Diving Tourism and Fisheries in Marine Protected Areas: Market Values and New Approaches to Improve Compliance in the Maldives Shark Sanctuary

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Abstract

Marine protected areas are probably the most prevailing instruments available to reduce the overexploitation of marine resources. However, economic incentives and a lack of acceptance of regulations of fishers can lead to illegal fishing activities, causing further overexploitation with negative consequences for livelihood and food security of communities. There are indications that in some places, dive operators reduce incentives for illegal fishing through contributing to the economic development of the area, surveillance activities and social programs. This project aims at exploring the relationship between the diving tourism industry and illegal shark fisheries in the shark sanctuary of the Maldives in order to understand the capacities and incentives of diving tourism to improve fishers' compliance. I will use survey techniques to determine the financial revenue of the shark diving industry and examine the historical development of its socio-economic importance. Surveys will also explore whether illegal fishing activities influence the trip demand of tourists and analyse what different circumstances are most likely to motivate dive operators to address illegal fishing through certain actions. Finally, I will use a Bayesian Network model to investigate what effects dive operators' actions have on fishers' compliance, the condition of shark populations and ultimately the number of tourists visiting the area. Results can help to diminish user conflicts and improve compliance of fishers in the Maldives. Hence, this project can contribute to the conservation of shark populations with positive outcomes for the local economy, community and marine ecosystems. My findings can be applied to other places that face similar problems like the shark sanctuary in the Maldives.

Key words: diving tourism; shark sanctuary; compliance; market valuation; decision models

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1. Introduction

Marine protected areas (MPAs) are one of the most prevailing instruments available to ease the overexploitation of marine resources and the degradation of marine habitats[1,2]. MPAs, however, often do not reach their full potential as a result of overexploitation from different user groups competing for the resources inside MPAs and ineffective governance and management regulations to overcome these problems[3]. User conflicts are especially evident where conservation measures such as no-take zones displace user rights from fishers and consequently increase fishing effort in the surrounding areas[4]. On the other hand, conservation measures result in an increased production of fisheries resources that move to outside the borders of no-take zones[5]. But even though this biological compensation may be large enough to offset fisher displacement, this process is not immediate[6] and may not benefit all societal groups[7]. Hence, MPAs have also been criticized for leading to negative impacts for some people. This is problematic since the success of MPAs depends on acceptance from the community and a lack of support might lead to non-compliance of regulations.

Correspondingly, one of the most challenging problems in reaching conservation targets in MPAs is illegal, unreported and unregulated (IUU) fishing[9]. Illegal fishing is conducted by vessels of countries that are parties to a fisheries organization but which operate in violation of its rules, or operate in a country's waters without permission. Unreported catches are not reported, misreported or underreported catches to the relevant authorities by fishing vessels or flag state. Unregulated fishing is conducted by vessels without nationality or flying flag of states not parties of fisheries organizations and who therefore consider themselves not bound by their rules[10]. Illegal fishing vessels usually contribute more to the overexploitation of fisheries resources than legal fisheries because they are not controlled, often use destructive fishing methods, and produce higher amounts of bycatch[11].

There are several contributing and compounding factors responsible for the persistence of IUU fishing. Overexploitation of marine resources and overcapitalization of fishing fleets push fishers to use their capacities in the most profitable way[12]. Economic incentives to engage in IUU fishing arise where the economic gains of breaking the rules are higher than the risk of being detected and the type and level of sanctions in place[13]. In addition, social aspects such as legitimacy of management regulations, equity of the distribution of user rights as well as the lack of knowledge on the rules and on the seriousness of the problem, all can influence the compliance of fishers[14].

These factors build a vicious circle when IUU fishing leads to further overexploitation of marine resources, prolonging or hindering the recovery of fish populations and ecosystems, with negative consequences for livelihood and food security[15]. Moreover, IUU fishing creates social tensions with different stakeholders that legally exploit resources, and causes losses to the local economy[15]. Worldwide, IUU fishing losses are estimated to be between 11 and 26 million tonnes annually, representing between US$10 bn and US$23.5 bn of foregone benefits for legal fisheries[16]. Moreover, costs of achieving compliance are likely to be substantial[17].

