

Participatory Fishing Community Assessments to Support Coral Reef Fisheries Comanagement

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Participatory Fishing Community Assessments to Support Coral Reef Fisheries Comanagement¹

John N. Kittinger²

Abstract: Comanagement of natural resources involves shared management authority and responsibility between resource users or community groups at local levels and central government authorities. In data-poor, small-scale fisheries systems, community-based planning efforts can be informed by participatory research approaches that involve community members and stakeholder groups in the design, development, and implementation of research. This article draws upon research in Maunalua Bay, O'ahu, Hawai'i, to illustrate the utility of participatory assessments in communities, institutions, and organizations as they transition toward comanagement arrangements. A community-led survey effort revealed temporal changes in habitat use patterns and declines in key fisheries species and habitats. Fishing activities in Maunalua Bay are primarily non-commercial in nature and many of the direct benefits from local fisheries are distributed through social-kinship networks. The fishing community exhibited a high capacity for engagement in community-based planning efforts and also provided input on proposed management measures. The article concludes by documenting the social and environmental factors that influence the distribution of coral reef fisheries ecosystem services, and assessing sliding baselines among community fishers. Participatory resource assessments hold promise for building local social adaptive capacity, bringing together disparate stakeholder groups, and building place-based natural resource management plans reflective of local contexts and community priorities.

COMMUNITY-BASED planning and natural resource management processes include a diversity of strategies (typically developed and implemented by community leaders, stakeholder groups, and institutions at the local level) to plan for and manage natural re-

sources and the social and environmental systems in which they are embedded. Community-based planning processes have advantages in that local stakeholders are given greater control in resource management, are afforded increased legitimacy in decision-making processes, and are able to incorporate place-based approaches more reflective of local conditions and community priorities. In the context of small-scale fisheries, comanagement has been shown to produce both social and ecological benefits (Basurto 2005, Gelcich et al. 2010), including increases in standing biomass of fisheries stocks (e.g., Cinner et al. 2005, Friedlander et al. 2013 [this issue]).

For these reasons, there has been an increased focus on comanagement arrangements versus top-down and centralized government approaches to managing common pool resources such as fisheries (Berkes 2009, Cinner et al. 2012*b*). Comanagement can take many forms but generally involves shared

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management authority and responsibility between resource users or community groups at local levels and central government authorities (Berkes 2010). In the context of coastal communities and small-scale fisheries, comanagement is associated with increased collaboration and learning among partners, integration of traditional ecological knowledge and place-based approaches, higher compliance with regulations, community empowerment, and increased stakeholder buy-in and stewardship (Jentoft et al. 1998, Jentoft 2005, Pomeroy et al. 2007, Berkes 2009, Gelcich et al. 2010). But comanagement can also lead to increased social conflict, perverse incentives for resource overexploitation, and other undesirable outcomes (Castro and Nielsen 2001, Gelcich et al. 2006).

The success of comanagement arrangements in preventing collapse of common-pool resources and engendering collaborative stewardship is believed to be dependent in part on institutional arrangements, and there has been substantial scholarly attention devoted to the institutional design principles associated with long-enduring common-property resource regimes (Ostrom 1990, Cox et al. 2010). Contextual factors specific to resource systems and particular social-ecological settings have also received attention: for example, in coral reef fisheries, factors such as resource dependence, livelihood strategies, and aspects of economic markets can also be determinants of comanagement success (Cinner et al. 2012*b*, Wamukota et al. 2012).

Comanagement and other community-based approaches have gained significant attention in traditional and small-scale coastal fisheries in the tropical Pacific for the potential to sustain the flow of beneficial ecosystem goods and services and integrate customary methods of resource management. Coastal nearshore fisheries in the tropical Pacific are multispecies, multigear fisheries that are typically data poor (Dalzell et al. 1996) and thus not amenable to conventional fishery management approaches that rely heavily on data-intensive stock assessments to determine maximum sustainable yields (Johannes 1998, Ruddle and Hickey 2008, Friedlander et al.

2013 [this issue]). However, describing these fisheries as data poor is somewhat disingenuous, because local and traditional ecological knowledge sources about these systems are often quite detailed, sophisticated, and rich (Johannes 1981; Hviding 1996), providing ample opportunity to use nontraditional information sources to manage tropical coastal fisheries (Johannes 1998).

Given the lack of conventional data sources (e.g., stock assessments) for these fisheries systems and capacity in many centralized government resource programs, communities and researchers working in a participatory approach at the local level are perhaps best poised to assess the social and environmental aspects of small-scale fisheries systems relevant to community planning and resource management (Jentoft 2000). Participatory approaches that involve communities and researchers working collaboratively can help build capacity and shared knowledge among stakeholder groups and can function as a mechanism by which to engage resource users in community planning and management processes (Chambers 1994, Chuenpagdee et al. 2004). Participatory community fishing assessments can also provide valuable empirical data about fisheries ecosystems and fishing communities, including social, economic, and cultural information about coastal communities, biophysical attributes of the geographic area, resource harvesting patterns, attributes of resource distribution systems (both formal and informal), and other general information about the community (Walters et al. 1998, Pollnac and Crawford 2000, McGoodwin 2001). Community-generated information can provision local-level planning processes and form the basis for resource management plans that are important steps in developing and sustaining comanagement arrangements and strengthening stewardship initiatives at the local level (Wiber et al. 2004).

This article describes how participatory fishing community assessments can support community-based planning processes and build capacity for fisheries comanagement, drawing on research conducted in Maunalua Bay, O'ahu, Hawai'i. Maunalua Bay is situated along the urbanized southeastern coast

of the island of O‘ahu and is one of the largest bays in the Hawaiian archipelago. Approximately 60,000 people live in coastal watersheds directly adjacent to the bay, which is fronted by 12 km of shoreline, 10 small watersheds (<5 km from ridge to reef), and ~17 km² (1,700 ha) of ocean waters (Mālama Maunalua 2009). A diversity of human ocean uses occurs in the bay (Figure 1).

A community-led survey of the Maunalua Bay fishing community was undertaken to assess perceptions of the health of the bay and its fisheries, characterize the fishing community and their activities in the bay, and solicit information from the fishing community about recommended actions for planning and management. In the next section the methodology employed in this research is described. Subsequently the results are described in detail and discussed in terms of their relevance to community-based stewardship efforts and comanagement of small-scale fisheries.

