Marine Policy 103 (2019) 59–67

Contents lists available at ScienceDirect

Marine Policy

journal homepage: www.elsevier.com/locate/marpol

Socio-economic impacts of marine conservation efforts in three Indonesian fishing communities

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A B S T R A C T

Numerous conservation initiatives have been undertaken to protect large marine animals by legal protection and implementing marine protected areas (MPAs). Despite these efforts, many marine animals are still threatened, partly due to lack of compliance with conservation regulations. Meanwhile, research suggests that conservation efforts which also take socio-economic factors such as fishermen's livelihoods into account during planning and implementation are more likely to succeed. This study examined the compliance and socio-economic situation of local fishing communities at three sites in Indonesia (Nusa Penida, Tanjung Luar and Komodo National Park) where shark and manta ray conservation efforts have been implemented. 59 local residents were interviewed. The results showed that 49% of those residents had experienced a deterioration and 37% an improvement in their economic situation since conservation efforts in the form of species protection or MPAs were implemented in their area. The economic situation of the residents was associated with their access to alternative livelihoods, access to information on conservation rules, and relationship with conservation authorities. Particularly, interviewees with easier access to alternative income and a positive relationship with conservation authorities also experienced an increase in their economy. In addition, compliance with conservation efforts was positively related to improved economic situation, access to alternative livelihoods and information on conservation rules. These factors all differed among the three study sites, leading to different compliance levels between sites. The results of this study indicate the importance of considering socio-economic factors and of involving local communities when planning and implementing conservation efforts.

1. Introduction

Shark and ray populations have faced widespread declines in recent years [1], and these declines are also reported by fisheries on a national level [2]. A major reason is the high demand for shark fins used for traditional food in the Asian market [3,4], and manta ray gill plates which are marketed as traditional treatment for a wide variety of conditions [5,6].

Targeted shark fishing is the main source of livelihood for many fisheries in eastern and southern Indonesia [5]. Indonesia has the highest number of annual shark landings in the world and is one of the largest exporters of shark fins [7]. Declining numbers and sizes of caught sharks, as well as high catch rates of CITES-listed species, suggest that catch rates in the country are unsustainable [8,9]. Furthermore, Indonesia has some of the most aggressive targeted fisheries for manta rays [5]. Fishermen have recently observed declining numbers and sizes of caught manta ray specimen [10].

To facilitate conservation of these species, numerous conservation initiatives have been taking place in the country. One potential way to halt and perhaps even reverse population declines of sharks and manta rays is to implement Marine Protected Areas (MPAs) around their habitats. Manta ray sanctuaries were established in Indonesia in the Marine Protected Areas (MPAs) in Raja Ampat in 2012, Komodo National Park in 2013, and Nusa Penida in 2013, as a tool to facilitate conservation of the species [5]. In addition, the reef manta ray (*Mobula alfredi*) and the oceanic manta ray (*M. birostris*) were listed as a CITES endangered species in 2013 and the Indonesian government declared them as protected in 2014 [5]. Whale sharks (*Rhincodon typus*) also gained legal protection status in Indonesia in 2014, and export was simultaneously prohibited on five shark species listed as endangered [8].

A Marine Protected Area (MPA) is a “clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values” [11]. They have been popular instruments globally for addressing stresses to coral reef systems such as overfishing, and at the same time to foster alternative livelihoods within the region [12]. Studies on oceanic manta rays in the Indo-Pacific [13] and studies on reef manta rays in Australia [14] show a high degree of residency and predictable aggregation sites in their movement patterns, which suggests that MPA-type protection methods are effective for protection of these species. In addition, shark sanctuaries in Raja Ampat have led to rapid recovery of shark populations targeted by fishing [1]. The migratory nature of sharks and the

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https://doi.org/10.1016/j.marpol.2019.02.007
Received 21 June 2018; Received in revised form 5 January 2019; Accepted 7 February 2019

probability of capture outside borders has, however, been an issue for protection in MPAs in Australia [15].

Although MPAs have a high potential to influence local communities, they are in most cases only framed from a biological perspective [16]. MPA evaluations commonly neglect their social impacts [17], which may lead to situations where the objectives of an MPA may initially conflict with the interests of local users [18]. This can be particularly severe when introduction of the MPA is done without consideration given to its potential impacts on local communities. Previous research has shown that top-down, hierarchical governance approaches tend to be ineffective in achieving conservation aims [18,19]. The local context is important to consider in marine conservation governance, and a mix of top-down and bottom-up governance instruments may sometimes be more successful than a pure top-down approach [20,21]. Empirical findings coupled with theoretical perspectives have been advocating involvement of bottom-up, local governance systems in implementing conservation initiatives. One term for such governance models is collaborative management, or co-management, which emphasizes pragmatism and balance between state and market actors [18].

Conservation efforts that include local residents in related economic activities have been shown to facilitate reaching environmental objectives [22,23]. For example, an MPA designed to alleviate fishermen poverty in North Sulawesi, Indonesia proved to have a positive effect on their economic situation. In addition, dependency on fishing for livelihood was initially reduced, leading to better conservation outcomes [24]. However, some studies have shown that proposed alternative livelihoods, in this case mariculture, need to be accepted by coastal communities when conservation efforts are introduced, in order to be successful [25]. Fishermen unwilling to drop fishing entirely listed economic profits as one of the major factors for not doing so [25]. Dive tourism has also proven to generate substantial economic benefits, such as the economic value generated from shark diving in Palau. Here, a nation-wide shark sanctuary has been in place since 2009 and shark tourism accounts for more than 8% of Palau's GDP [26]. Similarly, manta ray diving in Indonesia has an estimated annual value of close to US$10.7 million, while the total annual income from manta ray fisheries is estimated at approximately US$442,000 [23]. Tourism development may, however, lead to exclusion of small-scale local users, meaning that social justice aspects need to be considered, with particular focus on directing the benefits from increased tourism to the local actors who actually bear the costs of conservation [18,27,28].

