amenable to collection and analysis to afford qualitative, and in some cases quantitative, information that can be integrated with scientific data. Recognizing and bringing this knowledge to bear in reserve and fishery management would constitute an expansion of co-management at Big Creek, and would likely enhance understanding of the fishery, the reserve, and the interactions between them.

A fourth set of questions focuses on the spatial and temporal trends in fishing relative to the Big Creek reserve. What are fishers' perceptions, attitudes, and beliefs about MPAs in general, and the Big Creek reserve in particular? Does the existence of the reserve make a difference in their decisions about whether and where to fish along the Big Sur coast? Is fishing pressure at the reserve's perimeter greater than elsewhere? Has it increased, decreased, or remained the same over time?

McClanahan and Kaunda-Arara (1996) report that after the establishment of a no-take MPA in Kenyan waters, fishers redirected their effort, concentrating along the edge of the reserve. They cite this concentration of fishing activity at the MPA's perimeter as the cause of its failure to result in increases in mean sizes and ages of fish in the fished area despite the increases observed in the protected area. They attribute this redistribution of fishing effort to fishers' perceptions that fishing would be better along the MPA perimeter (although the coincident banning of set nets in the same area likely played a role as well).

For the Big Sur fishery, as elsewhere, the environmental, regulatory, and market conditions of fishing have changed in the five years since the reserve's designation. Moreover, fishers have had five years of conducting their fishing with the legal marine reserve in place. What changes, if any, did they make in their fishing in response to the reserve? What social and economic effects, positive and negative, have they experienced in connection with those changes and the reserve's formal establishment? What, if any, changes have they noticed in the resource and the fishery? How have fishers' attitudes, beliefs, and expectations of the reserve and the adjacent fishery changed over time? What factors have most influenced these changes?

CONCLUSION

The cooperative arrangement at Big Creek was instrumental to the legal designation of the Big Creek Ecological Reserve because it facilitated the incorporation of social and economic, as well as ecological, concerns into efforts to establish the reserve. But the co-management arrangement has potential value beyond the establishment of the reserve for its continued management and evaluation. This potential lies not only in the Hook-and-Line Survey through which fishers are contributing fishery-dependent data, but in the opportunity for eliciting and integrating their local ecological knowledge with scientific data, and engaging them more fully in the management process. The resulting communication, information, and understanding can help insure that social and economic considerations are aired and addressed throughout the MPA process, and thereby contribute to more effective use of MPAs as a management tool.

The questions raised about the reserve, the fishery, and the interaction between the two are sociocultural and economic, as well as biophysical, and have important implications for Big Creek Ecological Reserve and for the consideration of MPAs as a fishery management tool more generally. This is all the more significant as California proceeds to implement the 1998 Marine Life Management Act, which calls for greater collaboration among managers, scientists, and the fishing industry, and for fuller consideration of co-management for the state's fisheries. More generally, the Big Creek case may be instructive to those considering alternative approaches to fishery management, such as co-management and MPAs.

ACKNOWLEDGMENTS

Many thanks to Mary Yoklavich, the California Department of Fish and Game, and CalCOFI organizers for enabling my participation in the CalCOFI symposium on marine refugia. Special thanks go to the Big Creek fishers; reserve manager John Smiley; Julie Beck, and Chris Wilcox (research assistants on the MBRS and MERRP projects, respectively); other researchers and agency personnel for their invaluable input and support; Will Daspit and Christian Bantzer for PacFIN data and support; and two anonymous reviewers. Funding support from UCSC's Office of the Vice Chancellor for Research and the Monterey Bay Regional Studies (MBRS) Program, and the California Marine Ecological Reserves Research Program (project no. R/BC-2) is also gratefully acknowledged.

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