MATERIALS AND METHODS

Participatory action research (PAR) describes a suite of approaches that involve researchers and community members working collaboratively in the visioning, goal-setting, design, data-gathering, and assessment phases of research (Whyte et al. 1989). PAR approaches differ from traditional research in that local participants are engaged actively in all phases of the research. In contexts where the research is directed toward a community-based planning effort, PAR approaches can ensure that research products can more directly inform these planning efforts. Such approaches have been shown to yield valid data that are useful for community planning and management (van Asselt Marjolein and Rijkens-Klomp 2002, Scholz et al. 2004, Aswani and Lauer 2006*a, b*).

A participatory assessment was undertaken by researchers and community members associated with a local nongovernmental organization to assess social and ecological dimensions of nearshore fisheries in Maunalua Bay. The PAR assessment project team was formed in early 2010, and a series of joint planning meetings was convened between researchers

and community members from October 2010 to January 2011 to develop a collaborative research agenda. The project team developed an interview instrument, pretested it among a small group of respondents, and field research activities were conducted January–July 2011. Community volunteers with previous experience in the Maunalua community, as long-time residents, members of fishing families, or with extended involvement in community stewardship programs, were recruited to form a survey team. Most survey team members had previous research experience in interviewing or social data collection and analysis. A community training session for 12 survey team members was held in January 2011 to standardize interviewing methods and data collection and reporting by the survey team.

The study site of Maunalua Bay was defined as the approximately 12 km (~8 miles) of shoreline and ~17 km² (6.5 square miles) of ocean waters bounded by two points, Kawaihoa and Kūpikipiki‘ō (also known as Koko Head and Black Point, respectively) along the southeastern coast of O‘ahu (Figure 1). Fishers were deemed to be “Maunalua Bay fishers” if they utilized habitats and areas within these areas, irrespective of where their home residence was located.

Knowledgeable fishers were identified using a chain referral or “snowballing” sampling method to identify individuals and their network of social contacts (Penrod et al. 2003, Bernard 2006). A purposive sampling approach was employed among identified individuals to preferentially interview fishers who were highly knowledgeable about Maunalua Bay fisheries, ecosystems, and the community. Purposive sampling is a type of sampling in which “particular settings, persons, or events are deliberately selected for the important information they can provide that cannot be gotten as well from other choices” (Maxwell 2009:235). This sampling typology is commonly employed in studies seeking to characterize specific dimensions of a set of issues and is a valid method for achieving representativeness or comparability among a broad set of cases or topics (Teddlie and Yu 2007).

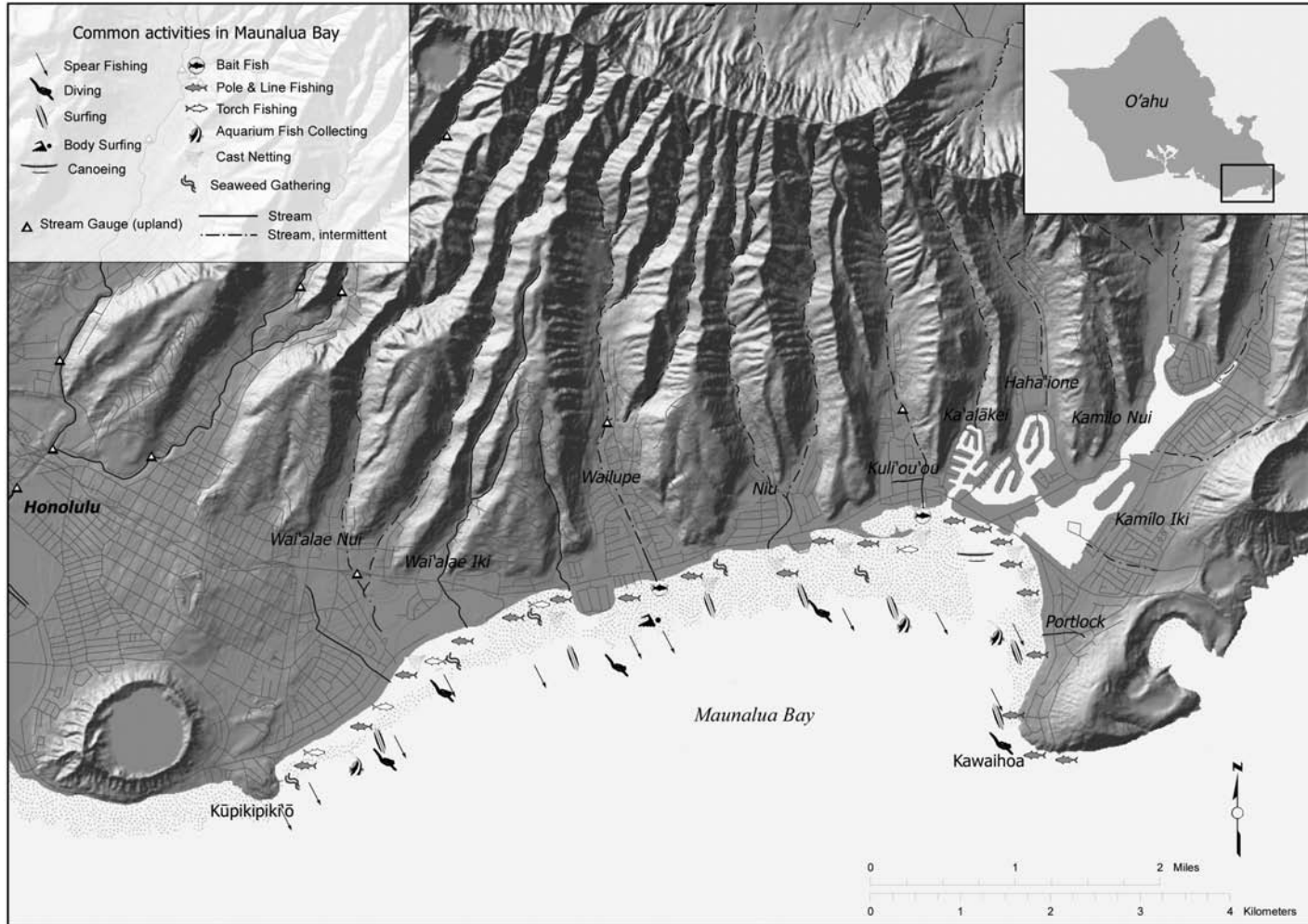


FIGURE 1. Maunalua Bay, O'ahu, with common ocean activities in the bay shown. (Figure courtesy Impact Assessment, Inc.)

Structured, face-to-face interviews were conducted with fishers by the survey team to gather quantitative and qualitative information among the Maunalua Bay fishing community. All interview methods followed accepted social science protocols (Bernard 2006, Bickman and Rog 2009). Quantitative and qualitative interview data were transcribed from interview notes by survey team members and entered into a common spreadsheet (Microsoft Excel). A quality assessment was performed on all data to ensure accuracy, and data were subsequently imported into SPSS statistical software (SPSS 2001) for analysis.