Because of the economic importance of shark and manta ray fishing to some Indonesian fishing communities [5], it is likely that efforts to conserve these species will have a considerable impact on people's livelihoods. It is therefore important to include fishing communities as stakeholders during the implementation of MPAs and other forms of marine conservation, in order to understand their situation and interests. This can in turn prevent potential conflicts of interest and increase the likelihood of fishing communities complying with conservation rulings. Stakeholders are both those who are affected by, or can affect, a decision [29] and individual persons, groups and institutions with vested interests in an intervention [30]. Participation is a process where individuals, groups or larger organizations affected by certain decisions, take an active role in forming them [31]. Because of the potential environmental and conservation gains, stakeholder participation is increasingly being seen as an important component of environmental decision-making processes. It is argued that involving stakeholders will not only increase fairness in decisions, but also improve the quality and durability of decision-making, as well as compliance with decisions taken [32,33]. Such a process can promote local ownership and cooperation. It can generate a sense of responsibility and stewardship for natural resources, harnessing local knowledge of the area and facilitating obtainment of feedback on conservation management [18]. Furthermore, if the process of involving stakeholders is of good quality it is more likely that the complexity of human-environmental interactions will be recognized [34]. Participation can likewise empower stakeholders through co-generation of knowledge with researchers and an increased capacity to use this knowledge [35]. For these reasons, public participation is seen as vital to achieving conservation goals in MPA planning [36]. IUCN has stated that MPA management should involve local fishermen in its establishment and zoning, and that fishermen should also contribute to control and surveillance [36]. If the processes that stakeholders participate in are not well run, they can develop consultation fatigue as they perceive that their involvement generates little reward or influence on decision making [37]. For example, a study on two MPAs in Aceh, Indonesia found that a sense of low participation and low trust in government from fishermen correlated with illegal fishing activities [38]. Finally, stakeholder participation can facilitate trust building between fishers and management authorities, a factor that has been revealed as necessary for successful implementation of marine conservation initiatives [39].

While there is a potential economic argument in favor of manta ray-watching tourism compared to manta ray fishing [23], there is a need for social science studies on how the efforts to protect manta rays and sharks affect the socio-economic situation for the local communities [40]. Equity aspects are often central to how fishermen react to MPA proposals, making research on such aspects a priority. Particularly, the restrictions on fishing that many MPAs impose mean that fishermen often bear many of the costs of MPAs while gaining few of the benefits [18]. In addition, local people lacking the proper qualifications to work in the tourism industry, such as language fluency or vehicle ownership, may have trouble accessing the potential economic benefits from it [41]. Thus there have been concerns that MPAs can become vehicles for marginalizing local people while benefitting tourism interests, the state and NGOs [18]. This can lead to resentment towards both local tourism and nature conservation [41]. Although alternative livelihoods, including tourism, have been promoted as a way to offset opportunity costs faced by locals and increase their compliance [18], tropical artisanal fisheries have at times been marginalized by eco-tourism businesses, who benefit from preserving fish populations and species within MPAs [28]. Marginalized people can represent a threat to conservation objectives [18], as potential negative effects on local people's economy may affect their compliance with the conservation rules. Obtaining a better understanding of the socio-economic situation for fishing communities is therefore critical to ensure sustainable conservation and management of manta rays [10,23] and sharks [42].

The aim of this study is twofold. First to investigate how the shark and manta ray conservation efforts described above have affected local fishing communities socio-economically. Second to explore if the changes to their livelihoods, as well as their perception of the conservation processes, have affected their compliance with the conservation efforts. Members of fishing communities in three different regions of Indonesia, sharing a common resource pool in the form of sharks and manta rays while facing different conservation methods, were interviewed to gain insight into these questions.

2. Methods

2.1. Study sites

The study was done by conducting field interviews in fishing communities in three different regions of Indonesia: Nusa Penida located southeast of Bali, Tanjung Luar village on southeast Lombok, and Komodo National Park (Fig. 1). The three case sites, and the conservation efforts being implemented in them, have been summarized (Table 1). Studies using photo identification have proven that reef manta rays (*M. alfredi*) migrate between the Komodo and Nusa Penida MPAs, which are two of the most economically important destinations for manta ray tourism in Indonesia [5]. Because Lombok island is located in between these MPAs, the fisheries of Tanjung Luar pose a

