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Evaluating marine protected areas for managing marine resource conflict in Hawaii

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ABSTRACT

Conflict surrounding commercial fisheries is a common phenomenon when diverse stakeholders are involved. Harvesting reef fish for the global ornamental fish trade has provoked conflict since the late 1970s in the State of Hawaii. Two decades later the state of Hawaii established a network of marine protected areas (MPAs) on the west coast of the island of Hawaii ("West Hawaii") to protect and enhance the fish resources and alleviate conflict between stakeholders, principally between commercial dive tour operators and aquarium fishers. The perceptions held by these stakeholders on West Hawaii and Maui were evaluated to understand how MPAs influenced conflict dimensions, as the former location had a well-established MPA network designed to alleviate conflict, while the latter did not. This was accomplished by analyzing the following questions: (1) perceptions about the effectiveness of MPAs to alleviate conflict and enhance reef fish; (2) perceived group encounters and threats to coral reefs; (3) willingness to encourage fishing; and (4) value orientations toward the aquarium fish trade. The results indicate the MPAs in West Hawaii were moderately effective for alleviating conflict, encounters between stakeholders occurred on both islands, dive operators strongly opposed commercial fishing and perceived aquarium fishing as a serious threat to the coral reef ecosystem, and polarized value orientations toward the aquarium fish trade confirms pervasive social values conflict. The conflict between these groups was also asymmetrical. MPAs are inadequate for resolving long term conflict between groups who hold highly dissimilar value orientations toward the use of marine resources. Future marine spatial planning and MPA setting processes should include stakeholder value and conflict assessments to avoid and manage tensions between competing user groups.

1. Introduction

The commercial capture of marine resources has been fraught with conflict since the early part of the 20th century when the participation in commercial fisheries proliferated [1]. Fisheries conflict typologies have focused on describing: who controls fisheries; how fisheries are controlled; relations between fishery users; relations between fishers and other users of the aquatic environment; and relations between fishers and non-fishery issues [2,3]. Although these typologies are useful for identifying incompatibilities between groups, they do not explain why the incompatibilities occur, which is paramount for understanding when conflict for common pool resources develops at a deeper, more cognitive level [4].

Another approach for examining conflict requires an investigation of social values and interpersonal conflict dimensions. Social values conflict may occur when individuals or groups of people do not share similar norms and values about an activity [5,6], and it can occur even when there is no physical contact between conflicting individuals or groups [7]. Values serve as the foundation for attitudes and beliefs, where the pattern, direction and intensity of basic beliefs form value orientations toward things such as fish and coral reefs [8,9]. Vaske et al. [5] empirically described a classic case of social values conflict between wildlife viewers and hunters in Colorado, United States. Despite spatial separation via topography and management regulations, the wildlife viewers simply oppose hunting the animals they enjoyed viewing. This value difference engendered a social values conflict between hunters and wildlife viewers.

Interpersonal conflict may occur when the presence or behavior of an individual or group interferes with the goal of another individual or group [10]. For example, interpersonal conflict may arise when a novice fisher encroaches and disturbs the space of a more experienced one. In this example, interpersonal conflict may occur when two fishers vie for the same resource; one fisher seeks solitude while another seeks company with other fishers; when a more experienced fisher believes the less experienced one may diminish the chance of catching fish. To examine social values and

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interpersonal conflict more systematically, Vaske et al. [6] suggested researchers evaluate whether opposing groups observe each other while undertaking their respective activity and if they perceive each other as a problem (Fig. 1).

These conflict dimensions have never been quantitatively described between commercial fishers and other stakeholders in Hawaii's nearshore marine environment.

The direction in which conflict occurs is also important. Symmetrical conflict, or two-way conflict, occurs when both groups observe and perceive each other as a problem, while asymmetrical conflict, or one-way conflict, may occur when one group observes the other and perceives them as a problem [11]. Asymmetrical conflict is widely documented between recreational groups, such as between canoeist and motorboaters, hikers and trailbikers, oar-powered and motor-powered whitewater rafters, cross-country skiers and snowmobilers, backpackers and horsepackers, water skiers and anglers, and hunters and wildlife viewers [11].

Many coastal regions in the tropics have experienced a shift away from fishing and trade economies toward tourism-dependent ones. This often pits burgeoning tourism against fisheries in the competition for ocean space and resources [3,12–15]. Conflicts between tourism and fishing industries were documented in Jamaica [16], the Philippines [13–15], Tanzania [17], the Caribbean [12,18], the Galapagos Islands [19], Australia [20] and the United States [21,22]. Marine protected areas (MPAs) are an effective tool for protecting biodiversity and important habitats, and enhancing fisheries [23]. More recently, however, MPAs have also been employed as a spatial tactic for separating incompatible user groups [18,22,24–26]. Using MPAs in this context can leave some stakeholders feeling marginalized when they are excluded from areas they commonly use while others maintain access and use benefits [13,22,27]. This perceived marginalization can hinder conflict resolution and sometimes inflame tensions, particularly when conflicting party values are unclear or ignored [13,22,27]. For example, Oracion et al. [13] describe a situation in which conflict developed between the dive tourism industry and fishers over the perceived economic advantages the former party enjoyed from the implementation of MPAs in the Philippines. Broad and Sanchirico [28] found that groups reliant on tourism are more likely to support spatial management, such as MPAs, because they are seldom excluded from these areas. Although using MPAs may work to alleviate conflict, especially interpersonal conflict, between opposing marine stakeholders, its efficacy has rarely been empirically examined in a marine system.

Harvesting reef fishes for the global aquarium trade involves 45 countries and removes approximately 30 million fish per year from tropical coral reef ecosystems [25,29]. Conflict between aquarium trade fishers and the tourism sector was reported in Australia [30], Fiji [30], Maldives [25] and Hawaii [22], with overharvesting reef fish populations as the most common complaint [30]. Bruckner [31] suggested using spatial zoning and closures for managing multiple stakeholder conflicts when associated with marine aquarium fisheries, which was done in Hawaii.

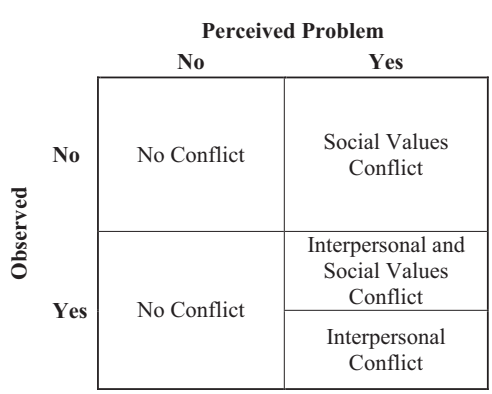

Fig. 1. Theoretical matrix for evaluating social values and interpersonal conflict (adapted from Ref. [6]).