A range of measures have shown to be crucial to enhance fishers' compliance. Economic incentives to engage in IUU fishing can be reduced by improving monitoring, control and surveillance capacities and sanction schemes as well as the economic and social situation of fishers[18]. Community-based management that includes stakeholders in the early planning process of MPAs can improve the equity and legitimacy of rules and discourage non-compliance[19]. Also, well-marked boundaries of no-take zones have shown to improve compliance[20]. Compliance in turn reduces the speed of ecosystem degradation and increase the biomass of protected species while saving enforcement costs[17,21].
The implementation of these measures is however a challenging task in many places. Coastal developing countries with low governance capacity are particularly susceptible to IUU fishing, because they face many of its' root causes and governments usually don't have the necessary resources to address non-compliance[16,22]. Next to governments, who usually address IUU fishing, a couple of other actors have emerged to combat IUU fishing. Some are multinational agencies such as the Coral Triangle Initiative that aims at creating coalitions between its' member states in the Indo-Pacific in order to tackle problems related to illegal fishing activities that cross national borders[23]. Others are non-for-profit organizations like the PEW Charitable Trust and Wild Aid, as well as for-profit actors[24]. For-profit actors are typically fisheries associations and operators in the fish supply chain who get involved because they gain economic benefits from reducing IUU fishing[19,23]. While fisheries associations have made progress in deterring IUU fishing in the southern ocean[24], in general the presence of legal fishing vessels does not deter illegal fishing activities[11]. In a marine reserve in Chile where fishers hold the exclusive territorial user right of the area, many fishers chose not to participate in monitoring, mainly because they consider government policing enforcement of marine areas and the sanction scheme for IUU fishing to be ineffective[25].

Next to for-profit actors in the fisheries sector, certain branches of the eco-tourism industry also benefit from combating IUU fishing because their benefits depend on a healthy marine environment[26]. Eco-tourism is defined as the "responsible travel to natural areas that conserves the environment, sustains the well-being of the local people, and involves interpretation and education"[27]. In some cases, eco-tourism is linked to the so called "pro-poor tourism" movement which aims at promoting opportunities for the poor to benefit from tourism[28]. Combined, these tourism developments consider social, ecological and economic aspects and have therefore the potential to be sustainable. Eco-tourism based on wildlife viewing is among the most profitable eco-tourism streams[29] and where marine eco-tourism is based on interacting with certain species, these species can have a much higher economic value when kept alive compared to their value as a fisheries resource[30–32]. In some places like the Maldives, Palau and Fiji, diving with charismatic marine fauna such as sharks is an important contributor to the national economy[33]. Even though it is widely acknowledged that sharks play a key role in maintaining marine ecosystem health[34,35], economic arguments seem to be more successful in encouraging governments to ban shark fisheries. Thus, these and other places announced their waters shark sanctuaries. In the shark sanctuary of Palau, diving with sharks generates high revenues for the government and several sectors of the economy[36]. Hence, fishers also profit from shark diving as it becomes more lucrative to sell fish legally to tourists than to fish for sharks illegally[36]. A dive operator in the shark sanctuary in Raja Ampat (West Papua) has taken various actions against IUU fishing including actively patrolling the area around dive sites and reporting IUU fishing vessels to authorities[9,17]. Moreover, this dive operator addresses a number of root causes of IUU fishing through investments in several social programs[26]. In the shark sanctuary of Fiji, another dive operator and some conservation groups established a community-based management where local villagers exchanged their fishing rights for a compensation that is paid by tourists in form of user fees[37]. Apart from that, this dive operator executes different tasks such as training local people, mediating between fishers and authorities, monitoring the area and training honorary officials that enforce the reserve[37].