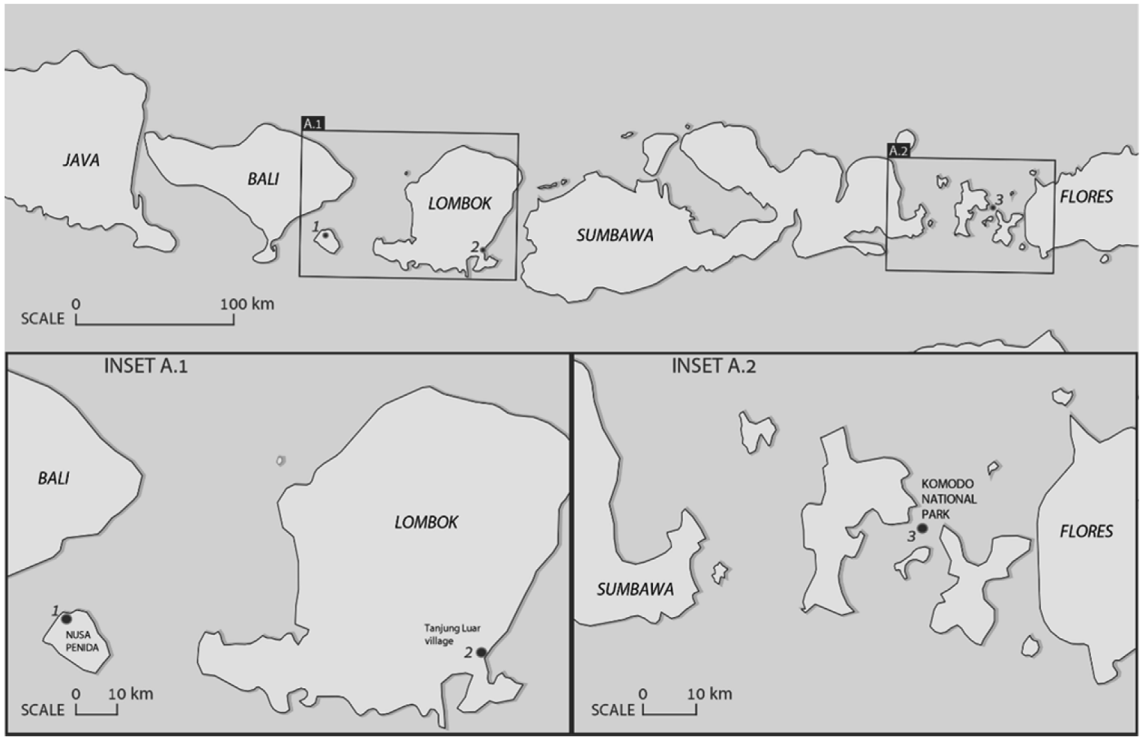

Fig. 1. Map displaying study case sites in Bali, West Nusa Tenggara, and West Manggarai regions. Case sites are numbered as follows: 1) Nusa Penida 2) Tanjung Luar village 3) Komodo National Park. Reef manta rays are proven to travel between case sites 1) and 3), while 2) is one of Indonesia's largest manta ray fisheries [5].

potential threat to the manta rays moving between the two regions and subsequently to their economic operations [5,10]. Shark fishing is also an important source of employment in Tanjung Luar, especially for women [43].

The Nusa Penida MPA spans over 200 square kilometres [5], covering the waters around Nusa Penida, Nusa Lembongan, and Nusa Ceningan islands. The MPA was declared in 2010 to protect the high levels of marine biodiversity, in particular megafauna like the manta rays. It was also meant to protect the livelihoods of the local communities who depend on marine resources for their livelihood [44]. In 2013 it was declared a manta ray sanctuary [5]. A majority of the 46,000 residents depend on regional marine biodiversity for their daily survival, and about 850 residents have fishing as their main livelihood [45]. The MPA has a zoning system which is designed to cater to the different interests of stakeholders [44].

Tanjung Luar village is located in the southeast parts of Lombok, Nusa Tenggara. It has been labelled as the biggest shark fishery in Indonesia and one of its most productive manta ray landing ports [8,43]. Sharks and manta rays are the most important groups of fish landed in the area [7]. Low income levels in Tanjung Luar mean that restrictions on shark and ray catches can have serious socio-economic consequences for fisher families. It can also cause ripple effects on the local economy by reducing downstream processing of shark products [43]. The main beneficiaries of the shark fin trade have been boat owners and traders, however, rather than fishermen and their families [43].

The islands Komodo, Rinca and Papagaran are located within the Komodo National Park in the West Manggarai province of Flores. It was established in 1980 [46]. The 7000 square kilometer zone that makes up the national park was declared as a manta ray and shark sanctuary in 2013 [5]. One of the main drivers was to protect the manta ray tourism economy [5]. The National Park is managed by the Indonesian Ministry of Forestry in Jakarta and is considered to be managed in a centralistic manner [47]. As of 2002, 4000 inhabitants were living within the national park, spread out over four settlements [46]. Regular marine patrols started in the park in May 1996 to combat destructive fishing practices, such as fishing with dynamite and potassium cyanide. However, artisanal fishermen have continued to fish inside protected zones, over-exploiting them in the process [47].

Table 1
Type of conservation effort affecting case site fishing communities.

Case site	Type of conservation effort	Type of enforcement	Implications for fishing communities[a]
Komodo National Park	7000 km^2 protected area (1980); Shark, manta ray sanctuary (2013)	NGO representatives; National Park boat patrols	Fishing zone restrictions; Fishing gear restrictions
Nusa Penida	200 km^2 MPA (2010); Shark, manta ray sanctuary (2013)	NGO representatives; MPA boat patrols	Fishing zone restrictions; Fishing gear restrictions
Tanjung Luar Village	Nationwide legal protection of shark, manta ray species (2014); Nationwide export prohibition of additional shark species (2014)	Government, fishery department representatives; Law enforcers	Prohibition to fish and sell shark, manta ray species previously targeted for fishing and export

[a] Based on study interviews and previous research (see *Introduction*).

Table 2
Interviewees' main livelihoods in study case sites.