The aquarium fish trade in Hawaii started on Oahu in the 1950s and rapidly expanded to other islands in the 1970, with the largest share of the annual catch originating from the west coast of the island of Hawaii (hereinafter "West Hawaii") [32]. Conflict between aquarium fishers and other stakeholders in Hawaii as a result of perceived overharvesting of reef fishes was first documented in 1978 [33]. The conflict nearly erupted into violence in the late 1990s before the public pressured the state to intervene [34]. In July 1998, the State of Hawaii passed House Bill 3457, which upon approval became known as Act 306, and called for management to ensure resource sustainability, enhance nearshore fish resources and minimize conflicts [34]. Act 306 resulted in the designation of the entire 235 km of West Hawaii's coastline as a Fishery Management Area, and later allowed for the creation of nine MPAs (regionally termed Fish Replenishment Areas). These MPAs prohibited the harvest of reef fish for the aquarium trade along ~35% of the coastline, which included ~7.4% of coastline previously protected. In 1997, Tissot and Hallacher [35] observed significant depletions in West Hawaii reef fish in areas where aquarium fishing occurred, suggesting that MPAs might assist in recovery of fish populations. Act 306 also authorized the creation of the West Hawaii Fisheries Council, a volunteer community advisory group established to receive community input on co-managing nearshore fisheries with state fishery managers [22,36]. These accomplishments were the result of a collaborative effort between the State's Division of Aquatic Resources (DAR), the dive tourism sector, nonprofit organizations, aquarium fishers, academics, residents and other stakeholders.

More recently, hard-line animal rights activists from Maui attempted to ban, or severely restrict the aquarium fishery using multiple state legislative bills that were subsequently rejected [37,38]. However, unlike on West Hawaii, where there are approximately 40 active aquarium fishers [39], state records report ≤ 5 active aquarium fishers on Maui [40] and the coastal MPA spatial coverage around Maui is $<2\%$ [41]. Animal rights activists vehemently oppose the trade despite the small size of the fishery and the lack of any direct evidence suggesting it is a serious threat to the island's marine ecosystem [42].

Here, the effect of MPAs on the dimensions of conflicts between aquarium fishers (hereinafter "fishers") and dive operators on West Hawaii and Maui are examined by investigating the following questions: (1) Do fisher and dive operator perceptions on West Hawaii differ regarding the effectiveness for MPAs to alleviate conflict and enhance reef fish populations? (2) Do fisher and dive operator perceptions differ on West Hawaii and Maui regarding encounters with the opposing group and threats to coral reefs? (3) Are fishers and dive operators on Maui and West Hawaii equally willing to encourage recreational, subsistence, and/or commercial fishing? and (4) Do dive operators and fishers on West Hawaii and Maui hold similar value orientations toward the aquarium fish trade? These stakeholders were selected as research subjects not only because there is a history of conflict between fishers and dive operators on West Hawaii [22,34,43], but also because they both exploit reef fish for commercial purposes: fishers generate revenue from harvesting the resource, while dive operators generate revenue from clients who come to observe the resource. Focusing on these stakeholders does not negate the importance of others in Hawaii's coastal marine ecosystem. To our knowledge, this is the first attempt to empirically evaluate whether MPAs are an effective tool for improving values conflict between two commercial entities, such

as commercial fishers and dive operators. This research contributes significantly to the understanding of conflict dimensions related to MPAs, coastal resource management and the global aquarium fish trade.

2. Methods

2.1. Data collection

Data were collected through two distinct survey instruments disseminated to fishers and dive operators on West Hawaii and Maui. The lack of a sampling frame required the employment of several purposive sampling methods. This approach may constrain data inferences but is appropriate for exploratory purposes [44]. The findings from these exploratory endeavors are not generalized beyond the sampled population. Dive operators were classified as boat captains and crew who worked at a commercial outfitter providing recreational SCUBA and snorkel experiences to clients.

The objective of the first survey instrument was to evaluate stakeholder perceptions regarding the effectiveness of the MPAs on West Hawaii for alleviating conflict and enhancing reef fish abundance. The DAR mailed the first survey to fishers on West Hawaii during the summer of 2007. The objective was to obtain responses from the ~39 active fishers previously reported [39]. Each permit holder received a questionnaire, letter of purpose and a self-addressed stamped return envelope. Snowball sampling (or chain referral sampling) was also used to augment the mailed questionnaires because the actual active fisher population was only an estimate and there was concern fishers might not respond favorably to receiving inquiries from the DAR, given the history of conflict surrounding this fishery [22,34,43]. Snowball sampling uses existing subjects to recruit new ones from among their peers; it is ideal for researching sensitive issues involving groups of people who are dispersed and difficult to identify [45].

To evaluate the MPA goals, five point Likert scale questions were used, in which possible responses ranged from 1 (extremely ineffective), 2 (ineffective), 3 (neutral), 4 (effective) and 5 (extremely effective). Respondents were also asked how often they fished, so as to gauge activity, and the study classified respondents as "active" if they fished at least once per month. The justification for this criterion is based on the assumption that fishers catch ≥ 100 yellow tang per month. This assumption is supported by the following: (1) the average fisher completes 3–4 dives per trip and can average ~100 fish per dive-hour [46]; (2) yellow tang comprise approximately ~80% by number and ~70% by value of aquarium landings from West Hawaii [39]; and (3) it is not uncommon for fishers to report catching ≥ 1000 yellow tang per month [39]. This assumption implies that fishers harvest ≥ 1200 yellow tang per year, which is similar to the value used previously [39] for defining an "active" fisher. All 23 surveys returned were from permit holders who met the "active" fisher criterion. This resulted in a response rate of approximately 59% when using the estimated number designating the active fishers population size ($n=39$).

The first survey instrument was sent to dive operators on West Hawaii during the summer of 2008. A database of existing dive operators was initially created using industry experts, internet searches and local phone books. This database contained company and personnel names, websites, email addresses, physical locations and phone numbers, and it was used as a reference to ensure industry representation and to avoid duplicating survey dissemination. Thirty dive operators, or outfitters, were identified on West Hawaii using this approach. Next, dive operators were intercepted and sampled purposively at major boat launch sites in West Hawaii (i.e., Puako, Honokohau, Kailua Pier and Keauhou). All intercepted recipients received a questionnaire, letter of purpose and a self-addressed stamped return envelope. In addition, questionnaires were delivered to the remaining dive operators in the database who were not intercepted at boat launch sites. Approximately 103 questionnaires were disseminated of which 36 were returned, resulting in a 34% response rate.

A second questionnaire was disseminated on Maui and West Hawaii during the summer of 2009 and winter of 2010, respectively. This allowed an examination of: (1) perceptions held by fishers and dive operators regarding threats to the reef; (2) perceived encounter rates between surveyed groups held by dive operators and fishers; (3) value orientations toward the aquarium fish trade among by fishers and dive operators; (4) dive operator and fisher willingness to encourage recreational, subsistence, and commercial fishing; and (5) dive operator awareness about the aquarium fishery. This questionnaire was disseminated in a manner similar to the first one, with slight modifications made to improve its accessibility for respondents on West Hawaii. For example, the survey was made available online using SurveyMonkey™ for fishers and dive operators on West Hawaii. The online and paper versions were identical, and online access instructions were included in the letter. A postcard was also sent to fishers on West Hawaii, one month after the questionnaire was mailed to them, encouraging participation; it also included online access instructions. Maui dive operators were intercepted and sampled purposely at major boat harbors (i.e., Lahaina, Maalaea, Kihei, and Mala), and surveys were disseminated using the same approach employed on West Hawaii.

