Shark-diving Tourism as a Financing Mechanism for Shark Conservation Strategies in Malaysia

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Abstract

This study estimated the economic value of the shark-diving industry in Semporna, the most popular diving destination of Malaysia, by surveying the expenditures of diving tourists and dive operators through the region. A willingness-to-pay survey was also used to estimate the potential of the industry as a financing mechanism for enforcement and management of a hypothetical shark sanctuary. The study showed that in 2012, shark-diving tourism provided direct revenues in excess of USD 9.8 million to the Semporna district. These economic benefits had a flow-on effect, generating more than USD 2 million in direct taxes to the government and USD 1.4 million in salaries to the community. A contingent valuation analysis indicated that implementation of a fee paid by divers could generate over USD 2 million for management and enforcement of a shark sanctuary each year. These findings suggest that shark diving is an important contributor to the economy of the Semporna region that could be used as a mechanism to assist financial resourcing for management and conservation strategies.

Keywords: Marine protected area; socio-economic valuation; shark sanctuary; enforcement; Semporna; willingness-to-pay

1. Introduction

Shark-diving is a fast-growing tourism industry that at a global scale has been estimated to engage around 600,000 participants every year [1]. In 2013, established shark-diving operations could be found in approximately 45 countries spread throughout tropical and temperate waters around the world and many generated significant economic benefits to local economies. For example, in Fiji shark diving inputs over USD 42 million annually to the country's economy, whereas in Palau, Micronesia, the industry generates around USD 18 million per year, accounting for approximately 8% of the Gross Domestic Product [2,3]. In Australia and French Polynesia, shark diving generates annual revenues of USD 25.5 and 5.4 million per year, respectively, while at the small archipelago of Fernando de Noronha, Brazil, this activity generates USD 2.6 million annually [4,5,6]. Worldwide, the most valuable shark-diving industry occurs in the Bahamas, where it generates annual revenues of over USD 109 million [7]. The financial benefits of shark-diving are distributed across several sectors of the local economy, because tourists spend money on both diving and also on a variety of other goods and services such as accommodation, food and transport. Shark-diving tourism also generates income through tax revenues, enabling governments to provide services and infrastructure to communities [2,3].

Many of the sharks species on which this tourism industry is based are, however, exposed to an extensive global fishery with an estimated catch of at least 100 million individuals per year [8]. Sharks are very susceptible to overexploitation, because they have long generation times and low growth and reproductive rates, which has led to declines of many populations worldwide [9]. Reductions in the abundances of sharks pose a threat to the shark-diving industry and have major implications for local economies of nations involved in the activity [10,11]. Moreover, the depletion of shark populations may also have a negative impact on the ecological integrity of marine systems, where sharks have an important regulating role [12,13].

The economic value of shark-diving tourism provides a strong incentive for the implementation of management strategies that seek to maintain healthy populations of sharks. Between 2009 and 2017, at least 13 nations and territories around the world banned shark fisheries and/or the trade of shark products within their waters by implementing shark sanctuaries. These sanctuaries are multiple-use marine protected areas (MPAs) that typically impose prohibitions on fisheries that capture sharks as target species or bycatch, while still permitting the operation of other fisheries in the same area [14]. The effectiveness of shark sanctuaries as a management option to conserve populations depends on managers having access to sufficient funds to implement surveillance and control activities to enforce sanctuary status and the engagement and compliance of local communities in the cessation of targeted fishing

[15,16]. Despite the importance of enforcement, many of the small island countries that have implemented sanctuaries lack the economic and logistic means to effectively police regulations, a situation exacerbated by the large areas of open sea encompassed by many sanctuaries.