Case site	Main source of livelihood	Number of interviewees (total n = 59)
Nusa Penida (Nusa Lembongan, Nusa Penida islands)	Fisherman	11
	Mariculture worker	2
	Ex-fisherman	1
Komodo National Park (Komodo, Rinca, Papagaran islands)	Fisherman	21
	Wife of fisherman	4
	Mariculture	2
	Souvernir shop owner	1
	Park ranger	1
	Fish trader	1
Tanjung Luar Village	Ex-shark fisherman	4
	Shark fisherman	2
	Shark market labour	2
	Shark boat owner	2
	Wife of shark fisherman	1
	Wife of shark boat owner	1
	Fisheries office worker	1
	Shark trader	1
	Ex-manta ray trader	1

2.2. Interviews

To collect the data for the study 59 semi-structured interviews were conducted [48], 14, 30 and 15 in Nusa Penida, Komodo National Park, and Tanjung Luar village, respectively. Interviewees were either local fishermen or other types of stakeholders with fishing-related livelihood sources. Snowball sampling [49] was used with the help of hired field guides, making use of their local knowledge and connections to select the interviewees. Out of 59 interviews 47 were males and 12 were females. The main source of livelihoods of the interviewed individuals were summarized (Table 2).

The interview guide was designed to include questions relevant to fishing communities dealing with marine conservation efforts, such as how their economic circumstances had been affected, if they had been given information and knowledge of relevant conservation rulings (for example, MPA zoning), if they complied with them, and what opinions they had on the conservation efforts they were facing (Table 3). Questions were asked with the purpose to both test their knowledge and let them voice any concerns that they might have. Because the interviews were semi-structured and open-ended, some interviewees did not comment on all of the topics. Field guides translated interviews as they were conducted. All the interviews were recorded and transcribed.

2.3. Analysis

The data acquired from the interviews was analyzed in several steps. First, Excel 2016 was used to organize the interview responses manually into six different categories representing main variables in the qualitative analysis (Table 3). Each variable was coded into categories describing the quality of compliance with conservation rules (COMPL), economic impact of the conservation efforts on the interviewees and their communities (ECON), interviewee's access to alternative livelihoods (ACCE), their level of knowledge on the conservation rules (INFO), relationship with authorities (RELA) and opinion on conservation activities (OPIN), as perceived by the interviewees (Table 3).

Interview responses were visualized quantitatively with bar charts. Statistical tests were not performed on the answer categories since there was no obvious null hypothesis or expectation to the answers. To explore how answers were associated to each other a principal component analysis (PCA) was performed using the co-variance matrix, on the categorical answers given for each of the six groups (Table 3). In the PCA only answer categories 1 or 2 were used, and thus answer category 3 (no mention etc.) was excluded.

A qualitative analysis of the interviews was then undertaken to provide context for the results of the statistical analysis. Emphasizing on livelihoods and relations with conservation authorities, the circumstances for fishing communities in the three different field sites were pieced together based on the gathered descriptions from interviewees.

3. Results

3.1. Quantitative analysis

The interviewees' responses relevant for each of the six variables are summarized (Table 4), as is the percentage of response categories excluding the "no mention" category (Fig. 2). Results show that a majority of the interviewees had a high compliance with marine conservation efforts but that their income had decreased due to conservation. Alternative livelihoods were available to about half of the interviewees. Most of the interviewees had been provided with a high degree of

Table 3
Categorization and coding of interview responses.

Variable	Description	Categorization and coding
COMPL: Compliance with local marine conservation efforts	How interviewees characterize their or their community's compliance with marine conservation efforts affecting them, for example through mentions of obedience or disobedience with regulations (fishing restrictions, MPA zoning, protected species) [31] [22,23,38];	Good = 1 Poor = 2 No mention = 3
ECON: Effect of conservation on economic income	If interviewees had experienced any increase or decrease in their or their community's economic income, due to marine conservation efforts [25] [23,28,41];	Increase = 1 Decrease = 2 No mention/no change = 3
ACCE: Access to alternative livelihoods	If interviewees had experienced easy or poor/no access to alternative sources of income, for them or their community (not dependent on fishing sharks/manta rays or fishing within protected areas) [22,23,28,41]	Easy access = 1 Poor/no access = 2 No mention/not considered = 3
INFO: Information on conservation rules	If interviewees showed a high or low degree of knowledge on conservation rules (MPA zoning, protected species). This indicates if they have been considered and given information by authorities [32,33,35,36]	High = 1 Low = 2 No mention = 3
RELA: Relationship with conservation authorities	How interviewees characterize their or their community's relations with conservation authorities, such as government representatives or park rangers (interaction-based: Conflicts, collaboration, dialogues) [37,38].	Good = 1 Bad = 2 No mention = 3
OPIN: Opinions on conservation efforts	If interviewees had a good or bad opinion of local marine conservation efforts, and the motivations behind them [8,34,37]	Good = 1 Bad = 2 No mention = 3

Table 4
Results from interview answers. Absolute numbers and percentages are given for each case site and for the whole survey (Total).