The DAR on West Hawaii removed inactive fishing permits from their database around the time the second questionnaire was mailed. Consequently, fewer questionnaires were mailed ($n=47$) to fishers on West Hawaii. Twenty-eight completed questionnaires were received, resulting in a 53% response rate. One hundred eleven questionnaires were disseminated to dive operators on West Hawaii and 38 were returned, resulting in a 34% response rate. On Maui, 105 questionnaires were disseminated to dive operators and 46 were returned, resulting in a 44% response rate. Ten questionnaires were mailed to people who held aquarium fishing permits on Maui; however, it was estimated that there were ≤ 5 people on Maui who actively fished with any regularity. Four questionnaires were returned from Maui fishers, resulting in an 80% response rate from active fishers, assuming there were five active fishers.

To investigate perceived reef threats, respondents were asked on a five point Likert scale about the factors they felt threatened the quality of coral reefs and their associated fish populations. Threats were reported as "no threat," "minor threat," "moderate threat," "threat" and "serious threat." The threat factors included: poor management, invasive species, throw-net fishing, hook and line fishing, aquarium fishing, bottom fishing, surround net fishing, troll fishing, spearfishing, recreational overuse, global warming/climate change, land-based development/pollution, natural oceanic processes, and other. The "poor management" attribute was purposely undefined and thus left open to interpretation. Respondents who indicated "other" as a threat were instructed to specify this factor. Next, respondents were asked how often they encountered each other while undertaking their respective activity using "never," "occasional" and "frequent" response variables. "Encounter" referred to any and all engagement experienced by these groups. Dive operator awareness about aquarium fishing was also evaluated using a five point Likert-scale question, in which responses ranged from 1 (unaware) to 5 (very aware).

Finally, willingness to encourage fishing and value orientations toward the aquarium fish trade were investigated. Respondents were asked if they would encourage commercial fishing,

recreational fishing, subsistence fishing, all three fishing categories, or none of the three fishing categories. Separately, three measurable items were used to formulate a latent values construct (i.e., a theoretical concept), which in this case was the value orientation toward the aquarium fish trade. Respondents were asked about their level of agreement with three value statements (or items) on a 1 (strongly disagree), 2 (disagree), 3 (neutral), 4 (agree) and 5 (strongly agree) point Likert scale. The three value statements included: V_1) harvesting reef fish for commercial trade is wrong; V_2) reef fish belong on the reef, not in tanks; and V_3) the trade in reef fishes is inhumane. Other value statements were also evaluated: V_4) Reef fish are acceptable as pets; V_5) Reef fish are a renewable resource for human use; and V_6) Home aquarium keeping is a wonderful educational hobby.

2.2. Data analysis

Likert scale responses were analyzed using Mann–Whitney *U* tests in Minitab version 15 and Wilcoxon matched-pairs signed-rank tests in StataIC version 12. The former test was used to compare differences between two independent samples, while the latter test was used to compare differences between two related samples. The results were considered significant at $p<0.05$. These tests are appropriate for the level of measurement and small sample sizes that exhibit non-normal distributions [47–49]. Statistical interisland within-group equivalencies for all perceived threats and willingness to encourage commercial, recreational or subsistence fishing were detected. Therefore, these responses were combined by group (i.e., fishers versus dive operators) and analyzed further. The medians and means were calculated for all threat factor responses for both groups; the top three factors with the highest median and mean values were selected and categorized in terms of percentages for further analysis. The fishing category responses were calculated as percentages and analyzed using chi-square analysis. Maui fisher responses were identical in terms of their perceived level of encounters with dive operators (i.e., they never encountered them while fishing). Therefore, their median response value was used and compared to West Hawaii fisher response values using 1-sample sign test.

Construct reliability for the value orientation statements was tested using Cronbach's alpha in Minitab version 15 software. This test is a measure of internal consistency to ensure that statements are estimating the same general construct. An alpha coefficient ≥ 0.65 and item adjusted total correlations of ≥ 0.40 imply that the variables are reliably measuring their respective orientation [50,51]. Construct reliability analysis validated combining corresponding variables for further analysis. Item adjusted total correlations are coefficients for the score on an individual item and the sum of the scores on the remaining items, and generally should be >0.40 [51]. The "alpha if deleted" variables assess whether removing an item from the analysis improves the internal consistency [51].

Exploratory factor analysis (EFA) employing the principle factor and orthogonal varimax rotation was used to extract and confirm that the value orientation statements were measuring a single factor. Construct validity for the value orientations toward the aquarium fishery was determined using confirmatory factor analysis (CFA). Multivariate normality is an assumption of CFA and was tested using the Doornik–Hansen [52] and Mardia's [53] tests for multivariate kurtosis and skewness; however, Satorra–Bentler robust estimator was used to correct for these assumptions because they were violated [54]. Factor loadings were considered acceptable at ≥ 0.55 [55]. The comparative fit index (CFI) with a value ≥ 0.95 as a post-estimation measure for assessing overall CFA model fit was used, as it is robust and stable when dealing with smaller sample sizes ($50<n<250$) [56,57]. StataIC version 12 software was used for performing the factor analysis functions. After construct validity and reliability were confirmed, the value orientations toward the aquarium fish trade held by both groups were compared using Mann–Whitney *U* tests.

3. Results

The perceived ability for the MPAs to enhance reef fish abundance differed between fishers and dive operators on West Hawaii ($U=1237.0$, $p<0.0001$, Table 1). There was no difference between these groups regarding their perceptions for the MPAs to alleviate conflict ($U=620.0$, $p=0.449$, Table 1). Dive operators perceived the MPAs were more effective for enhancing fish abundance than for alleviating conflict ($z=-4.379$, $p<0.0001$, Table 1), while fishers perceived the MPAs were more effective for alleviating conflict than for enhancing fish abundance ($z=3.436$, $p=0.0006$, Table 1).

The three perceived threat factors with the highest means and medians as reported by fishers were land-based development and pollution, invasive species and poor management, whereas aquarium fishing, land-based development and pollution, and poor management were the highest for dive operators (Table 2). Although both groups perceived poor management as a concern, dive operators more often perceived it as a greater threat (Table 3). Dive operators on West Hawaii ($n=38$) were more aware about aquarium fishing than their counterparts on Maui ($n=45$) ($U=1629.5$, $p=0.0175$).

Dive operators on both islands indicated they both occasionally encountered fishers ($U=1909.5$; $p=0.6990$). In contrast,

Table 1
Perceived MPA effectiveness for achieving conflict alleviation and fish abundance enhancement goals in West Hawaii.