Given that shark-diving tourism offers a significant income stream to local economies in many countries, one option to fund the establishment and management of sanctuaries or other conservation strategies, such as bans on targeted shark fishing, might be to explore options for levies on this type of tourism. This requires, firstly, detailed information about the socio-economic importance of the local shark-diving industry and secondly, information on the willingness of tourist participants to fund such levies. Some of the revenues from shark diving-tourism, such as tax revenues, are relatively simple to identify. However, many economic benefits are not measurable in market transactions and must be assessed using non-market valuations. For example, travel cost surveys [17] can be used to estimate to what extent local tourism expenditure relies on the abundance of shark populations and/or the presence of a shark sanctuary at a tourist destination. Other non-market valuation methods such as contingent valuation [18] can be used to estimate visitors' (and non-visitors') willingness-to-pay (WTP) for the ability to see high abundances of sharks, the presence of a shark sanctuary or the imposition of bans on shark fishing. Non-market valuation surveys can also be employed to estimate how much shark divers would potentially be willing to pay to enter sanctuaries, and can thus reveal what additional financial resources could be generated by the introduction of entrance fees [6]. This is particularly important in developing countries that lack the resources to police and enforce management strategies [16,19].

This study investigates these matters for the marine environments of the Semporna district in Malaysia, where conflicts between shark fishing and diving tourism have generated initiatives for management strategies including shark sanctuaries and a moratorium on shark fishing across the region. The study estimated the market value of shark-diving tourism, including direct revenues and taxes generated for both the local communities and government. Using a WTP survey, the study also estimated the potential revenues that could be generated through user fees from dive tourists to administer conservation strategies.

2. Methods

2.1 Study site

Semporna is a district in the southeast of the Malaysian state of Sabah, on the island of Borneo (Figure 1).The district is located on the border of the Coral Triangle and is the most biodiverse area of marine

fauna in the world [20,21]. The Semporna region maintains Malaysia's largest dive tourism industry, with its islands (e.g. Mabul, Pom-Pom, Kapalai, Mataking and Ligitan) and the Tun Sakaran Marine Park as popular diving destinations. According to the local diving industry, the main drawcard for divers to visit the area is the island of Sipadan, which received about 43,900 divers in 2012 (Sabah Parks - Personal comm.). Around Sipadan, divers have the opportunity to interact with large predatory fishes such as sharks. Common reef shark species such as the white-tip reef (*Triaenodon obesus*), grey reef (*Carcharhinus amblyrhynchos*) and scalloped hammerhead (*Sphyrna lewini*) sharks are regularly sighted around the island. Although less frequent, other species such as the Borneo shark (*Carcharhinus borneensis*) and the whale shark (*Rhincodon typus*) can also be observed. The Sipadan Island Park (168 km^2) and the Tun Sakaran Marine Park (350 km^2) are both largely no-take zones; however, hook and line fishing is allowed in specific zones of the latter park.

In Sabah, it has been estimated that approximately 22,000 people rely on fishing activities [22]. Local fisheries target mainly reef-associated fish species, but pelagic species of carangids and scombrids are also commonly caught. There are also reports of fishers targeting sharks in the region. Malaysia was ranked as the world's ninth-largest fishery for shark and ray products between 2000 and 2011 but decreasing shark landings indicate a decline in shark populations in the region [23]. This suggest that both legal and illegal fishing activities still put pressure on shark numbers [8]. Concerns about the impact of fishing on shark populations in the region have resulted in a proposal to implement a moratorium on shark fishing and a shark sanctuary in the district.