Variable	Nusa Penida (n = 14)	Komodo NP (n = 30)	Tanjung Luar (n = 15)	Total (n = 59)
COMPL				
Good	12 (86%)	14 (48%)	6 (40%)	32 (54%)
Poor	0 (0%)	8 (26%)	8 (53%)	16 (28%)
No mention	2 (14%)	8 (26%)	1 (7%)	11 (18%)
ECON				
Increase	6 (43%)	3 (10%)	1 (7%)	10 (17%)
Decrease	0 (0%)	19 (63%)	10 (66%)	29 (49%)
No mention/ change	8 (57%)	8 (27%)	4 (27%)	20 (34%)
ACCE				
Good access	9 (64%)	7 (23%)	6 (40%)	22 (37%)
Poor or no access	0 (0%)	20 (67%)	7 (47%)	27 (46%)
No mention	5 (36%)	3 (10%)	2 (13%)	10 (17%)
INFO				
High	10 (71.4%)	13 (43%)	14 (93%)	37 (63%)
Low	2 (14.3%)	12 (40%)	1 (7%)	15 (25%)
No mention	2 (14.3%)	5 (17%)	0 (0%)	7 (12%)
RELA				
Good	12 (86%)	6 (20%)	4 (26.66%)	22 (37%)
Bad	0 (0%)	20 (67%)	10 (66.66%)	30 (51%)
No mention	2 (14%)	4 (13%)	1 (6.66%)	7 (12%)
OPIN				
Good	12 (86%)	8 (26%)	6 (40%)	26 (44%)
Bad	0 (0%)	17 (57%)	8 (53%)	25 (43%)
No mention	2 (14%)	5 (17%)	1 (7%)	8 (13%)

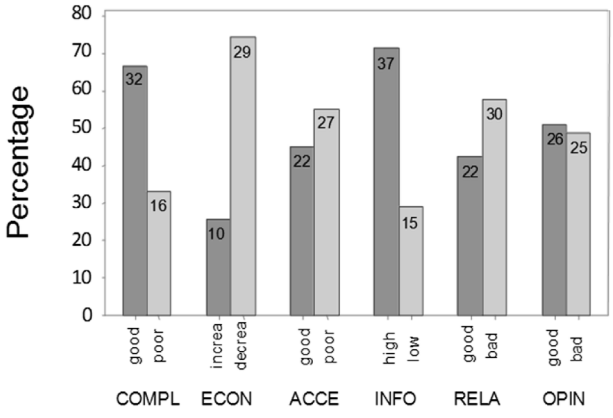

Fig. 2. Percentage of answers on the six categories of questions. No mentioned answers have been excluded and the numbers within the bars give absolute number of answers (COMPL: Compliance with local marine conservation efforts; ECON: Effect of conservation on economic income; ACCE: Access to alternative livelihoods; INFO: Information on conservation rules; RELA: Relationship with conservation authorities; OPIN: Opinions on conservation efforts).

information on the conservation rules, but a majority also answered that their relationship with conservation authorities were not good. Finally, about half of the interviewees claimed they had positive opinions on the motivations behind conservation efforts (Fig. 2).

The six categorical answers were readily described by the first two principal components which explained 60 and 13% of the variation respectively (73% of the total variation, see Appendix, Table A1). COMPL, ECON, ACCE, RELA and OPIN had relatively high positive loadings on PC1 (Fig. 3), suggesting that high scores (good or increase) on this PC were positively associated. For example, interviewees who had experienced an increase in income also had a higher compliance with marine conservation (Figs. 2 and 3). COMPL and OPIN had relatively high loadings on PC2 while ACCE had a high negative loading on this PC (Fig. 3). This suggests that interviewees that had access to alternative livelihoods had low compliance with marine conservation and

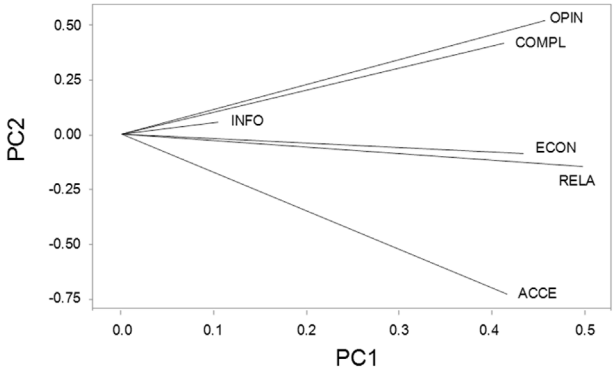

Fig. 3. Plot of loadings from principal components analyses. COMPL = compliance with local marine conservation efforts, ECON = effect of conservation on economic income, ACCE = access to alternative livelihoods, INFO = information on conservation rules, RELA = relationship with conservation authorities, OPIN = opinions of conservation efforts.

low positive opinions on the motivation behind the marine conservation (Figs. 2 and 3). However, PC2 explained only 13% of the variation and therefore the pattern revealed in PC1 (which explained 60%), where a positive relationship was found between all three variables: ACCE, COMPL, and OPIN should be emphasized rather than the negative relationships suggested by PC2.

3.2. Qualitative analysis: effect of conservation on economic income (ECON) and access (ACCE) to alternative livelihoods

In general, 17% of interviewees had experienced an improvement of their economic situation since marine conservation efforts started in their area, while 49% had experienced negative economic consequences. 37% of interviewees had easy access to alternative livelihoods, while 46% stated they had difficult or no access. However, the situation differed among the study sites.

In Komodo National Park the majority of interviewees had experienced negative effects on their economic situation from the park. Interviewees mentioned that the zoning system had complicated their access to fishing grounds. As their designated fishing zones were moved further away, this led to increases in fuel costs for the fishing boats. There were also restrictions on the fishing gear used, limiting the catch capacities and making the gear currently owned useless, forcing them to make new investments.