	Fishers ($n=23$)		Diver operator ($n=34$)	
	Conflict alleviation (%)	Fish enhancement (%)	Conflict alleviation (%)	Fish enhancement (%)
Extremely ineffective	13.04	**39.13**	0.00	2.94
Ineffective	17.39	8.70	20.59	2.94
Neutral	**34.78**	30.43	**38.24**	14.71
Effective	26.09	17.39	35.29	**61.76**
Extremely effective	8.70	4.35	5.88	17.65

Table 2
Means and medians for perceived threats to coral reefs and fishes held by fishers and dive operators.

Threat	Fishers			Dive operators		
	Mean	Median	*n*	Mean	Median	*n*
Poor management	**3.30**	**3.00**	27	**4.33**	**5.00**	82
Invasive species	**4.07**	**4.50**	28	3.89	4.00	82
Thrownet fishing	2.39	2.00	26	3.03	3.00	80
Hook and line fishing	2.37	2.00	27	2.84	3.00	82
Aquarium fishing	2.29	2.00	28	**4.43**	**5.00**	83
Bottom fishing	2.62	2.50	26	3.11	3.00	81
Surround net fishing	2.78	2.00	27	3.48	3.00	79
Troll fishing	2.44	2.00	27	2.68	3.00	77
Spearfishing	3.00	3.00	27	2.74	2.00	80
Recreational overuse	3.22	3.00	27	3.00	3.00	82
Global warming/climate change	3.04	3.00	27	3.18	3.00	79
Land-based development/pollution	**4.25**	**4.00**	28	**4.35**	**5.00**	82
Natural oceanic processes	2.82	3.00	27	2.32	2.00	79

of the 23 West Hawaii fishers responses, 15 were above, 8 were equal to, and 0 were below the Maui fisher median value (Sign test median=1), which reflected reports of having no encounters with dive operators (p=0.0001). Fishers were more inclined to encourage all three fishing categories, while dive operators were more willing to encourage subsistence and recreational fishing but not commercial fishing (Table 4). Neither group indicated they would solely encourage commercial fishing.

The alpha values exceeded the minimum reliability criteria ($\geq$0.65) and therefore the value statements (e.g., V_1, V_2, and V_3) were reliably measuring the latent aquarium fish trade value orientation construct (Table 5). The other value statements (V_4, V_5, and V_6) did not meet the reliability criteria and were therefore omitted from further analyses.

The EFA extracted one factor that explained 69% of variation (eigenvalue=2.32; loadings: V_1=0.78, V_2=0.95, V_3=0.91), further confirming that the value statements measured the same construct. The CFA model revealed factor loadings $\geq$0.55 for all three statements with a CFI model fit value of 1.0, implying that the measured value statements were valid for describing the latent aquarium fish trade value orientation construct (Fig. 2). The value orientation held by Maui dive operators and fishers (U=325.0, p=0.0001) and West Hawaii dive operators and fishers (U=14070.0, $p<0.0001$) were both significantly different (Table 6).

Table 3
Top three perceived threats to Hawaii's coral reefs and fishes held by dive operators and fishers.

Threat factor	Divers (%)	Fishers (%)	U	p-value
Poor management	n=82	n=27	5093.0	<0.001
No threat	2.4	3.7		
Minor threat	1.2	18.5		
Moderate Threat	12.2	**40.7**		
Threat	29.3	18.5		
Serious threat	**54.9**	18.5		
Aquarium fishing	n=83	n=28	5588.0	<0.001
No threat	0	14.3		
Minor threat	3.6	**64.3**		
Moderate threat	10.8	10.7		
Threat	24.1	0		
Serious threat	**61.5**	10.7		
Land-based development/pollution	n=81	n=28	1467.5	0.56
No threat	0	0		
Minor threat	1.2	3.6		
Moderate threat	18.3	14.3		
Threat	24.4	35.7		
Serious threat	**56.1**	**46.4**		
Invasive species	n=82	n=28	4406.0	0.32
No threat	0	0		
Minor threat	13.4	14.3		
Moderate threat	17.1	14.3		
Threat	**36.6**	21.4		
Serious threat	32.9	**50.0**		

Table 4
Fisher and dive operator willingness to encourage three fishing categories.

	Fishers (n=27) (%)	Diver operators (n=69) (%)	$\chi 2$	p
Commercial	0.00	0.00	36.20	<0.001
Recreation	7.41	34.8		
Subsistence	7.41	**43.5**		
All of the above	**63.0**	7.25		
None of the above	22.2	14.5		

4. Discussion

Previous research on West Hawaii's MPA network has focused on examining its efficacy for enhancing reef fish abundance [58,39]. This study is the first to empirically examine the other goal for establishing West Hawaii's MPA network: conflict alleviation. Although multiple stakeholders frequently interact on West Hawaii's coast, this research focused on the interactions and conflict between commercial dive operators and aquarium fishers because of the historical tensions between these groups [22,34,43]. Our findings indicate that fishers and dive operators on West Hawaii were uncertain regarding the ability for the MPA network to alleviate conflict. The interisland within-group differences observed among fishers and dive operators was negligible. Dive operators on both islands held similar perceptions regarding the frequency they encountered fishers, believed aquarium fishing was a serious threat to the reef, would encourage recreational and subsistence fishing far more than commercial fishing, and shared similar value orientations toward the aquarium fish trade. In contrast, fishers on both islands believed land-based pollution and development were serious threats to the reef, strongly encouraged all three fishing categories, and shared similar value orientations toward the aquarium fish trade; however, fishers on

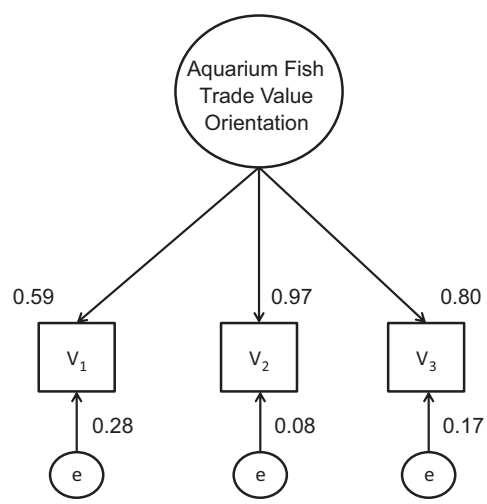

Fig. 2. Confirmatory factor analysis indicates single factor model validates value orientations toward the aquarium trade in Hawaii (CFI=1, e=error). The larger circle at the top represents the latent construct, while the smaller circles at the bottom are the error values for the measured value (V) variable. The error values differ from the latent factor because their effect is associated with only one measured variable. The straight line pointing from a latent construct to the measured value (V) variables indicates the correlation between the latent variable and the measured value (V) variables [56].

Table 5
Cronbach's alpha results for value orientations toward the aquarium fish trade.