RESULTS

Profile of the Fishing Community

Fifty-eight fishers from the Maunalua Bay area and surrounding communities were interviewed. All respondents were male, and 74% resided in communities directly adjacent to Maunalua Bay. No women fishers were interviewed, which was not intentional and may have been an artifact of the purposive sampling approach. The average age of interviewees was 51 years, and most interviewees were between 40 and 60 years of age. The majority of respondents (>80%) were originally from Hawai'i, and many of those who were not born in Hawai'i had lived in the Islands for the majority of their adult lives. Most fishermen had completed either a bachelor's degree (40%) or some college (29%), and all but 4% of respondents had completed high school, indicating a high level of education among the fishing community. About a third of respondents (17/57 [29%]) reported holding a State of Hawai'i commercial fishing license, and 17% (10/57) identified themselves as sport fishing guides.

Most fishers included in the interviewing effort exhibited a long history of fishing in the bay. The mean number of years fishing in Maunalua Bay was 35, and 40% of fishers interviewed exhibited 40+ years fishing in the bay. Five fishers (8.7%) had 55+ years of fishing experience in the bay (Figure 2). These data suggest that the interviewing effort was

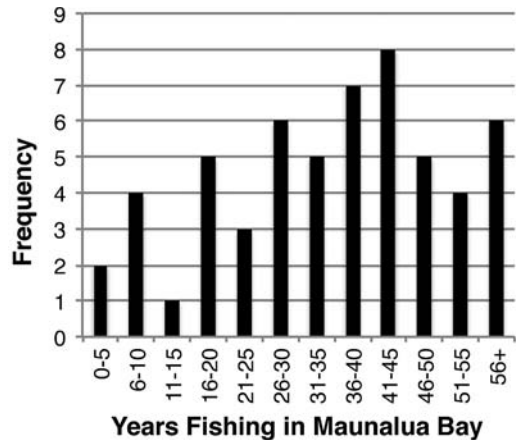


FIGURE 2. Years of experience fishing in Maunalua Bay of fisher interviewees ($n = 57$). Mean years of experience was 34.90 (standard deviation = 15.7).

successful in targeting knowledgeable and experienced fishers in Maunalua and surrounding communities.

Fishing Activities and Ocean Use Patterns in Maunalua Bay

Fishers were first asked to describe the percentage of their time spent in different habitat types both when they started fishing and currently (Table 1). On average, fishers reported spending more time in the deep reef, offshore/pelagic, and reef edge zones than when they first started fishing. Previously, more time was spent fishing the intertidal and inside reef zones that are closer inshore. In addition, effort appeared to be spread more evenly across habitat types when fishers first started fishing than currently. Though patterns differed by fisher and their preferred habitat, there has been a general increase in usage of offshore/pelagic zones and deep reef areas and a decrease in usage of intertidal and inshore reef zones.

Fishers were also asked to describe the specific species they targeted, the gear types they used, and the average catch (by weight) when they first started fishing and currently. Fishers utilized a broad range of gear types, which is common in multispecies fisheries in coral reef

TABLE 1

Habitat Utilization Patterns by Maunalua Bay Fishers When They First Started Fishing the Bay and at Time of the Survey (January–July 2011)

Habitat Type	When First Started Fishing (%)	Currently (%)	% Change
Shore/Intertidal	37	14	-62
Inside reef (reef flats and back reef)	18	12	-33
Reef edge (reef crest)	19	20	+5
Deep reef (deep fore reef and mesophotic reef zones)	14	26	+86
Offshore/Pelagic zones	12	28	+133

TABLE 2

Gear Types Utilized by Maunalua Bay Fishers ($n = 58$)

Gear Type	Frequency of Use (n)	Total Sample (%)
Spear ^a	44	76
Pole ^b	28	48
Trolling	24	41
Nets ^c	16	28
Bottom-fishing gear	12	21
Traps	3	5
Other ^d	6	10

Note: The categories are not mutually exclusive (e.g., a respondent could report using multiple types of gears).

^a Includes three-prong, sling, and spear gun, as well as free diving and tank diving.

^b Includes boat and shore casting, bamboo poles, slide baiting, hand line, whipping, and spinning.

^c Includes throw net (6), lay net (4), net (4), crab net (2), bag net (1), fence net (1), gill net (1), hoop net (1), lobster net (1), and surround net (1). Number of responses (in parentheses) adds up to more than total net fishermen because some fishermen reported more than one type of net.

^d Includes dunking, damashi, torching, and squidding.

environments (Polunin and Roberts 1996). The most common gear types included spears, poles, and trolling gears, and other gears included nets, bottom-fishing, traps, fly-fishing, and other gear types (Table 2).

Perceptions of Environmental Change in Maunalua Bay

Fishers were asked to assess the condition of the bay through time, starting with their first association with the bay. The vast majority of fishermen interviewed reported substantial declines in the health and abundance of the bay and its fisheries resources (Figure 3). Assessments of the most-experienced fishers (top 75% quartile, >45 years experience fishing) were compared with those of the least-experienced fishers (bottom 25% quartile, <24 years experience). Among experienced fishermen who began fishing the bay before the 1970s, the perceptions of decline were more pronounced (a 60% decline). Newer fishermen whose first association with the bay was 1990 or later, by contrast, perceived slightly less environmental change. The difference between assessments of experienced and those of least-experienced fishers was statistically significant for the 1990s only (Figure 3).

Fishery catch data were also aggregated by species and by gear type to identify the major trends in commonly exploited fisheries species in Maunalua Bay (Table 3). Among the most commonly exploited species in Maunalua Bay, catches declined from 31% to 76% when comparing current catches versus catches when interviewees first started fishing. The five most commonly exploited species included goatfish (weke, moano, 'oama, kūmū), reef jacks/trevallies (ulua and pāpio), bonefish ('ō'io), parrotfish (uhu), octopus (he'e), and crustaceans (crab [pāpa'i], lobster [ula], shrimp ['ōpae]). Changes in some species such as jacks/trevallies and bonefish may be explained by changes in the primary habitats accessed by fishers (e.g., from inshore to offshore habitats) or changes in the fishery (e.g., the rise of a sport-fish fishery for bonefish, which may have increased effort and catches correspondingly).