Only 23% of the interviewees in Komodo had access to alternative livelihoods, the major obstacle being a lack of access to financial support to start new businesses, such as local shops or street kitchens. Although there were some individual efforts from conservation authorities to provide alternative livelihoods, e.g. providing the communities with kayaks to rent to tourists or training guides, these possibilities were limited. For example, to become a tour guide on one of the islands required years of training and education in flora and fauna, making it a more specialist type of tourism job. A local fisherman also explained that: "*They recruit 20 people from this village to become naturalist guide, while [there is] more than 1000 people in the village.*"

In Nusa Penida, 43% of interviewees had seen an increase in their income while none had experienced any negative effects. Many expressed an understanding that their livelihoods depend on the region being protected, especially those working part-time in tourism. Access to alternative livelihoods was perceived as easy, especially in tourism which was used as additional sources of income by half of the interviewees, e.g. by using their boats to take tourists to popular snorkeling and manta ray watching sites.

The economy of the Tanjung Luar area is heavily dependent on fishing, with ca. 85% of livelihoods being fishing-related (of which about 20% are shark fishermen) according to one interviewee. Most of

the interviewees, 66%, thus had perceived a negative effect on their income linked to conservation.

Shark fishing can be relatively lucrative since the catch is auctioned, meaning that prices can vary greatly depending on external demand. The decreasing amounts of sharks being brought to the market also seemed to cause ripple effects in the local economy, since working hours decreased in businesses linked to shark fishing (e.g. street kitchen workers or laborers at the shark market). Some of the interviewed fishermen had alternative livelihoods, but these mainly revolved around local shops or street kitchens, which in turn were also often dependent on the activity of the fish market.

3.3. Qualitative analysis: knowledge and access to information (INFO) on conservation rules

In general, 63% of interviewees showed a high degree of knowledge of local conservation efforts, while 25% showed a low degree. There were, however, also differences in the degrees of knowledge between the different case sites.

In Komodo National Park, 43% of the interviews indicated a high degree of conservation-related knowledge and 40% a low degree. Many complained about poor access to information on regulations. For example, it was unclear for many community inhabitants on where they were allowed to fish in the national park and what fishing equipment they could use, sometimes leading to confiscation by park rangers from fishermen unaware of these rules. Fishing zones were also sometimes changed without informing the local community, which led to difficult situations when they were caught fishing in these areas, thereby causing frustration and resentment among community members.

Meanwhile, most of the interviewees in Nusa Penida revealed higher degrees of knowledge on the MPA and its regulations. This can likely be explained by the fact that stakeholder groups had been continually consulted and informed by the NGO (Non-governmental organization) managing the MPA implementation since the early stages of its planning.

In Tanjung Luar a majority of interviewees had a high degree of knowledge on the protective legislation being implemented, which could be explained by the importance of shark fishing to the local economy and the subsequent concern for restrictions. According to interviewees, Government officials had come to the area on several occasions to discuss the restrictive regulations on shark fishing.

3.4. Qualitative analysis: relationship with conservation authorities (RELA) and opinions of conservation efforts (OPIN)

In general, 37% of interviewees spoke of positive relations with conservation authorities, while as much as 51% mentioned negative relations. At the same time, 44% expressed positive opinions while 43% expressed negative opinions of their local conservation efforts. However, site specific relationships and opinions were found.

In Komodo National Park relations between fishing communities and conservation authorities (mainly the park rangers) seemed to be relatively strained. Only 20% of interviewees spoke of good relations with conservation authorities while 67% mentioned poor relations. According to several interviewees, park rangers used threatening or aggressive methods to manage the national park. Lack of previous stakeholder dialogue had apparently given rise to dispute in the past, as community members felt that their interests had not been taken into consideration when planning the zoning system. As expressed by a fish trader: "*They make zone plan. We refuse their zone plan. It become conflict. They did not involve us since the beginning.*"

Among several interviewees, however, there were also expressions of gratitude towards the park management for protecting the park from outside fishermen who were using destructive fishing equipment, such as bombs or potassium.

Opinions on the park and its implications among Komodo National Park inhabitants were similarly poor. Only 26% of interviewees expressed positive opinions, while 57% had a negative opinion. A recurring topic was the perceived unfairness of the zoning system. According to interviewees, the limitations to their fishing activities were too strict, and their quality of life had been compromised as they needed to constantly bring documents to prove their identity when fishing in what they saw as their own waters.

In Nusa Penida a majority of interviewees had a good opinion of the MPA management and boat patrols. They characterized the attitudes from the management as friendly and respectful, placing high trust in them. The interviewees mentioned that fishermen were provided education from the MPA management about how to start or improve their tourism businesses, and that fishing had improved since the region got protected from fishermen using destructive fishing gear such as poison, bombs and compressors. The positive perception of the relationships with authorities in this site seems to be linked to the close dialogue that had been held between fishermen and MPA authorities.

Similarly, most of the Nusa Penida interviewees expressed positive opinions about the MPA and its purpose. Some interviewees even expressed contempt towards the government on Bali for not taking further steps to protect the island. The following quote captures the words of many interviewees:

"My belief is the planning is very good, and we believe if [we] have MPA, the coral here will [be] protected. And my son and my grandson, I hope [will] still [have] coral. And tourist [will] still [be] looking there. Because if [we do] not have MPA, the people from the other village, like people coming from Lombok, they [are] catching this [the fish] with the compressor, come down and break the coral. And nobody care [about] that. But now, the MPA [management] cares [for] that, [which] is why I am very happy, because MPA [management] care about that".