Value orientation statements	$\bar{x}$	Item adj total correlation	Alpha (α) if deleted	Cronbach's α
Harvesting reef fish for commercial trade is wrong (V_1)	3.22	0.75	0.94	0.91
Reef fish belong on the reef, not in tanks (V_2)	3.39	0.90	0.82	
The trade in reef fishes is inhumane (V_3)	3.24	0.84	0.86	

Table 6
Median, range and sample size (n) for value orientation statement responses from fishers and dive operators on West Hawaii and Maui.

Value orientation statements	West Hawaii fishers (n=23)		West Hawaii dive operators (n=38)		Maui fishers (n=4)		Maui dive operators (n=45)	
	Median	Range	Median	Range	Median	Range	Median	Range
Harvesting reef fish for commercial trade is wrong (V_1)	1.0	1.0	5.0	4.0	1.5	3.0	4.0	4.0
Reef fish belong on the reef, not in tanks (V_2)	1.0	2.0	5.0	3.0	2.0	1.0	4.0	4.0
The trade in reef fishes is inhumane (V_3)	1.0	1.0	4.0	3.0	2.0	2.0	4.0	4.0

Maui perceived encountering dive operators less frequently than their West Hawaii counterparts. These within-group similarities and between-group differences likely explain the underlying and recurring conflict surrounding the aquarium fishery that is pervasive in Hawaii. The results are discussed below in the context of social values and interpersonal conflict, and the policy implications for managing conflict in nearshore marine environments are also described.

The difference between dive operators' perceptions regarding MPA effectiveness in enhancing reef fish populations and those of fishers was significant, with the former perceiving MPAs as markedly more effective. Williams et al. [39] showed significant increases in reef fish abundance inside West Hawaii MPAs and declines were noted in areas that remained open to the aquarium fishery. Anecdotal evidence suggests most commercial dive operators use state-deployed moorings located inside many of West Hawaii's MPAs. Conversely, harvesting reef fish for the aquarium fishery is prohibited in all the MPAs and therefore fishers operate in the remaining coastal areas; the same areas where declines in reef fish were detected. Therefore, it was not surprising that dive operators perceived the MPAs as more successful for enhancing reef fish populations than do fishers in West Hawaii.

Although dive operators perceived that the MPA network enhanced reef fish populations in West Hawaii, this study revealed more uncertainty from dive operators and fishers regarding the ability of the MPA network to alleviate conflict. This was unexpected given that the MPA network partitioned the coastline and forced fishers to move farther north and south to areas less frequented by commercial dive operators [59]. Thus, it appears that spatially separating opposing user groups may reduce interpersonal conflict, but its efficacy for managing conflict remains questionable when social values differences between groups prevail [5].

Dive operators' perceptions regarding encounters with fishers were similar on both islands despite the prevalence of more fishers on West Hawaii relative to Maui. West Hawaii fishers occasionally encountered dive operators while fishing; Maui fishers indicated they never encountered them. These findings were unexpected because there are significantly more dive operators on both islands than fishers and therefore it was expected fishers would have reported higher encounters with divers. It is possible that Maui dive operators have a heightened awareness to the presence of fishers due to the anti-aquarium trade campaign and therefore may identify them more regularly. Alternatively, fisher misidentification may occur more frequently on Maui because aquarium fishing boats are not marked with "AQ" stickers and flags as required in West Hawaii.

It is difficult to definitively conclude whether the MPA network on West Hawaii reduced encounters between these stakeholders, as it appears they still occur, which implies that sustained or recurring conflict between these groups is possible. The locations of encounters were not evaluated, but given that many fishers in West Hawaii use harbors that are often within or adjacent to MPAs [59], which is where many dive operators take their clients, it is likely these groups frequently encounter each other in transit to or from dive/fishing sites or at the harbors. These types of encounters will unlikely change and are difficult to avoid, but even if they could be avoided conflict could still persist.

The coral reefs surrounding the state of Hawaii have sustained significant deleterious impacts from fishing (including aquarium fishing), invasive species, climate change, coral diseases, recreational overuse, coastal development and runoff, and coastal pollution [36,42,60]. Therefore, neither group mistakenly identified threats to the coral reefs and fish for West Hawaii and Maui, but surprisingly dive operators on both islands perceived aquarium fishing as one of the three principal threats. This is certainly not the case on Maui where threats to the coral reef ecosystem from anthropogenic eutrophication are more significant concerns [61].

Environmental activism may explain why dive operators on Maui perceived aquarium fishing as a primary threat. Hard-line animal rights activists on Maui, who vehemently oppose the aquarium fish trade, implemented an aggressive anti-aquarium fishing campaign in an attempt to garner support for their legislative agenda aimed at banning the fishery state-wide. Although it is plausible that this campaign influenced Maui dive operator awareness about this fishery, the level of awareness held by their counterparts on West Hawaii was significantly higher, so it is unlikely the anti-aquarium fishing campaign solely influenced respondents' perceptions. It appears that the hard line opposition to the aquarium trade, originating in Maui, actually galvanized West Hawaii residents. This may have occurred because residents on West Hawaii, particularly those involved in the West Hawaii Fishery Council, worked tirelessly to develop a co-operative approach to managing their nearshore marine resources. These efforts included dive operators and fishers. The attempts, by people from Maui, to dismantle this co-management system may have engendered resentment from people on West Hawaii. Investigating how community cohesiveness strengthens co-management regimes in a U.S. context is warranted, particularly in West Hawaii.

Dive operators and fishers on both islands identified poor management as a threat to Hawaii's reefs. As part of Act 306, West Hawaii residents cultivated a co-management environment for its nearshore marine resources [34]. Conversely, a similar approach for managing the nearshore marine resources on Maui remains absent [42]. Co-management approaches for managing marine resources are an effective strategy for long-term success [62,63]. Therefore, it was surprising that both groups on West Hawaii indicated poor management as a threat. This could be explained by two factors. First, Jentoft et al. [64] argued that fisheries co-management requires communal values that are rare in industrialized and increasingly globalized fisheries. Perhaps social value and worldview contradictions held by these user groups influenced their perception about the effectiveness of the co-management approach. Second, Tissot [33] identified fisheries law enforcement as a limitation for managing nearshore marine resources in Hawaii. It is therefore possible that respondents conflated inadequate fisheries law enforcement with poor management, an understandable confusion because these responsibilities are performed by two distinct divisions who operate within the same department in Hawaii's state government.

It was expected that fishers would encourage all fishing categories, but having dive operators show such strong reluctance to encourage commercial fishing was unanticipated. Dive operators were more willing to encourage recreational and subsistence fishing than commercial, yet evidence suggests that global fish stocks are threatened by recreational and commercial fishing [65,66]. This implies some level of bias against commercial fishing by dive operators. Commercial fishers are often viewed by opponents as predatory profit maximizers who act in self-interest [2]. Similar assertions about aquarium fishers were expressed by dive operators and may have contributed to their unwillingness to encourage commercial fishing. Unexpectedly, fishers were also slightly more inclined than dive operators to not encourage all three fishing categories. Although it is unclear why this was the case, it seems sensible for fishers to believe that encouraging other people to fish would result in greater competition and diminish economic incentives, particularly in an open access fishery [67].