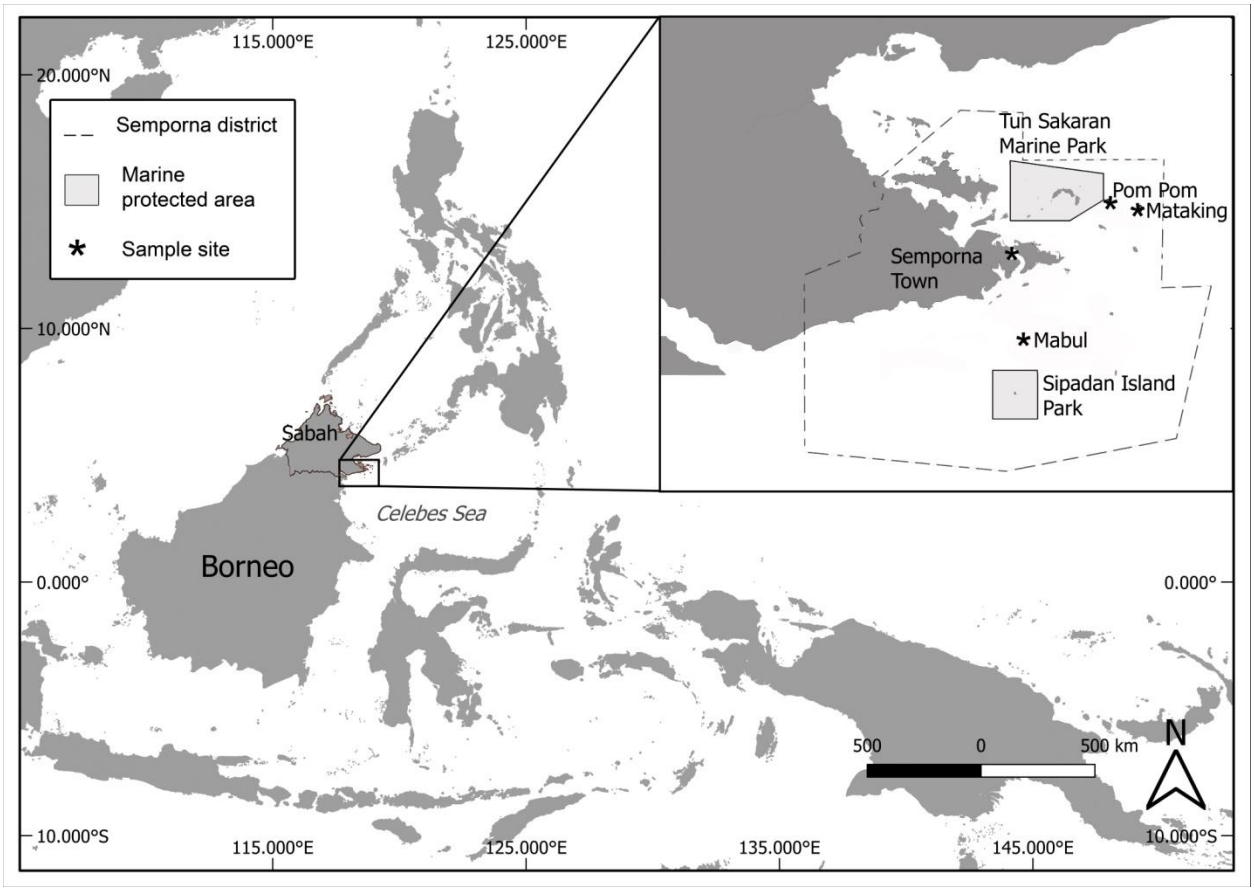

Figure 1: Map of the Semporna region

2.2 Surveys

Three self-administered questionnaires were administered with three samples of respondents in the Semporna district: dive tourist, guides, and operators. These questionnaires were designed to elicit the market and non-market values generated by shark-diving tourism in the region. The survey was conducted between September and October 2012. The questionnaires followed the protocols established by other shark-diving industry valuations conducted in Palau and Fiji [2,3]. Questionnaires and a printed explanation of the purpose of the research were handed to tourists and dive guides at the end of their dive trip.

The dive tourist survey collected information about divers' demographic characteristics, their motivations to visit the destination, their satisfaction with the diving experience, and expenditures while in the region. These expenditures included costs of accommodation, living costs, diving and shark diving (when applicable), domestic transfers, and money spent on other activities (e.g. land tours) while in the region. The questionnaire also included a contingent valuation component, in which divers were asked their

maximum WTP for a daily fee to provide funds for enforcement of a hypothetical shark sanctuary (Section 2.4).

The dive guide survey was conducted to collect socio-demographic information, as well as characteristics of the shark-diving industry, such as dive sites visited, shark sightings, divers' motivations to visit the region, average number of divers and sharks at sites, and employment information (salaries, length of employment etc.).