The Tanjung Luar interviewees most commonly expressed an attitude of distrust or disappointment towards conservation authorities. Only 27% of interviewees mentioned good relations with authorities. This could be linked to the perceived negative impacts of the protection on the local economy and limited possibilities for alternative livelihoods. While there were government plans for helping to develop the area as a compensation for the lost income, nothing had happened yet, which had generated disbelief in the promises from the authorities, according to the interviewees: "*Many time the government come and talk to the fishermen about the plan, why protect and what the government do. But so far only talk. Up until today, nothing. This started over a year ago".*

Local opinions of the legal protection of shark and manta species were, however, slightly more positive with 40% of interviewees expressing favorable views of the protection efforts. Although the fishermen sympathized to some extent with the protection efforts, economic aspects led to lower compliance with regulations and negative opinions of them.

3.5. Qualitative analysis: compliance with marine conservation efforts (COMPL)

Over half (54%) of the total number of interviewees characterized their and their communities' degree of compliance with marine conservation efforts as good, while 28% spoke of it as poor. There were, however, differences between the three study sites.

In Nusa Penida, most of the interviewees characterized their compliance as good, while in Komodo National Park there were much lower levels of compliance. Some Komodo interviewees had taken a defiant stance towards the conservation efforts and its enforcers and were not following the regulations. This seems to be linked to the frustration regarding low information provided about these rules. The following two quotes from interviewee fishermen illustrate this: "*More income now. Because we do not care about their zones or whatever*", and "*Of course there is zoning plan, but we just do not care*". A number of interviewees also recounted a past incident where a fisherman had been arrested by park rangers due to use of illegal equipment and taken to Labuan Bajo

on the mainland, allegedly under gun threat. This event had led to fisherman protests in Labuan Bajo. As also described above, the relations between Komodo park rangers and fishing communities seem to have been relatively strained, which can have affected their willingness to comply with conservation rules.

The high compliance in Nusa Penida could potentially be linked to the high share of respondents from this area who experienced improvements to their economy, who had access to alternative livelihoods, as well as the generally positively perceived relationship with authorities and positive opinion about conservation. Also, Nusa Penida respondents had the highest level of information about the conservation in the area, which could have contributed to their compliance. In addition, rather than being a government decision made remotely, the organization managing the MPA had been approached by local island inhabitants in 2000 to create a protected area around the islands. There had also been a continuous dialogue between stakeholders during the design and implementation of the MPA. This could have contributed to the positive opinion of the local people on conservation efforts, high knowledge levels, and development of good relationships with authorities.

In contrast, most of the Tanjung Luar interviewees characterized local compliance as poor, making this site least compliant as compared to the other sites. The interviews suggested that this could be linked to the importance of shark and manta fishing and its association with their economy, fishermen perceiving that conservation led to a decrease in their economy, while at the same time not providing sufficient access to alternative livelihoods that would compensate for that. The issues with implementing legislative protection of shark and manta species, and the consequential economic dilemmas that fishermen met with, can be illustrated by the following anecdote: the consistent meetings with government representatives had generated an understanding among the local fishing community that shark and manta ray species were becoming protected due to declines in their population. These protection efforts naturally led to even lesser supplies of fins from these specimen being available on the market, which in turn meant that market demand for these species increased further. Consequently, the economic incitement increased for fishermen to catch specimen from these species when they had bitten onto the hook, despite having knowledge of the protection and associated punishment. Rather than bringing the whole shark back to land, the fins of these species were then cut on deck and hidden on the boat, and the body thrown back into the water. These fins were then sold elsewhere than Tanjung Luar's fish market, to avoid punishment.

4. Discussion

This study has found that most of the interviewees perceived a decrease in their economy due to the implementation of marine conservation efforts. They had limited access to alternative livelihoods and had poor relationships with conservation authorities. Still, among all the interviewees relatively many had a good opinion about the conservation efforts and showed high degrees of compliance with them. However, there were differences between the three case studies which highlight the importance of considering socio-economic aspects and, particularly, local contexts in marine conservation planning. As found in previous research, implementation of conservation may have negative socio-economic consequences for local people [28] and their situation is not always taken into account [17]. Access to alternative sources of income for stakeholder populations is, thus, seen as important in order to improve their situation and to ensure long-term success for conservation efforts [10]. Manta ray tourism in particular has proven to be of significant economic value to local people in Indonesia and globally [23]. Previous studies in Southeast Asia have shown that stakeholders gaining access to eco-tourism benefit economically from it, while if excluded they can have their livelihoods compromised instead [28] which may affect their compliance [50]. This study suggests the same pattern, since it found a positive relationship between access to alternative livelihoods (ACCE) and effect of conservation on economic situation (ECON). Furthermore, qualitative analysis of the interviews suggests that the experience of improvements in economy and access to alternative livelihoods could be linked to high compliance (e.g. the case of Nusa Penida).

In general, the socio-economic aspects linked to the implementation of conservation efforts, in the form of MPAs and legal protection of fished species, seem to contribute to the level of compliance with conservation regulations. Respondents that perceived a decrease in their income complied less with regulations, while respondents whose economic situation improved due to conservation and who had access to alternative livelihoods complied more. This highlights that in order to facilitate compliance, it is helpful to ensure that the livelihoods of local people are not undermined. Particularly, it has been suggested that attention should be paid to fair distribution of potential benefits of conservation, so that the ones who bear the costs of it (usually local communities) can also gain from it [18].