Catch decreases were also commonly reported by fishers using different gears in coral reef environments (shallow and deep-reef) in Maunalua. Among the most commonly used reef gears (spears, poles, and throw nets),

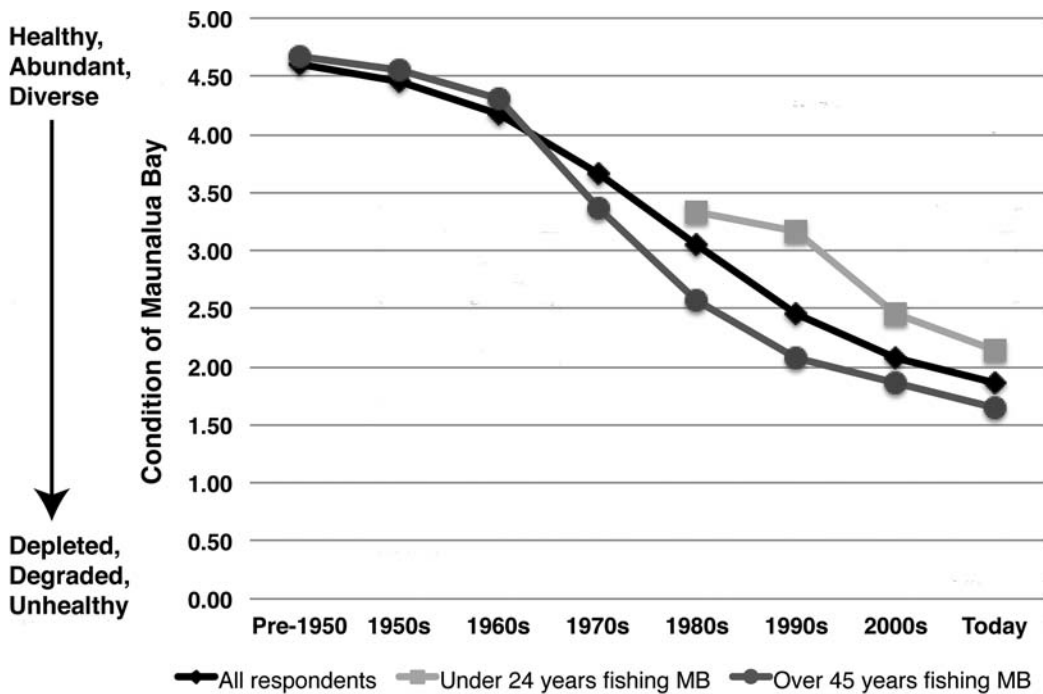


FIGURE 3. Fishers' perceptions of environmental change in Maunalua Bay over the past 50 years. Fishermen assessed the condition of the bay at different times, starting with their first association with the bay. Perceptions of environmental condition (vertical axis) were assessed on an ordinal scale from 1 to 5 stars, with five stars being very healthy, abundant, and diverse, and one star being severely degraded. Assessments of the most-experienced fishers (top 75% quartile, >45 years experience fishing) were compared with those of the least-experienced fishers (bottom 25% quartile, <24 years experience). Differences between experienced and new fishers were statistically significant for the 1990s only ($P < .05$) (independent samples t test).

multispecies catches have declined 13%–62% (Table 4), with pole and spear fishing showing the greatest declines (41% and 62%, respectively), and throw-net fishing showing the least decline (~13%). Estimates of changes in catch by species and gear type reflect the results of memory recall by fishers interviewed in this research, and the findings cannot be viewed independent of the context of larger changes in the fishery. For example, changes in effort, habitat quality or condition, gear advancements and other technologies, and other factors may have influenced catch weight through time.

Fishers also reported qualitative observations of environmental changes observed in Maunalua Bay, drivers of change, and per-

ceived threats to fisheries resources. Observations varied by respondent, but some general trends regarding coastal fisheries were apparent. First, most fishers described major declines in marine resources and habitat quality and increases in human threats to the bay through time. Second, important fisheries resources were most commonly characterized as declining, including species that either had declined substantially from past abundances or were no longer common. The primary fisheries resources described as declining included reef fish, schooling coastal pelagics (e.g., *Selar crumenophthalmus* [bigeye scad, akule] and *Decapterus* spp. [mackerel scad, 'ōpelu]), algae/seaweed (limu), and reef-building corals.

TABLE 3
Single Species Catch Size: Current versus When Fishers First Started Fishing

Species	Sample Size ^a (n)	Catch per Trip: Today, kg (lbs)	Catch per Trip: When First Started Fishing, kg (lbs)	Change (%)	Qualitative Observations from Fishers
Goatfish ^b (weke, moano, 'oama, kūmū)	11	0.69 (1.53)	2.90 (6.40)	-76.03	<ul style="list-style-type: none"> • 1–2 lbs (0.45–0.91 kg) now, used to be 2+ lbs (0.9+ kg) • Takes longer to catch • Definitely smaller
Ulua ^c (including pāpio)	18	1.49 (3.28)	2.62 (5.77)	-43.20	<ul style="list-style-type: none"> • Fish are smaller; no big ones • Also would catch uku (gray jobfish) (rare that they come inshore) and uhu (parrotfish) (back in the day, had about 4–5 lbs [1.81–2.27 kg] avg. catch, now get 1–2 lbs [0.45–0.91 kg] if lucky)
'Ō'io ^d	8	1.96 (4.33)	2.87 (6.33)	-31.58	<ul style="list-style-type: none"> • Will see 10 to 15 fish but only catch one about every five trips • Will see 5–30 'ō'io in the same age range
Uhu ^e	4	2.61 (5.75)	10.09 (22.25)	-74.16	<ul style="list-style-type: none"> • Seasonal; hard to approximate average
He'e (or tako) ^f	7	1.68 (3.71)	4.21 (9.29)	-60.00	<ul style="list-style-type: none"> • Used to see a lot more tako, but it seems that their food source has diminished so they have decreased in number • Biggest tako was 3–4 lbs (1.36–1.81 kg) back in the day
Crustaceans ^g (crab, lobster, shrimp)	5	2.36 (5.20)	4.85 (10.70)	-51.40	<ul style="list-style-type: none"> • Used to catch plenty of lobster ranging from 3 to 5 lbs (1.36–2.26 kg) but do not see lobster anymore • Stopped fishing like this after Hurricane 'Iniki, which changed the habitat; all gone now. Rule back in the day was if the crab could get out of the bucket, keep it. If not, it's too small, so release it

^a Number of times species were mentioned independently (i.e., not as part of a multispecies catch) in interviews with Maunaloa Bay fishers.

^b Mullidae spp.

^c Jacks and trevalleys (Carangidae spp.).

^d Hawaiian bonefish (*Albula* spp.).

^e Parrotfish (Scaridae spp.).

^f *Octopus* spp.

^g Ōpae (various shrimp species); ula (spiny lobster [*Panulirus* spp.] and slipper lobster [*Parribacus* and *Scyllarus* spp.]); pāpa'i (various crab species).