The effectiveness of private actors at preventing IUU fishing is still under debate as their involvement in security issues depends on their motivation, capacity and interest[38]. Moreover, interest conflicts between different dive operators or dive operators and the fisheries sector could arise or increase which in turn may reduce the effectiveness of efforts to improve compliance[38]. Finally, if not well managed, tourism itself represents a major source of threats to the marine environment[39–42]. Yet, the responsibility from the private sector to advance sustainable development is essential, as commerce is an important basis of society. As eco-tourism based on diving activities are major industries in many tropical developing countries, understanding how dive operators could be integrated in measures to overcome non-compliance from fishers can be a significant support to governmental agencies. Still until now, the role of dive operators in combating illegal fishing and consequently conserving the marine environment has been largely unrecognized in the literature.

The aim of this project is to present a series of studies that explore the relationship between the diving tourism and illegal shark fisheries in the shark sanctuary of the Maldives in order to understand the capacities and incentives of diving tourism to improve fishers' compliance. Specifically, this research will (i) determine the market value of sharks for the shark diving industry in the Maldives, (ii) investigate the behaviour of dive operators and dive tourists towards illegal fishing activities and (iii) investigate the effects of different actions from dive operators on fishers' compliance, shark populations and dive operators' revenues.

2. Methods

2.1 Study area

The proposed study will take place in the Maldives, a small island nation in the Central Indian Ocean. I chose the Maldives because they exemplify a number of challenges that seem to by typical for MPAs in small island nations[43]. Since the 1970s, the economic importance of the traditional tuna and shark fisheries started to be increasingly substituted by the tourism industry[44], which nowadays dominates the nations' economy and made up 27% of the gross domestic product in 2014[45]. Diving and snorkelling are the highest ranked activities of tourists in the Maldives[45] and watching marine megafauna such as rays and sharks is an essential element of the diving tourism industry[31]. Anderson et al. (1993) investigated the market values of the shark fishery and the shark diving industry and found that shark watching generated approximately US$ 2.3 million in direct diving revenue per year, compared to US$ 1.17 million of export earnings from shark products in 1991[46]. He also estimated that a grey reef shark may be worth several hundred times more alive at a dive site than dead as a fisheries resource[46]. A declining status of shark fisheries and concerns over decreased shark sightings from divers encouraged the government in 2010 to declare the Maldives a shark sanctuary and announced a total ban on shark fisheries in its waters[47].

Previous studies suggest that the market value of diving tourism specialized on megafauna such as whale sharks and manta rays in the Maldives increased over recent years[31,51]. The direct expenditures for whale shark watching in the South Ari Atoll only was e.g. estimated for 7.6 to 9.4 million US$ in the years 2012 and 2013[31]. Andersons' work from 1993 on the direct revenues from shark watching seems therefore rather outdated. However, it is not clear to what extent the implementation of the shark sanctuary has influenced the growing shark watching market in the Maldives. Moreover, there are a number of issues undermining the effective implementation of the shark sanctuary. Major

problems are the implementation of the ban on import, export and trade of shark products because regulations are in conflict with other government laws. Moreover, stakeholders were not consulted prior to the ban, there is not sufficient provision of alternative livelihood options for shark fishers and there is a lack of regular monitoring[48]. Previous studies have also noticed a large disparity between the economic value of eco-tourism and the financial investment in environmental conservation[49]. Such failures mean that sharks are still being caught illegally in the Maldives[48,50] which contributes to an ongoing conflict between the diving tourism industry and the fisheries sector and might hinder the recovery of shark populations[48].

2.2 Market valuation of the shark diving industry in the Maldives

The first part of the study aims to estimate the financial revenue of the shark diving industry in the Maldives. The financial revenue of an industry is consistent with the Gross Domestic Product and represents therefore a useful indicator of the economic importance of an industry. I will update and enhance the information from 1993 by estimating the revenues from the overall shark diving industry for several groups of the community in the Maldives. Information will be obtained with different stakeholders that are related to the shark diving industry. During two weeks of pilot study, I will analyse the general profile of the tourists engaged in diving activities. Based on this information, I will design a self-administered questionnaire for diving tourists. During six weeks of fieldwork in May, June 2016, questionnaires will be handed to the divers at the end of their trips. In this time, I will furthermore conduct face-to-face interviews with dive operators, dive guides and local fishers. Based on these surveys and official statistics from the Maldives government, I will calculate the revenues of different groups of the community as suggested by Vianna et al. (2012)[36]. Furthermore, I will compare the described estimates on the revenues from the shark diving industry with previous literature in the area in order to understand how the market value of the shark diving industry changed over the last two decades. Table 1 (next page) shows information that I will obtain, the revenues I will estimate and the according formulas.