The dive operator survey involved interviews with managers of dive businesses based in the town of Semporna, and islands of Mabul, Pom-Pom, and Mataking. These surveys included companies that currently held licenses to dive at Sipadan (12 companies with a daily quota of 120 divers) and dive companies that operated exclusively in other sites of the Semporna region. The questionnaire for dive operators obtained information about the characteristics of the businesses, including number of tourists taking dive trips, main dive attractions and activities, information about employees and operators' expectations regarding the dive industry. Detailed information regarding expenditures related to the diving operation and salaries were also collected.

2.3 Economic revenues from shark diving

The direct economic benefits from shark-diving tourism were estimated based on tourists' expenditure on diving, accommodation, living costs, and local transport. These benefits capture the business revenues brought to the region by the shark-diving industry. It is recognised that business revenues do not equate to the total economic benefits from the shark-diving industry: shark-diving services contribute to a range of market and non-market (consumptive and non-consumptive) values [24]. Nevertheless, revenue provides a useful indicator of the economic importance of the industry, and is consistent with other common economic metrics such as GDP.

The analysis of direct economic benefits from shark diving included the revenues of businesses that benefit directly from the presence of shark divers (i.e. dive operators, hotels, resorts, restaurants, and souvenir shops) as well as the flow-on of revenues to the local community in the form of employee wages. Business tax revenues from the dive operators and associated businesses that provide services for shark divers were also calculated. The analysis also included data that were collected in the tourist survey: the average expenditure of dive tourists in the Semporna district and the percentage of divers who stated that their visit to the region was conditional on the possibility of sharks being sighted. Other key information consisted of the total number of divers visiting the Semporna district in 2012, provided by the

Sabah Parks. The economic variables and formulas for data analyses are shown in Tables 1 and 2. For further details on the methodology, see [3].

Table 1: Description of constants and parameters used to estimate revenues generated by the shark-diving industry in the Semporna district.

Variable		Description (units)	Values	Source
D	# divers per year	Total number of divers visiting the district per year (#/yr)	43,898	Sabah Tourism
SD	#shark divers per year	Estimated number of shark divers visiting the district per year (#/yr)	10,096	Tourist questionnaire
SDP	Shark-diving parameter	Proportion of shark divers (SD/D)	0.23	Tourist questionnaire
W	Wages	Average salary of employees of diving industry in the Semporna district (USD/yr)	3,137	Operator questionnaire
BT	Business tax contribution	Minimum tax rate contribution	0.2	Operator questionnaire
E	Number of employees	Estimated number of employees in the dive industry in the Semporna district	2,000	Wood et al. 1997 [25]
A	Average days of diving	Average number of days diving in the Semporna district (days)	4	Tourist questionnaire

Table 2: Formulas to calculate the economic value and distribution of revenues from shark diving in the Semporna district (all variables except diver expenditure in USD/yr, diver expenditure in USD/trip).

Abbreviation	Estimate	Formula	Source
Business revenues from tourism			
BRD	Business revenues from divers	D x DET	Tourist questionnaire
BRS	Business revenues from shark diving	BRD x SDP	Tourist questionnaire
Community benefits from shark diving			
DCID	Direct community income from diving	W x E	Operators questionnaire
DCISD	Direct community income from shark diving	W x SDP x E	Operators questionnaire
Tax revenues from shark diving			
BRTD	Business revenues tax from diving	BRD x BT	Operators questionnaire
BRTSD	Business revenue tax from shark diving	BRS x BT	Operators questionnaire
Expenditures			
DET	Diver expenditure per trip	Accommodation expenses + Diving expenses + Extra expenses	Tourist questionnaire

Divers' willingness to pay			
REV_{ENF}	Potential annual revenues from daily park fees for enforcement	$WTP_{ENF}\ x\ D\ x\ A\ x\ currency\ rate$	Tourist questionnaire

* For a detailed explanation of calculations see [3].