Postlanding Disposition and Redistribution of Catch

Respondents were also surveyed about the postlanding disposition and distribution of locally caught seafood ("fish flow"). Catch disposition varied among fishers, but on average the largest proportion of seafood harvested is kept for consumption within the household, either directly by the fishers them-

selves (47.7%) or by family and friends to whom a portion of the catch was given (16.6%; total = 64.3%) (Table 5). About a quarter of the catch was reported as released, and 11.5% of the catch was reported as sold. Most fishers interviewed characterized their activities as primarily noncommercial (subsistence, recreational, or cultural), but some fishers did report a commercial aspect of their fishing activities. None of the fishers interviewed re-

TABLE 4
Changes in Multispecies Catch by Gear Type: Current Catch versus When Fishers First Started Fishing (Reef Species Only)

Gear Type	Sample Size (<i>n</i>)	Catch per Trip: Today, kg (lbs)	Catch per Trip: When First Started Fishing, kg (lbs)	Change (%)	Commonly Targeted Species ^a
Spear ^b	38	3.30 (7.27)	5.65 (12.45)	41.59	Āholehole, kūmū, 'āweoweo, he'e/tako, uhu, menpachi, roi, to'au, awa, moano, pāpio, ta'ape, nenuē, mū, 'ama'ama, uku, ulua, weke, 'ōmilu, kole, kala, pāku'iku'i, palani, ula, pāpa'i, puhi
Pole ^c	22	1.53 (3.37)	4.07 (8.98)	62.47	Kākū, awa, āholehole, menpachi, moano, pāpio, nabeta, 'ō'io, weke, kūmū, moi, 'ama'ama, uku, humuhumu, kūpīpī
Throw net	4	6.35 (14)	7.37 (16.25)	13.85	Ama'ama, moi, uhu, 'ō'io, āholehole, kūmū, weke

Note: Other gear types/methods were not included due to small sample size.

^a Hawaiian fish and invertebrate names taken from Randall (2008) and Hoover (2006); online list of reef fish names: http://en.wikipedia.org/wiki/List_of_fish_of_Hawaii.

^b Includes three-prong, sling, and spear gun, as well as free diving and tank diving.

^c Includes boat and shore casting, fly-fishing, bamboo poles, slide baiting, hand line, whipping, and spinning.

TABLE 5
Disposition of Catch Reported by the Maunalua Fishing Community (*n* = 58)

Disposition	% of Total
Kept for consumption in the household	47.7
Given away to friends and family	16.6
Released	23.4
Sold	11.5
Other	0.9

lied solely on fishing as their primary income, but 27.6% (*n* = 16/57) of respondents indicated that they sell a percentage of their catch. However, the average contribution of income from these activities was relatively small (6.6%) as a percentage of their total income. The average amount received by those who did sell fish was \$421 (per fishing trip when fish was sold), but this mean was inflated by a small number of individuals that reported much higher values. Among fishers who reported selling a portion of their catch (16/57), only 62.5% reported holding a commercial license. An average of 9.1% of commercial license holders' personal income came from

selling fish. Among those that reported selling a portion of their catch (*n* = 16), the most common purchasers of fish included local markets on the island of O'ahu (8/16), restaurants (7/16), and the Honolulu commercial fish auction (5/16).

Fishing Community Capacity and Management Recommendations

Fishing community capacity and willingness to engage in local planning and stewardship efforts was gauged through a series of questions that assessed fishers' involvement in local organizations and fishery-related activities and their perceptions of current fisheries enforcement. A subsequent section focused more fully on assessing levels of support for proposed management actions. The level of involvement of the fishing community in local organizations and activities is high, as indicated by fishers' participation in public meetings, fishing tournaments, and community organizations. This indicates a high level of community capacity to engage in management, as gauged through participation in community-based events and organizations.

TABLE 6

Perceptions of Fisheries Enforcement and Existing Regulations in Maunalua Bay (MB) ($n = 58$)

Questions Answered by Fishers	Agree/ Strongly Agree	Disagree/ Strongly Disagree	Neutral	Don't Know
A. I know/understand the rules and regulations of fishing in MB	91%	7%	2%	0%
B. The current rules and regulations are easy to understand	56%	32%	9%	3%
C. The current rules and regulations are sufficiently enforced in MB	12%	77%	4%	7%
D. I hardly ever see enforcement personnel in MB	81%	14%	5%	0%
E. I know guys who have been cited for illegal fishing recently	11%	68%	3%	18%
F. I've heard of guys who've been cited for illegal fishing recently	39%	47%	3%	11%
G. If the current rules/regulations were enforced, they would be sufficient to protect marine resources in MB	42%	47%	9%	2%
H. If management of the bay were to continue as it is now, my grandchildren will enjoy an abundant and diverse environment	16%	77%	3%	4%

Most fishers understand existing fisheries rules and regulations (91%), and about half (56%) believe that these rules are easy to understand (Table 6). Fishers overwhelmingly disagree that the current rules and regulations are sufficiently enforced in Maunalua Bay (77% disagree/strongly disagree), and the majority of fishers agree that fisheries enforcement personnel are not commonly seen in the bay. Fishers' perception of a lack of current enforcement presence in the bay is corroborated by fishers' experience in the bay regarding enforcement: most interviewees responded that they did not have friends or acquaintances that had been cited (68%) or that they had not heard of someone who had been cited (47%).

Fishers also demonstrated a high level of local enforcement capacity. Nearly half of fishers (25/58 [43%]) notified the state fishery enforcement agency (State of Hawai'i DOCARE) when they observed illegal fishing activities. Other fishers engaged in informal enforcement, including by documenting the illegal activity (e.g., by taking pictures or video of the activity, often with mobile phones) (10/58 [17%]). About a quarter of fishers personally confronted violators themselves versus calling enforcement personnel (15/58 [26%]).

Maunalua fishers were asked to indicate their level of support for various management measures that were proposed as possible fu-

ture alternatives by the community non-governmental organization and survey team (Figure 4). Fishers indicated a high level of willingness to participate in a community-based program (84.5%). Most fishers also indicated support for some conservation measures, including harvest bans for some species (65.5%) and bans on certain types of fishing gear (75.9%). Most fishers would not support totally closing the bay to fishing (only 12.1%), and about half of all fishers interviewed (48.3%) supported closing the bay for 3–5 years, restocking with native species, and then reopening with effective regulations and enforcement. Almost all fishers (96.6%) supported effective enforcement of current regulations.