2.3 Interactions between diving tourism and illegal fishing activities

The second part of this project will investigate the attitude, opinion and behaviour from the diving tourism towards illegal fishing activities in the Maldives. I will solely focus on illegal fishing rather than on IUU fishing activities because shark fisheries are banned in the Maldives and unreported and unregulated fisheries are therefore not relevant in this work. I will put emphasis on two stakeholders: tourists and dive operators and will collect relevant information through questionnaires and interviews. Surveys will be conducted during six weeks of fieldwork from September to November 2016 in the Maldives.

Table 1: Financial revenues associated with the shark diving industry as well as the information to obtain these revenues, the sources of information and the formulas to be used.

Revenue	Information to obtain	Source	Formula
Annual business revenue from sharks in the shark diving industry (BRS)	Average expenditure per dive tourist (DET)	Tourist survey	BRS = DET x D x SDP
	Number of divers per year (D)	Government statistics	
	Proportion of all divers who are shark divers (SDP)	Tourist survey	
Direct community income from shark diving (DCISD)	Diver expenditure on dives (DED)	Tourist survey	DCISD = D x SDP x DED x W
	Proportion of diving industry income that is allocated to paying wages and salaries (W)	Operator survey	
Fishers income from shark diving tourism (FISD)	Average annual fishers income (FI)	Fisher survey	FISD = FI TFP x SDP/T
	Proportion of fish sold to tourists multiplied by the hotels and restaurants revenue attributable to tourists (TFP)	Fisher survey	
	Annual number of tourists visiting the Maldives (T)	Government statistics	
Tax revenue from the shark diving industry (TTRSD)	Business revenue tax (BT)	Operator survey	TTRSD = TAX x D x SDP + SDP x D x BT x DE + NSDP x T x AT x AE + NSDP x T x BT x OE
	Proportion of shark divers out of all tourists (NSDP)	Tourist survey	
	Accommodation tax (AT)	Operator survey	
	Diving expenses (DE)	Operator survey	
	Accommodation expenses (AE)	Tourist survey	
	Other expenses (OE)	Operator survey	
Operational costs of shark diving (CSDO)	Percentage of the total revenues collected by the dive operator to cover operational costs (C)	Operator survey	CSDO = DE x D x C x SDP

Dive operators

A qualitative study will investigate whether or not and how different dive operators in the Maldives engage in actions against illegal fishing activities. I will also determine how different factors affect their decision to take action. These factors as well as possible types of actions that could be carried out will be identified through a literature review and interviews with dive operators. Results will be analysed using descriptive statistics. A preliminary collection of factors and possible responses is shown below.

Factors that influence a dive operators' decision to engage in actions against illegal fishing activities:

- Economic interests: Number of tourists in the area, capital and operational costs of actions
- Social interests: Relationship with local authorities and/or community
- Necessity of actions: Level of illegal fishing in the area
- Effectiveness of actions: Sanction scheme/ consequence that actions have for illegal fishers
- Affinity for nature: Quality of the marine environment

Possible actions of dive operators to respond to illegal fishing activities:

- Monitoring, control and surveillance
- Invest in alternative sources of income for fishers
- Invest in public educational programs
- Invest in common infrastructure
- Mediate between fishers and authorities
- Set signals at no-take zones