2.4 Willingness to pay

Contingent valuation is a well-established method to determine the WTP of individuals for the provision of non-market environmental goods or services, or for public policies that have not yet been implemented [26,27,28]. This study estimated the WTP of dive tourists for the enforcement of a hypothetical shark sanctuary (here called WTP_{ENF}). The contingent valuation question used a payment card, that showed tourists five categories of daily user fees in Malaysian ringgit (MYR) of 0, 1-15, 16-30, 30-60, >60. The bids were chosen based on local knowledge of dive operators about user fees from surrounding marine reserves. Respondents were asked to select their maximum WTP_{ENF} from the offered bid amounts. The payment card approach allowed us to observe the lower and upper bound of respondent *i*'s WTP_{ENF}. The statistical model estimated on contingent valuation data was based on the probability that respondent *i*'s WTP_{ENF} lay between the observed interval values; $\Pr(B_L < WTP_{ENFi} < B_U | X)$. The highest category (MYR>60) was right censored as a respondent's true WTP can be any value between 61 and infinity; $\Pr(WTP_{ENFi} > B_H | X)$. An interval regression (*intreg*) model was estimated in Stata13 software where individual WTP_{ENFi} was specified as a linear additive function of individual characteristics $\boldsymbol{X}_i$ and an independently and identically distributed error ε_i with zero mean.

Aggregate respondents' WTP for a daily fee for enforcement of a possible future shark sanctuary provides information about the potential annual revenues gained from implementing such an entry fee policy (here called REV_{ENF}). It was hypothesized that respondents with higher income would have a higher WTP. Other independent variables that were tested included gender, age, nationality, level of dive experience, and the likeliness of a diver returning to the region. Respondents were also asked whether a shark sanctuary in the Semporna region would affect the way they would recommend the destination to other divers.

3. Results

A total of 356 questionnaires were completed, of which 307 were answered by dive tourists and 33 by dive guides, sampled across 12 dive operators in the region. The survey also collected information from

16 of the 22 dive operators identified in the region, sampling the town of Semporna and islands of Mabul, Pom Pom and Mataking.

3.1 Tourist profile

Most diving tourists came from Europe (49%), followed by divers from domestic localities (17%) (Table 3). Most divers were relatively young (21-30 years old) males, with a low level of diving experience (5-49 dives), and an annual income between USD 20,000 and 49,999 (Table 3).

Table: 3 Summary of respondents' characteristics

Variable	N	Percentage
Age (years old)	***Mean ± St. Dev***	***34 ± 9.5***
< 21	5	1.8
21 to 30	115	40.5
31 to 40	112	39.5
41 to 50	35	12.3
> 50	17	6.0
Total	**284**	
Annual income (USD)	***Mean ± St.Dev***	***57.5 ± 37.4***
<20,000	58	21.6
20,000 to 49,999	70	26.0
50,000 to 79,999	67	24.9
80,000 to 119,999	40	14.5
> 120,000	34	12.6
Total	**269**	
Dive experience(number of dives)	***Mean ± St.Dev***	***118 ± 147***
< 5	13	4.6
5 to 49	142	50.0
50 to 99	60	21.1
100 to 499	48	16.9
> 500	21	7.4
Total	**284**	
Gender		
Female	129	45.4
Male	155	54.6
Total	**284**	
Region of origin		
Europe	136	47.9
Asia	100	35.2
Others	48	16.9
Total	**284**	
Likeliness to return to the region		
Definitely won't return	13	5

Unlikely to return	28	10
May return	102	36
Likely to return	83	30
Definitely will return	55	20
Total	**281**	
Effect of an hypothetical shark sanctuary on recommendation		
Negative / No effect	61	22.0
Little / Large effect	216	78.0
Total	**277**	

Interviews with divers showed that the principal motivation to visit the area was to engage in general diving activities (37%). A total of 25% of divers came to the Semporna specifically to dive at Sipadan, and 23% of the divers stated that they would not have chosen the region as a destination if there were no sharks to be sighted during the dives. Based on this percentage, it was estimated that about 10,000 divers are visiting Semporna annually mainly to see sharks and were classified as shark divers. Although not the sole motivation for diving in the region, 73% of divers stated that they were interested or very interested in diving with sharks.