There are myriad regional similarities and differences between West Hawaii and Maui that could influence the results of this research. One difference between these islands was the existence, on West Hawaii, of an MPA network that aimed to minimize conflict between aquarium fishers and dive operators. In the absence of any well-documented baseline prior to implementing the MPA network, it is difficult to conclusively argue whether it was effective for achieving its conflict mitigation goal. The MPA network spatially separated dive operators and fishers in West Hawaii [59], which may have diminished interpersonal conflict between these groups; however, the polarized value orientations toward the aquarium fish trade held by these groups on both islands implies some fundamental level of incompatibility. Spatially separating these groups will likely not resolve the recurring conflict that has occurred in West Hawaii since the late 1970s [43].

The perceptions of conflict between dive operators and aquarium fishers on Maui and West Hawaii also appear asymmetrical. Fishers on Maui reported never encountering dive operators and did not perceive them as a threat to the coral reef ecosystem. Although fishers on West Hawaii occasionally encountered dive operators, they also did not perceive them as a threat to the coral reef ecosystem. These responses by fishers on both islands suggest that they did not experience interpersonal or social values conflict with dive operators (Table 1). Conversely, dive operators on both islands claimed to occasionally encounter fishers and perceived them as a serious threat to Hawaii's coral reef ecosystem. It is possible that dive operators experienced both interpersonal and social values conflict with fishers on Maui and West Hawaii; however, dive operators have strong opposition to the aquarium fish trade as expressed in their value orientation toward it, implying that social values conflict with fishers is likely the principal driving force behind their opposition to the trade.

It is unclear where the strong value orientation against the aquarium trade held by dive operators originates. It is possible that some underlying values observed in traditional Hawaiian culture, that prohibited the harvest of marine resources for personal gain, influences state residents today [33]. For example, *mālama kai*, or serving and caring for the sea, is a value that traditional Hawaiian society upheld, and that is still widely invoked and embraced by state residents today. Another reasonable explanation is the self-selecting nature of each group which attracts people who hold a shared worldview toward the environment. Needham [9] found that many people participating in Hawaii's dive tour industry held a similar "biocentric" worldview toward the environment. This worldview is likely at odds with the more utilitarian one held by many commercial fishers, such as aquarium fishers in Hawaii. The cultural cognition hypothesis argues that worldviews held by specific groups reflect and reinforce their commitments to particular visions of the ideal society, which persist even when education, income, personality type and ideology are controlled [68]. Different worldviews likely explain the contrasting value orientations toward the aquarium trade held by fishers and dive operators in Hawaii.

There are a number of social factors in the state of Hawaii that may contribute to the aquarium fish trade conflict. The state experienced rapid human population growth and major coastal development that grew the tourism industry between the 1950s and 1970s [69,70]. Presumably these changes led to a growing level of affluence, education and urbanization that could have resulted in communities demanding stronger environmental protection [71,72]. This hypothesis is supported by the expanding number of MPAs implemented in Hawaii since the 1970s and the strong mutualistic worldview toward wildlife and the environment held by the state's residents [71,73]. These changes occurred while the state became increasingly dependent on the tourism industry, and specialized economies can cause entrenched conflict over resource allocation, particularly when the goal of one group conflicts with that of another [74].

These findings are relevant from a policy perspective because of the bourgeoning interest in deploying co-management strategies that use MPAs for managing common pool marine resources conflict. Adams et al. [4] believe policy debates around managing common pool resources, such as many marine fisheries, are often flawed because people involved frequently assume that others share their perspective regarding the particular problem discussed. Implementing co-management strategies that use MPAs remains a viable and effective approach when differing worldviews and values held by stakeholders are identified and understood [75]. Understanding and acknowledging these differences may help prevent more influential stakeholders from monopolizing the dialogue or process associated with co-management efforts. Co-management institutions that are ineffective at managing conflict may result in perceptions of inequality or injustice among the stakeholders that can then derail even the most well-intentioned effort [3,76]. Having equitably-delineated rights, community management systems with clear leadership, and fair law enforcement will help strengthen co-management regimes [3,63]. Therefore, marine resource managers should perform some baseline conflict assessment, prior to implementing MPAs, to examine the impacts from these interventions, presumably using a before-after-control-impact observational design whenever possible.

5. Conclusions

Although there were many interisland within-group similarities between fishers and dive operators on Maui and West Hawaii, it does not appear that the observed differences detected among these groups resulted from the MPA network in West Hawaii. The significant difference in value orientations toward the aquarium fish trade held by these groups appears as the primary factor contributing to the recurring conflict between them. Thus, spatially separating aquarium fishers and dive operators via MPAs is unlikely to be an effective long-term strategy for managing social values conflict in Hawaii. The MPAs may intermittently quell tensions between stakeholders, as they did after Act 306 was implemented on West Hawaii, but as both industries, particularly the dive tour industry, cycle through employees, tensions may periodically return as they have in recent past when high profile fishing violations were publicized.

More research is needed to understand whether social values conflict is prevalent in other fisheries, or if it is unique to the tropical aquarium fish trade. Opposition toward the aquarium fish trade in Hawaii might reflect a western value that may not exist

in other societies, particularly in places like the Philippines and Indonesia where most reef fish for the aquarium trade originate and where utilitarian lifestyles are more the norm. Additionally, although education and outreach campaigns were identified as best practice for resolving social values conflict [6], longitudinal research in this arena is needed to determine the effectiveness of these approaches. Last, additional research is needed to understand how differing values and worldviews between stakeholders influence conflict dimensions surrounding marine spatial management and co-management efforts.

It is essential to recognize that conflict should not always be perceived as something negative. Conflict may result in reconciliation that reflects society's resilience for coping with change [3]; however, achieving this result requires institutional capacity for preemptively dealing with conflict before, during and after tension arises. Performing stakeholder conflict evaluations before marine spatial management strategies are enacted is a valid first step for potentially predicting and resolving future marine resource conflict.