DISCUSSION

Coral reef fisheries provide a range of critical goods and services to cultures in the Asia-Pacific region, but overexploitation and other human activities threaten the ecosystem goods and services that reefs provide to human communities (Newton et al. 2007, Wilkinson 2008). Reef fisheries in developed and developing nations and territories in the region support the diets and livelihoods of millions and also provide important sociocultural services that support the heritage and traditions of coastal cultures (Whittingham et al. 2003). Despite these benefits, reef fish-

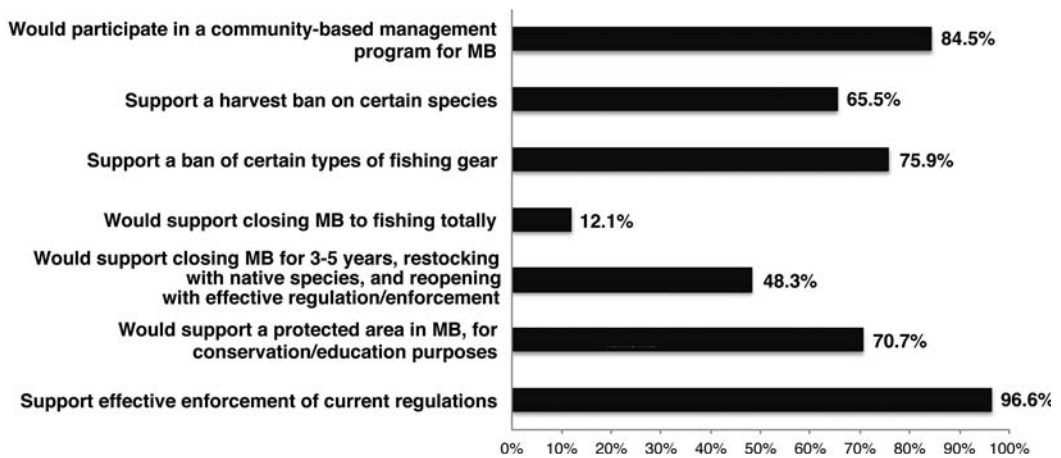


FIGURE 4. Support for various management measures among fishers in Maunalua Bay (MB).

eries have proven difficult to manage due to the multispecies and multigear nature of fisheries, the complexity of coral reef ecosystems, and because the nature of these systems precludes contemporary methods of fishery evaluation and subsequent regulation development (McClanahan et al. 2011). There is thus a need to develop and advance viable solutions to effectively manage and sustain coral reef fisheries and their linked human communities. This requires going beyond problem identification and toward exploring a diversity of potential solutions and their efficacy in different social and ecological contexts (McClanahan 2011).

Participatory action research represents one such approach that can help generate valuable social and ecological information on natural resource systems and advance stakeholder engagement and other social processes that are believed to be important prerequisites for comanagement arrangements (Chuenpagdee et al. 2004, Wiber et al. 2004). Several findings from this participatory study are discussed in the next section within the context of challenges in planning and managing small-scale tropical fisheries. These implications include (1) understanding and characterizing critical ecosystem services associated with coastal fisheries; (2) perceptions of environmental change among resource users; and

(3) provisioning community planning processes through participatory, user-generated research approaches. These key areas are discussed within the context of evolving comanagement governance arrangements.

Critical Ecosystem Services from Small-Scale Coastal Fisheries

Although fishing and gathering remain important aspects of local economies and communities in the Asia-Pacific region, their extent, spatial distribution, and the sociocultural factors that mediate these activities remain poorly understood. Ecosystem services from coral reef fisheries considered in this study include a complement of food provisioning and related cultural services that are not often well understood but that play a major role in determining fishers' behaviors and habitat-use patterns.

Data on the postlanding disposition and distribution of seafood products highlight the importance and prevalence of food provisioning ecosystem services associated with small-scale coastal fisheries in this system. Food provisioning services include direct consumption of locally caught seafood, which composed more than 64% of reported catch disposition (Table 5). This locally caught seafood subsidizes local household economies and

food budgets, contributes to health diets and lifestyles, and maintains social capital and cultural practices in communities.

Ecosystem services associated with coral reef fisheries in Hawai'i and other indigenous contexts often extend beyond livelihood and food provisioning services and include a portfolio of cultural ecosystem services embedded in the practices and traditions of coastal communities. These cultural ecosystems have largely remained difficult to assess and incorporate into assessments and management but are commanding more attention in recent literature (Chan et al. 2011, Chan et al. 2012). In the Pacific, catch is often exchanged or given away as part of traditional practice (Severance 2010, Vaughan and Vitousek 2013 [this issue]). The practice of giving fish catch maintains social capital between fishers and their community, promotes intergenerational transfer of traditional and local ecological knowledge and strengthens ties within social kinship networks at the community level (Naniolo and Meyer 1998, Severance 2010).

Cultural ecosystem services associated with small-scale fisheries are actualized through the entire process of fishing and gathering activities, from trip initiation to postlanding distribution and consumption. Social and ecological factors influence fishing behaviors and catch distribution at the community level and thus mediate the direct (e.g., food provisioning) and indirect (e.g., sociocultural significance) ecosystem services associated with coral reef fisheries (Figure 5). For example, the social capital held and maintained between fishers and their community can determine specific fishing behaviors. In Hawai'i local fishers are often called upon by community members to provide catch for a social event (e.g., weddings, birthdays), and these requests provide the social motivating factors or triggers for specific behaviors (Severance et al. 2013 [this issue]). The spatial distribution of fishers' social kinship networks also influences the distribution of catch through the community. Although most locally caught seafood is consumed in households based in the community, some portion of the catch can also travel considerable distances to family members and friends located farther afield

(Glazier et al. 2013 [this issue], Vaughan and Vitousek 2013 [this issue]). Ecological factors also influence the procurement and distribution of ecosystem services from coral reef fisheries. Weather and sea conditions can affect the accessibility of certain habitats, and some predictable seasonal patterns can limit access to fisheries habitats (e.g., large winter swells along northern coastlines). Local availability of habitat types, species seasonality, and species abundance (as a result of both natural and human factors) also influence catch type and subsequent postlanding utilization patterns.