The study found that the socio-economic impacts of marine conservation, as well as the levels of compliance differed between the three case sites. This highlights the importance of understanding the local context in designing conservation activities and regulations. The availability and possibilities of alternative livelihoods may be partially explained by external geographical factors. For example, the majority of tourists enter the Komodo National Park from Labuan Bajo on mainland Flores, possibly making it more difficult for island inhabitants to find work with tourism operators compared to mainland inhabitants on Flores. This, coupled with the long training required to be a land tour guide mentioned by interviewees, can be contributing factors in explaining the limited access to alternative livelihoods in the park. In addition, relationships between fishing communities and authorities in Komodo National Park were relatively bad, which could be related to the seemingly low levels of information provided to local people and could have contributed to lower compliance. In contrast, the respondents in Nusa Penida had an opportunity to develop good relationships with conservation authorities due to continuous stakeholder dialogue during implementation of the MPA, and thus they showed high degrees of knowledge about the conservation and a positive opinion towards it. In general, the respondents who had good relations with authorities and good opinions about the conservation efforts complied more with conservation regulations.

Compliance with marine conservation efforts among interviewees and their respective communities should be seen in light of the above described factors. They may all have influenced the decision-making processes of interviewees and other community inhabitants when faced with species protection or fishing zones. The communities in Komodo National Park and Tanjung Luar all had significantly lower degrees of compliance compared to Nusa Penida, and they had also found their livelihood situations compromised in a negative way. Furthermore, relations with conservation authorities and opinions of conservation efforts were also poorer in these two areas. Therefore, and especially with the cited comments from interviewees in mind, it is plausible that any decisions to not comply with conservation rules could be based on economic necessity, as well as being acts of defiance or distrust. This is in line with previous research [19,37,38]. In contrast, the dialogue between MPA management and local stakeholders in Nusa Penida is likely to have generated a high degree of mutual understanding of the needs of both fishermen and the marine ecosystem, which in turn was reflected in the design of the MPA zoning system. This could have contributed to explaining the high degree of compliance found in Nusa Penida, which also confirms the findings of previous research [32,33,36], highlighting the importance of promoting good relationships and building trust in contact with local communities when creating MPAs [18,38,39].

Finally, supporting the findings of previous research on top-down and bottom-up implementation of MPAs [18–21], a contributing factor

to the different outcomes in Nusa Penida and Komodo National Park may also be the differences in MPA design: the Komodo National Park MPA was implemented in 1980 and represents an older, more centralized and top-down, style of marine conservation [46,47]. It is possible that environmental factors took priority over local livelihood circumstances when deciding to create the conservation area [17]. This seems to have compromised the balance between environmental and social justice, marginalizing local small-scale fishermen. As illustrated by the conflicts between Komodo fishermen and park rangers, this might have hindered conservation goals [18]. This is in line with previous research showing that marginalization of local communities may undermine conservation efforts [18,38,41]. In contrast, Nusa Penida MPA was implemented in 2010 and was characterized by a more inclusive, bottom-up approach towards local stakeholders [44]. This signals that local circumstances were considered to a higher degree [20,21]. As the results indicate Nusa Penida stakeholders have been included in economic activities related to the marine conservation efforts, and they were more compliant with regulations, it can be suggested that the stakeholder dialogue has facilitated the MPA marine conservation objectives. In summary, although the key focus of this study was not on investigating the governance processes in MPA implementation, the results indicate that including bottom-up, inclusive elements and considerations for the local contexts in MPA implementation may make it more effective in achieving conservation aims compared to a strictly top-down MPA approach, which is in line with previous research [18–21].

In this study particular communities were selected which means that the results are not generalizable to all marine conservation projects. In addition, interviews were the only source of data, and there is thus a need for further research that would account for factors outside of the context of the study, such as market fluctuations or economic inflation [51]. Nevertheless, the study provides important insights that may contribute to marine conservation. They highlight the different aspects relevant for the fishing communities that need to be considered when designing MPAs and introducing fishing regulations.

5. Conclusion

The results of this study suggest that fishing communities place high value on their economic circumstances when faced with marine conservation efforts that would impact these. This supports the suggestion that local communities prioritize social justice and equity in conservation planning [18]. In addition, the findings indicate that prioritizing stakeholder participation, continuous dialogue and transparency in decision-making might increase trust and facilitate fair distribution of conservation benefits, in turn leading to better conservation outcomes [32,33,35,36]. As marginalized stakeholders were more prone to non-compliance with conservation rules, it can be beneficial for conservation authorities like government officials, MPA management or park rangers to maintain good relations with stakeholder fishing communities in relation to their conservation efforts. In addition, including planning for providing alternative livelihoods that are aligned with the local context when implementing marine conservation can contribute to improving local communities' long-term compliance with conservation rules. Overall, the study results highlight the importance of stakeholder participation for long-term economic, social and environmental sustainability.

Acknowledgements

Fieldwork for this study was financed by a Minor Field Study-scholarship from SIDA, the Swedish International Development Cooperation Agency. Decision to grant the scholarship was made by the Department of Earth Sciences, Uppsala University, Sweden (reference 161CRM). We would like to thank Dr. Vanessa Jaiteh for useful advice at the initial stages of the study; Abdul Muis Sulaiman and Dr. Eny Buchary who shared their experiences on fieldwork among Indonesian fisheries; Permana Yudiarso, Marthen Welly, Wira Sanjaya, Nyoman Karya, Komang Budiarta, Johan Bratt, Marta Muslin, Kathy Xu and Agus Harianto who helped with the fieldwork; and Laila Mendy who helped with proofreading the article. We would also like to thank all the individuals who were interviewed for their time and patience.

Appendix 1

Table A1
Factor loadings from the PCA using the six categories of answers.

Variable	PC1	PC2
Proportion	0.60	0.13
COMPL	0.413	0.413
ECON	0.433	−0.087
ACCE	0.416	−0.727
INFO	0.105	0.054
RELA	0.498	−0.147
OPIN	0.457	0.518

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