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References

[1] Caddy JF, Cochrane KL. A review of fisheries management past and present and some future perspectives for the third millennium. Ocean Coast Manage 2001;44:653–682.
[2] Charles AT. Fishery conflicts; a unified framework. Marine Policy 1992;16: 379–393.
[3] Bennett E, Neiland A, Anang E, Bannerman P, Rahman AA, Huq S, et al. Towards a better understanding of conflict management in tropical fisheries: evidence from Ghana, Bangladesh and the Caribbean. Marine Policy 2001;25: 365–376.
[4] Adams WM, Brockington D, Dyson J, Vira B. Managing tragedies: understanding conflict over common pool resources. Science 2003;302:1915–1916.
[5] Vaske JJ, Donnelly MP, Wittmann K, Laidlaw S. Interpersonal versus social-values conflict. Leisure Sci 1995;17:205–222.
[6] Vaske JJ, Needham MD, Cline RC. Clarifying interpersonal and social values conflict among recreationists. J Leisure Res 2007;39:182–195.
[7] Carothers P, Vaske JJ, Donnelly MP. Social values versus interpersonal conflict among hikers and mountain bikers. Leisure Sci 2001;23:47–61.
[8] Fulton DC, Manfredo MJ, Lipscomb J. Wildlife value orientations: a conceptual and measurement approach. Hum Dimens Wildl 1996;1:24–47.
[9] Needham MD. Value orientations toward coral reefs in recreation and tourism settings: a conceptual and measurement approach. J Sustainable Tourism 2010;18:757–772.
[10] Jacob GR, Schreyer R. Conflict in outdoor recreation: a theoretical perspective. J Leisure Res 1980;12:368–380.
[11] Donnelly MP, Vaske JJ, Whittaker D, Shelby B. Toward an understanding of norm prevalence: a comparative analysis of 20 years of research. Environ Manage 2000;25:403–414.
[12] Trist C. Recreating ocean space: recreational consumption and representation of the Caribbean marine environment. Prof Geogr 1999;51:376–387.
[13] Oracion EG, Miller ML, Christie P. Marine protected areas for whom? fisheries, tourism, and solidarity in a Philippine community Ocean Coast Manage 2005;48:393–410.
[14] Majanen T. Resource use conflicts in Mabini and Tingloy, the Philippines. Marine Policy 2007;31:480–487.
[15] Fabinyi M. The intensification of fishing and the rise of tourism: competing coastal livelihoods in the Calamianes islands, Philippines. Hum Ecol 2010;38:415–427.
[16] Bunce L, Gustavson K. Coral reef valuation: a rapid socioeconomic assessment of fishing, watersports, and hotel operations in the Montego Bay Marine Park, Jamaica and an analysis of reef management implications. World Bank Research Committee Project #RPO 1998:605–681.
[17] Masalu D. Coastal and marine resource use conflicts and sustainable development in Tanzania. Ocean Coast Manage 2000;43:457–494.
[18] Sandersen HT, Koester S. Co-management of tropical coastal zones: the case of the Soufriere Marine Management Area, St. Lucia, WI. Coast Manage 2000;28:87–97.
[19] Baine M, Howard M, Kerr S, Edgar G, Toral V. Coastal and marine resource management in the Galapagos Islands and the Archipelago of San Andres: issues, problems and opportunities. Ocean Coast Manage 2007;50:148–173.
[20] Lynch TP, Wilkinson E, Melling L, Hamilton R, Macready A, Feary S. Conflict and impacts of divers and anglers in a marine park. Environ Manage 2004;33:196–211.
[21] Dobrzynski T.J., Nicholson E.E. User group perceptions of the short-term impacts of marine reserves in Key West. In: Proceedings of the ninth international coral reef symposium, Bali, 23–27 October 2000, 2002, vol. 2. p. 759–63.
[22] Capitini CA, Tissot BN, Carroll MS, Walsh WJ, Peck S. Competing perspectives in resource protection: the case of marine protected areas in West Hawai'i. Soc Nat Resourc 2004;17:763–778.
[23] Harrison HB, Williamson DH, Evans RD, Almany GR, Thorrold SR, Russ GR, et al. Larval export from marine reserves and the recruitment benefit for fish and fisheries. Curr Biol 2012;22:1023–1028.
[24] Bohnsack J. Marine reserves: they enhance fisheries, reduce conflicts, and protect resources. Oceanus 1993;36:63–71.
[25] Wood E. Global advances in conservation and management of marine ornamental resources. Aquarium Sci Conserv 2001;3:65–77.
[26] Day JC. Zoning—lessons from the Great Barrier Reef Marine Park. Ocean Coast Manage 2002;45:139–156.
[27] Suman D, Shivlani M, Milon JW. Perceptions and attitudes regarding marine reserves: a comparison of stakeholder groups in the Florida Keys National Marine Sanctuary. Ocean Coast Manage 1999;42:1019–1040.
[28] Broad K, Sanchirico JN. Local perspectives on marine reserve creation in the Bahamas. Ocean Coast Manage 2008;51:763–771.
[29] Tissot BN, Best BA, Borneman EH, Bruckner AW, Cooper CH, D'Agnes H, et al. Ocean policy and market power can reform the coral reef wildlife trade. Marine Policy 2010;34:1385–1388.
[30] Wabnitz C, Taylor M, Green E, Razak T. From Ocean to Aquarium. Cambridge, UK: UNEP World Conservation Monitoring Centre, UNEP-WCMC; 2003.
[31] Bruckner AW. The importance on the marine ornamental reef fish trade in the wider Caribbean. Rev Biol Trop 2005;53:127–138.
[32] Walsh WJ, Cotton SP, Dierking J, Williams ID. The commercial marine aquarium fishery in Hawai'i 1976–2003. In: Friedlander AM, editor. Status of Hawaii's coastal fisheries in the new millennium, rev. edn. Hawaii Chapter, Honolulu: American Fisheries Society; 2004. p. 132–158 230 pp.
[33] Tissot BN. Integral marine ecology: community-based fishery management in Hawaii. World Futures 2005;61:79–96.
[34] Tissot BN, Walsh WJ, Hixon MA. Hawaiian Islands marine ecosystem case study: ecosystem and community-based management in West Hawaii. Coast Manage 2009;37:255–273.
[35] Tissot BN, Hallacher LE. Effect of aquarium collectors on coral reef fishes in Kona, Hawaii. Conserv Biol 2002:1759–1768.
[36] Walsh WJ. Community-based management of a Hawai'i aquarium fishery marine ornamentals '99. Waikoloa: Hawaii; 1999 p. 83–7.
[37] Talbot R. Senate Bills Call for Complete Ban on Sale of Hawaiian Aquatic Life. CORAL Magazine 2012〈http://www.coralmagazine-us.com/content/senate-bills-call-complete-ban-sale-hawaiian-aquatic-life〉, Retrieved April 18, 2012.
[38] Tablot R. Extremists Call for Ban on All Aquarium Livestock Collection in Hawaii. CORAL Magazine 2011〈http://www.coralmagazine-us.com/content/extremists-call-ban-all-aquarium-livestock-collection-hawaii〉, Retrieved April 18, 2012.
[39] Williams ID, Walsh WJ, Claisse JT, Tissot BN, Stamoulis KA. Impacts of a Hawaiian marine protected area network on the abundance and fishery sustainability of the yellow tang, *Zebrasoma flavescens*. Biol Conserv 2009;142:1066–1073.
[40] Talbot R. Hawaiian politicians seek to ban or curtail aquarium collection. CORAL Magazine 2011〈http://www.coralmagazine-us.com/content/hawaiian-politicians-seek-ban-or-curtail-aquarium-collection〉, Retrieved April 18, 2012.
[41] Williams ID, Walsh WJ, Schroeder RE, Friedlander AM, Richards BL, Stamoulis KA. Assessing the importance of fishing impacts on Hawaiian coral reef fish assemblages along regional-scale human population gradients. Environ Conserv 2008;35:261–272.
[42] Maui Coral Reef Recovery Team. Ola Nā Papa i Mālama 'Ia: A practical plan for the technical and cultural restoration of Maui's Coral Reefs. Maui Nui Marine Resource Council; 2012 (587 pp.).
[43] Maurin P, Peck S. The West Hawai'i fisheries council case study report. University of Hawai'i Sea Grant College Program; 2008.
[44] Cinner JE, McClanahan TR, Graham NAJ, Daw TM, Maina J, Stead SM, et al. Vulnerability of coastal communities to key impacts of climate change on coral reef fisheries. Global Environ Change 2012;22:12–20.