Ecosystem services may provide a better target for management activities in these coastal fisheries systems than the conventional "typology" of fishing activities that is often used by fishery management institutions. These fishing "typologies" are based on sectors common to conventional fisheries management, including recreational, subsistence, commercial, and cultural sectors. It remains difficult to formally define such sectors in many coastal, small-scale fisheries, where multiple activities can occur on the same fishing trip. Noncommercial fishing includes subsistence/consumptive, recreational, and cultural fishing and gathering activities that occur in ocean and nearshore coastal zones. Noncommercial fishing is the most prevalent type of extractive activity in most coral reef fisheries in Hawai'i, is largely unreported or undocumented, and can substantially exceed reported commercial landings. For example, using creel surveys, Friedlander et al. (2012) found that the catch within the Maui Kahekili Fisheries Management Area (FMA) exceeded the reported commercial catch by 37%. In that case, the commercial reporting zone is 98% larger than the FMA, suggesting that noncommercial and nonreported reef fishing may be more than an order of magnitude larger than reported commercial landings. Similarly, Friedlander and Parrish (1997) found that nonreported catch in Hanalei Bay, Kaua'i, was 90% greater than of the entire commercial reporting zone, which encompasses the entire north shore of the island of Kaua'i.

These estimates from other reef fisheries in Hawai'i are consistent with data reported

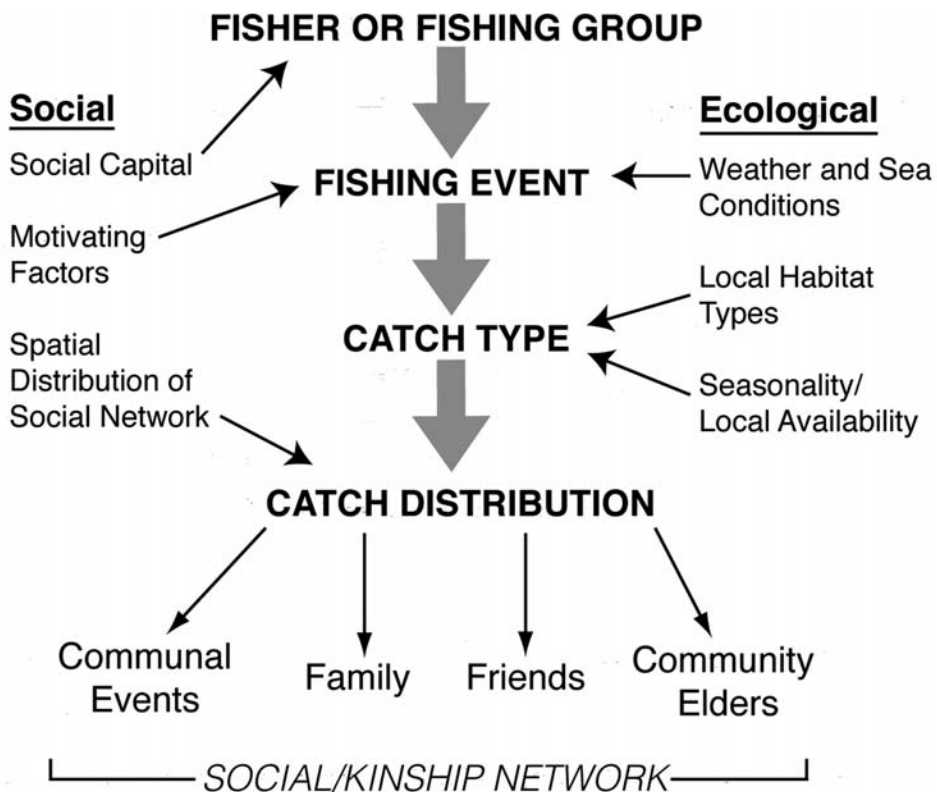


FIGURE 5. A heuristic model describing the social and ecological factors influencing noncommercial (subsistence/recreational/cultural) fishing behaviors and catch distribution at the community level. Fishing activities and fishers' behaviors are mediated by social factors including social capital, motivating factors, and spatial factors, which modulate a series of actions from trip initiation to catch disposition within a social-kinship network. Ecological factors such as weather and sea conditions and seasonality and local availability of habitat types and species also influence catch type and postlanding utilization patterns.

here that suggest that commercial activities compose a minor dimension of overall fisheries effort and extraction in Maunalua Bay (Table 5). Only 11.5% of the total catch from Maunalua Bay was reported as having been sold. Among fishers that reported selling, the income generated composed a minor percentage of their overall income (<10%). This pattern is consistent with "offset selling," whereby fishers sell part of their catch to offset costs associated with fuel, ice, and other supplies for fishing trips. It is also important to note, however, that selling, trading, or bartering of fish and seafood is embedded in local informal economies (Glazier 2007), but understanding of the structure and function of these in-

formal markets, which operate largely at the community and district level, remains limited.

The sociocultural determinants of fishing activities and coastal communities are not often quantified in typical assessments of ecosystem services and goods, but the data gathered here demonstrate the importance of fishing to the Maunalua Bay area and surrounding communities. Food provisioning and cultural ecosystem services from small-scale fisheries systems may represent better targets for management activities, particularly for community-based plans that are put into practice through comanagement arrangements. The importance of traditional harvesting and gathering in maintaining cultural

continuity and social well-being in Hawaiian communities is generally recognized, and recent efforts have brought empirical rigor to participatory assessments that can be used in management (e.g., McGregor et al. 1998). Community-based plans and comanagement arrangements may help protect food security and coastal fisheries sustainability (Turner et al. 2007, Bell et al. 2009), but more research is needed on the complex interactions between local and global drivers that affect environmental quality and socioeconomic conditions, the formal and informal governance systems that mediate natural resource use patterns, and how community assessments of ecosystem services can be used in comanagement arrangements (Brewer et al. 2012, Cinner et al. 2012b).

Sliding Baselines and Environmental Change

In many small-scale fisheries systems, data limitations preclude a quantitative assessment of temporal changes in fisheries ecosystems and their associated human communities. User-generated information from participatory research can, however, be used to reconstruct both social and environmental changes that are relevant for community-based planning processes and resource management plans.

In Maunalua Bay, fishers were nearly uniform in their descriptions of environmental change, particularly in the decline of habitat quality, catch abundance, and the causal factors associated with those changes. Catch declines were particularly illustrative of the declines in fisheries-targeted stocks and catch by gear type. Declines in catch, measured as percentage change in biomass of seafood caught, ranged from 31% to 76% for the most commonly exploited fisheries species (Table 3), and declines of 13%–62% were estimated for multispecies gears (Table 4). These declines show unequivocally that most Maunalua fishers describe healthier and more abundant fishery conditions when they first started fishing as opposed to current conditions.