Tourists

The contingent behaviour (CB) method provides an estimate of what people say they would do contingent upon the hypothetical condition of a good or service in a survey. The underlying utility function assumes that an individual aims at maximizing the utility from consumption of a good or service and is described as follows:

$$U_i = V_i + \varepsilon_i$$

Where U is the overall utility, V the observed utility and ε the unobserved utility associated with the ith alternative. Here, I will apply the CB method by asking diving tourists in the Maldives (i) if the engagement of a dive operator in actions against illegal fishing activities (see actions above) would influence the number of diving trips that they are planning to do with this dive operator in comparison to a dive operator that doesn't take actions against illegal fishing, (ii) if them observing illegal fishing activities and (iii) the number of sharks they see during their holidays would influence the number of diving trips that they are planning to do to the Maldives. I chose this method because the conditions upon which tourists might change their behaviour are probably not the currently observed conditions or at least I can't control these conditions[52]. I will use the software STATA and R Statistics for the statistical analysis in order to model the probability that a diving tourist will make a certain number of trips (i) with a particular dive operator and (ii) and (iii) to the Maldives depending on the dive operators' behaviour regarding illegal fishers, the presence of illegal fishing vessels and the number of sharks seen during their holidays in the Maldives, respectively. I will use count data models such as Poisson and negative binomial models as they are recognized to estimate recreational values[53]. The Poisson regression is commonly used when data show equality of the mean and the variance of the dependent variable (equidispersion)[54]. However, demand count data often do not meet these assumptions and also show signs of overdispersion[55]. Negative binomial model are more flexible with the assumption of equidispersion of the dependent variable and can deal with overdispersion[56].

Depending on the characteristics of my data, I will apply either the Poisson or the negative binomial model. The probability functions of both models are shown below.

Poisson model: $Prob(y = n) = \frac{e^{-y}\gamma^{n}}{n!}$

Where *y* represents a function of travel, site/dive operator and respondent characteristics[53], n is the number of diving trips a tourist makes and γ is the mean and variance of diving trips.

Negative binomial model: $Prob(y_i^c = \hat{y}_i^c) = \left(\frac{1/\alpha}{1/\alpha+\bar{y}}\right)^{\frac{1}{\alpha}} \times \frac{\Gamma(\hat{y}_i^c+1/\alpha)}{\Gamma(1/\alpha)\times\Gamma(\hat{y}_i^c+1)} \times \left(\frac{\bar{y}}{1/\alpha+\bar{y}}\right)^{y_{ic}}$

Where $\bar{y}$ is the mean number of trips at condition c, Γ is a gamma probability density function defined for y_i and α, a gamma distributed parameter[57].

2.4 Decision model for dive operators' actions to improve compliance

In a third part, I will use a Bayesian Network (BN) modelling approach to extend the information that I obtained from surveys with the different stakeholders in order to create economic and ecologically sustainable management options for the Maldivian shark sanctuary. The model will describe how different actions of dive operators affect a sequence of consequences which are: fishers' compliance, the state of shark populations and the number of tourists visiting the area. I chose BNs because they offer a comprehensive and flexible way to describe complex and multi-disciplinary systems and are a viable tool for decision analysis[58]. BNs are probabilistic models that portray a set of variables and their conditional relationships through a directed acyclic graph. Variables are illustrated by boxes (nodes) and are connected through arrows that represent causal relationships and determine the conditioning for the probabilities of different states for each variable[58]. Figure X shows my preliminary conceptual model.

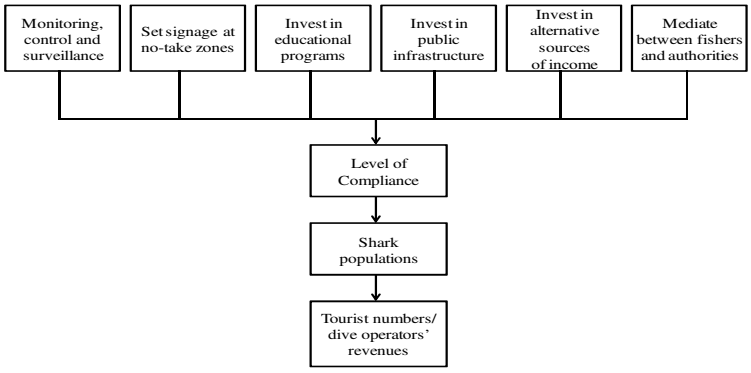

Figure 1: Conceptual model of the effects, different actions to improve fishers' compliance from dive operators have on the shark populations of the area and their business revenues.