[45] Biernacki P, Waldorf D. Snowball sampling: problem and of using nonrandom sampling methodologies. Sociol Meth Res 1981;10:141–163.
[46] Stevenson TC, Tissot BN, Dierking J. Fisher behaviour influences catch productivity and selectivity in West Hawaii's aquarium fishery. ICES J Mar Sci 2011;68:813–822.
[47] Siegel S, Castellan NJ. Nonparametric statistics for the behavioural sciences. New York: McGraw-Hill; 1988.
[48] Nachar N. The Mann–Whitney *U*: a test for assessing whether two independent samples come from the same distribution. Tutorials Quant Meth Psychol 2008;4:13–20.
[49] de Winter JCF, Dodou D. Five-point Likert items: *t* test versus Mann–Whitney–Wilcoxon. Pract Assess Res Eval 2010;15:1–12.
[50] Cortina JM. What is coefficient alpha? An examination of theory and applications J Appl Psychol 1993;78:98–104.
[51] Vaske JJ. Survey research and analysis: applications in parks, recreation and human dimensations. State College, PA: Venture Publishing; 2008.
[52] Doornik JA, Hansen H. An omnibus test for univariate and multivariate normality. Oxford Bull Econ Stat 2008;70:927–939.
[53] Mardia KV. Measures of multivariate skewness and kurtosis with applications. Biometrika 1970;57:519–530.
[54] Satorra A, Bentler PM. Corrections to test statistics and standard errors in covariance structure analysis. In: von Eye A, Clogg CC, editors. Latent variables analysis. Thousand Oaks, CA: Sage; 1994. p. 399–419.
[55] DiStefano C, Hess B. Using confirmatory factor analysis for construct validation: an empirical review. J Psychoedu Assess 2005;23:225–241.
[56] Tanguma J. Effects of sample size on the distribution of selected fit indices: a graphical approach. Educ Psychol Meas 2001;61:759–776.
[57] Schreiber JB, Nora A, Stage FK, Barlow EA, King J. Reporting structural equation modeling and confirmatory factor analysis results: a review. J Educ Res 2006;99:323–338.
[58] Tissot BN, Walsh WJ, Hallacher LE. Evaluating effectiveness of a marine protected area network in West Hawai'i to increase productivity of an aquarium fishery. Pacific Sci 2004;58:175–188.
[59] Stevenson TC, Tissot BN, Walsh W.J. Socioeconomic consequences of fishing displacement from a network of marine protected areas in Hawaii. Biol Conserv, in press.
[60] Friedlander, AM, Aeby G, Brown E, Clark A, Coles S, Dollar S., et al. The state of coral reef ecosystems of the Main Hawaiian Islands. In: The state of coral reef ecosystems of the United States and Pacific freely associated States, 2005. In: Waddell J. NOAA Technical Memorandum NOS NCCOS 11. NOAA/NCCOS Center for Coastal Monitoring.
[61] Dailer ML, Knox RS, Smith JE, Napier M, Smith CM. Using δ15N values in algal tissue to map locations and potential sources of anthropogenic nutrient inputs on the island of Maui, Hawai'i, USA. Mar Pollut 2010;60:655–671.
[62] Cinner JE, McClanahan TR, MacNeil MA, Graham NAJ, Daw TM, Mukminin A, et al. Comanagement of coral reef social-ecological systems. PNAS 2012;109: 5219–5222.
[63] Gutierrez NL, Hilborn R, Defeo O. Leadership, social capital and incentives promote successful fisheries. Nature 2011;470:386–389.
[64] Jentoft S, McCay BJ, Wilson DC. Social theory and fisheries co-management. Marine Policy 1998;2:423–436.
[65] Coleman FC, Figueira WF, Ueland JS, Crowder LB. The impact of United States recreational fisheries on marine fish populations. Science 2004;305: 1958–1960.
[66] Cooke SJ, Cowx IG. Contrasting recreational and commercial fishing: searching for common issues to promote unified conservation of fisheries resources and aquatic environments. Biol Conserv 2006;128:93–108.
[67] Beddington JR, Agnew DJ, Clark CW. Current problems in the management of marine fisheries. Science 2007;316:1713–1716.
[68] Kahan DM. Cultural cognition as a conception of the cultural theory of risk. In: Roeser S, Hillerbrand R, Sandin P, Peterson M, editors. Handbook of risk theory: epistemology, decision theory, ethics, and social implications of risk. New York, NY: Springer; 2012. p. 132–158 725–760.
[69] Bardolet E, Sheldon PJ. Tourism in archipelagos: Hawai'i and the Balearics. Ann Tourism Res 2008;35:900–923.
[70] Kittinger JN, Pandolf JM, Blodgett JH, Hunt TL, Jiang H, Maly K, et al. Historical reconstruction reveals recovery in Hawaiian coral reefs. PLoS One 2011;6:e25460.
[71] Teel TL, Dayer AA, Manfredo MJ, Bright A.D. Regional results from the research project entitled "Wildlife Values in the West." (Project Rep. No. 58). Project report for the Western Association of Fish and Wildlife Agencies. Fort Collins, CO: Colorado State University, Human Dimensions in Natural Resources Unit; 2005.
[72] Cinner JE, McClanahan TR, Daw TM, Graham NAJ, Maina J, Wilson SK, et al. Linking social and ecological systems to sustain coral reef fisheries. Curr Biol 2009;19:206–212.
[73] US National Ocean Service. National Marine Protected Areas Center. www.mpa.gov (accessed 27 April 2012).
[74] Cinner J, Bodin O. Livelihood diversification in tropical coastal communities: a network-based approach to analyzing 'livelihood landscapes'. PLoS ONE 2010;5:e11999.
[75] Gelcich S, Edwards-Jones G, Kaiser MJ. Importance of attitudinal differences among artisanal fishers toward co-management and conservation of marine resources. Conserv Biol 2005;19:865–875.
[76] Christie, P. Marine protected areas as biological successes and social failures in Southeast Asia. In: Shiple JB, editor. Aquatic protected areas as fisheries management tools: design, use, and evaluation of these fully protected areas. Bethesda, MD: American Fisheries Society; 2004. p. 155–64.