The data presented herein also confirm a difference in perceptions of environmental condition between longtime fishers and those

whose first association with Maunalua Bay was relatively recent by comparison (Figure 3). This phenomenon is known as the “shifting baseline syndrome” (SBS), whereby each generation calibrates their understanding of ecological conditions via their first association with the marine environment (Pauly 1995). Papworth et al. (2009) characterized two forms of SBS, including (1) generational amnesia, where knowledge extinction occurs because younger generations are not aware of past biological conditions; and (2) personal amnesia, where knowledge extinction occurs as individuals forget their own experience. These results suggest the presence of generational amnesia, which is related to age- or experience-related differences in perception among Maunalua Bay ocean users. Comparisons among all fishers showed that more-knowledgeable fishers with a longer association with the bay perceived more severe declines in Maunalua Bay than fishers that had relatively little experience in comparison (Figure 3). Though there was no corroborating test, evidence of personal amnesia was not found, and many longtime fishers were able to describe previous environmental conditions in great detail. The accuracy and utility of qualitative perceptions, including those estimated via memory-recall assessments, continue to be discussed by scholars (e.g., Shackeroff and Campbell 2007, Daw 2010), but many researchers have used such observations to reconstruct ecological and social baselines, pointing to the validity and reliability of such methods (e.g., Johannes et al. 2000, Sáenz-Arroyo et al. 2005, Maynou et al. 2011).

Integrated social and ecological assessments can help provision planning processes and form the basis for more effective local-state comanagement partnerships by establishing social and ecological baselines that can be used to develop community-based resource plans (Chuenpagdee and Jentoft 2007). The social and environmental baselines presented here include changes in environmental conditions (Figure 3) and catch levels (Tables 3 and 4).

In Maunalua Bay, these baselines have been used to establish a user-generated base-

line for environmental quality and conditions. These baselines provide in aggregate form evidence of declines in environmental quality that were held privately by many trusted, individual fishers and have been used to catalyze community action around restoration and stewardship. Such baselines in habitat quality and historical catch levels could also potentially be used to set planning targets for a community-based plan. Baselines such as this may help establish what targets are feasible given the current trajectory and past history of use.

Participatory Research in Community-Based Natural Resource Planning and Management for Small-Scale Fisheries

Researchers, communities, and practitioners continue to develop innovative methods for incorporating different knowledge types into resource assessments for “data-poor” fisheries (Walmsley et al. 2005, Honey et al. 2010, Starr et al. 2010). This study has provided a community-led assessment of spatial patterns of ocean use patterns, perceptions of enforcement, environmental and catch baselines, and levels of support for various management strategies. Together, these baselines may be used to assess changes in the social dimensions of ocean uses (activities, uses, behaviors, and perceptions) as well as the status of important fishery resources through time.

In small-scale fisheries, engaging the fishing community early and often in a process can be critical in developing a bottom-up approach that results in greater buy-in and support for stewardship programs (White and Vogt 2000, Helvey 2004, Basurto 2005). The participatory research process used in this study can function as a process of community engagement to build shared knowledge around a place. In this study, the survey team worked closely with the fishing community to develop a shared understanding of the status of the bay, historical practices in the bay, and to define the key challenges and opportunities for community stewardship. This colearning among partners has been shown to help increase community participation and successful cooperation between resource-

management institutions and their partners (White and Vogt 2000, Aswani and Lauer 2006a) and to help build social capacity for planning and management (Evely et al. 2011).

This participatory study also brought together local and traditional ecological knowledge (LEK/TEK) to articulate a basis for community-based management initiatives. In systems such as Maunalua Bay, where conventional data sources are unavailable or would be too costly to procure, LEK/TEK can provide the basis for a management plan and can function as a mechanism for building stakeholder involvement. Other scholars have suggested that LEK/TEK may form the basis for developing culturally appropriate management plans based on user-generated assessments of historical and current environmental conditions (Johannes et al. 2000, Haggan et al. 2003). Approaches based on local knowledge systems and customary practices have been shown to achieve higher compliance and to be more resilient to change (Cinner and Aswani 2007, Ruddle and Hickey 2008). Conversely, failure to productively engage resource users and their knowledge systems can lead to increased mistrust, conflict, and process breakdown, which can negatively affect the resilience of coastal ecosystems, natural resources, and the communities that depend on them.

In Hawai‘i, communities have used similar participatory assessments to develop community-based stewardship programs and to engage in transitioning toward comanagement (e.g., Poepoe et al. 2003, Hā‘ena Fisheries Committee 2011, Friedlander et al. 2013 [this issue], Vaughan and Vitousek 2013 [this issue]). Communities in Hawai‘i are increasingly interested in comanagement as a mechanism to incorporate customary practices and values and because such approaches are associated with better social and environmental outcomes. For example, Friedlander et al. (2013 [this issue]) have shown that reef fish biomass in community-managed areas is as high as in no-take marine reserves in Hawai‘i. Positive social outcomes include increased compliance, cooperation, and cohesion and higher rates of transfer of LEK/TEK at the community level. However, most

communities that have active comanagement arrangements have achieved it through lengthy and costly engagement with the legislative and state rule-making process. The institutional dynamics of local-state partnerships and social factors conducive to community-level collective action are the focus of current scholarship and research (Kittinger et al. 2012, Vaughan and Vitousek 2013 [this issue]; Ayers, 2011, unpubl. data) and need to be resolved if comanagement is to be explored as a viable management strategy under existing law and policy conditions (Hawai'i Revised Statutes 1994).

Participatory assessments are one potential solution for local and higher-level institutions in the transition to comanagement. Participatory research approaches can help (1) define past and current social and ecological trajectories of change through local and ecological knowledge holders, (2) engage disparate stakeholder groups through research activities and through collaborative colearning, and (3) provision community-based planning processes through user-generated assessments. Participatory assessments alone, however, are likely insufficient to ensure comanagement success. Other key issues such as power dynamics, the design of institutional arrangements, actor interactions, institutional capacity, and other factors may also influence the social and environmental outcomes of decentralized approaches to resource management (Olsson et al. 2004, Cinner et al. 2012a, Marín et al. 2012). At the local level, participatory approaches can support communities as they work to build social adaptive capacity, link together disparate stakeholder groups, and engage in planning processes for community-based resource management.

CONCLUSIONS

Participatory research approaches have gained traction as a method for supporting community-based natural resource planning and management (Chambers 1994, Sohng 1996). In the context of small-scale and traditional fisheries, participatory approaches have been shown to enable colearning

among stakeholders and engage resource users and other stakeholders in more-effective knowledge-to-action partnerships (Chuenpagdee et al. 2004, Wiber et al. 2004). This study shows the potential of participatory research approaches in helping integrate knowledge systems (customary and conventional), establish baselines of environmental and social change, and catalyze community action for collective stewardship. Participatory research may help spur the development of place-based approaches that are more closely aligned with local conditions and community priorities. Future prospects for implementation of community-based management, however, will be determined in part by the resources and capability of individual communities to navigate the complicated process for comanagement that currently exists in Hawai'i.

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