I will use the statistical software STATA to model the probability that the number of tourists increases, given the dive operator invests in a combination of variables using the probability function. For example:

$$P(MCS, EDU, INC) = P(MCS \mid \text{EDU}, \text{INC})\ \text{P}(\text{EDU} \mid \text{INC})\ \text{P}(\text{INC})$$

Where MCS, EDU and INC are abbreviations for the variables "monitoring, control and surveillance", "investment in educational programs" and "investment in alternative sources of income", respectively. Variables representing the dive operator's action to either engage in a certain activity or not can have the state "yes" or "no". I decided to not include different levels of engagement of dive operators for each action, because such scenarios are too complex for the model that we aim to generate. Different combinations of the actions from dive operators will result in different status of the variables "Level of compliance", "Shark populations" and "Tourist numbers/ dive operator's revenues". BNs can accommodate a variety of knowledge sources and data types[58]. Table 2 shows the sources of information that we intend to use in order to model the relationships of the given variables. Results will give us a set of actions against illegal fishing that represent the best outcomes for shark populations, while bringing the most benefits for dive operators.

Table 2: Sources of information for variables and conditional relationships between variables.

Variable/ Conditional Relationship	**Description**	**Source of information**
Variables	Actions of dive operators	Interviews with dive operators (see 2.3)
Conditional relationship	Actions of dive operators/ Level of fishers' compliance	Literature
Conditional relationship	Level of fishers' compliance/ Shark populations	Ecological data from the Australian Institute of Marine Science and Literature
Conditional relationship	Shark populations/ Dive operator's revenue	Questionnaire with dive tourists (see 2.2 and 2.3)

3. Significance of the project

During recent decades, a growing demand of shark fins has led to an extensive shark fishery and the overexploitation of many shark populations worldwide[59]. Sharks are especially susceptible to overexploitation and extinction because they have long generation times, and low growth and reproductive rates[60]. It is now widely acknowledged that the overexploitation of sharks can have serious negative economic and ecological impacts[33,34]. In the Maldives, the shark diving industry depends on healthy shark populations and represents a significant element of the economy[31]. Thus, a threat to shark populations could affect the revenues they bring for a variety of groups in the society. Moreover, the reduction of shark populations can cause cascading effects on lower trophic levels with negative impacts on the productivity of marine ecosystems such as coral reefs and sea grass beds[35,61]. In coastal developing countries, a healthy marine environment is the basis of all life support systems, including that of human well-being and socio-economic development[43]. Improving the effectiveness and efficiency of conservation measures for threatened and protected species like sharks is therefore crucial in promoting economic, social and environmental sustainability. This project aims to improve the understanding of the socio-economic value of the shark diving industry for the livelihood of the Maldivian community and how this value changed over the last two decades. I will furthermore shade light on interactions between the tourism industry and illegal shark fishing activities. Results will help

understand optimized stakeholder behaviour that potentially helps diminishing user conflicts and improve compliance of fishers in the area. Hence, my project can contribute to the conservation of shark populations with positive consequences for the local economy and marine ecosystems. My findings can be applied to other MPAs in a variety of places around the globe that face similar problems as the Maldivian shark sanctuary.

The work from Anderson et al. (1993) was the first structured estimation of the market value of a shark diving industry. Even though the literature on the market value of marine megafauna for the diving tourism has gained increasing attention, most of these studies are of cross-sectional nature and estimate the market value on a local[36] or global scale[62]. As the field of study is fairly recent there are no studies on trends in the market value of a particular shark diving industry[33]. The market valuation of the shark diving industry in the Maldives will therefore give a valuable update of the work from 1993 and will be a first step towards longitudinal data in this field.

An extensive and systematic review of the literature has confirmed that although much has been written about the economic importance of the diving tourism industry[33], illegal fishing in marine protected areas[11], and the theoretical framework of how to improve compliance, there is nearly an absence of information on how the diving tourism sector could reduce illegal fishing activities in MPAs. The second part of this project will therefore start filling this research gap by linking the named aspects using established methodologies of resource economics. My results might reveal important information for future projects in this field of study.

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