3.2 Revenues from shark-diving

With 23% of all divers classified as shark divers, the business revenue that could be attributed to shark diving in the region was USD 9.8 million. Benefits also flowed through the provision of salaries to employees of the diving industry. The average annual salary of employees was USD 3,137.

The diving industry in Semporna is responsible for the generation of approximately 2000 jobs [25]. Assuming that the number of jobs generated in this industry is directly proportional to the number of tourist divers visiting the region, sharks as a non-consumptive tourism resource are responsible for the maintenance of approximately 460 jobs that generate a direct annual income of USD 1.4 million to the local community. Business revenue tax to the government from shark-diving totalled USD 1.97 million (Table 4).

Table 4: Estimated revenues and income generated by the diving industry in the Semporna district in 2012.

Code	Description	Value (USD)
Annual business revenues		
BRD	All divers	42,772,849
BRS	Shark divers	9,837,755
Annual community income		

DCID	Direct community income from diving	6,274,000
DCISD	Direct community income from shark diving	1,443,020
Annual tax revenues		
BRTD	Business revenue tax from diving	8,554,570
BRTSD	Business revenue taxes from shark diving	1,967,551

3.3 Willingness-to-pay

A range of interval regression models were tested on the data. The final model results (Table 5) showed that income, gender, age, likeliness of a diver returning to the region, and likeliness of recommending the region to other divers were statistically significant in explaining respondents' WTP_{ENF}. Region of origin and diver experience were not significant predictors of WTP_{ENF} and were thus not included in the final model.

The estimated WTP_{ENF} for daily park fees of a respondent with all demographic covariates at their reference level (male, <21 years in age, annual income of USD <20,000, would not return to the region) is given by the constant term in Table 5, at MYR 84.15 (USD 28.00) per day. The socio-demographic variables included in the model reflect the differences in WTP_{ENF} between respondents with different characteristics. As shown in Table 5, female respondents were willing to pay MYR 5.1(USD 1.70) more than male respondents. The older the respondent, the lower was their willingness to pay (as indicated by the negative coefficient). As expected, respondents with higher income were willing to pay more than those with a lower income, although this effect was only significant for two of the five income categories (USD 20,000 to 49,999 and USD 80,000 to 119,999). Respondents who stated that they were more likely to return had a lower WTP_{ENF} than respondents who stated they would definitely not return. Finally, respondents who stated that a shark sanctuary in the Semporna district would positively affect their recommendation of the destination to other divers were willing to pay MYR 9.00 (USD 3.00) more per day than respondents who answered it would not, or would negatively, affect their recommendation.

Table 5: Interval regression results of divers' WTP_{ENF} a daily access fee to enforce a shark sanctuary (n = 259)

Variable	Coefficient	Std.err.	
Constant	84.12	15.58	***
Gender = 1 (Male)	-5.09	3.09	*
Age(years, <21 = reference)			

21 to 30	-33.32	13.49	**
31 to 40	-38.58	13.67	***
41 to 50	-42.61	14.93	***
> 50	-31.44	14.66	**
Annual income(USD, < 20,000 = ref)			
20,000 to 49,999	10.07	4.47	**
50,000 to 79,999	5.17	4.61	ns
80,000 to 119,999	13.30	5.16	**
> 120,000	4.44	5.83	ns
Likeliness to return to the region (1 = ref)			
Unlikely to return (2)	- 27.51	9.22	***
May return (3)	- 23.65	8.27	***
Likely to return (4)	- 20.40	8.37	**
Definitely will return (5)	- 30.08	8.72	***
Effect on recommendation	8.99	3.54	***
ln(σ)	3.11	0.05	***
Log-likelihood	- 457.51		
Pseudo-R^2	0.147		
AIC	947.03		

Notes: ***, **, * = significant at 1%, 5% and 10% respectively; ns = not significant; R^2 calculated against a constant-only model (LL = -536.395)

Table 6: WTP_{ENF} of divers with differing socio-demographic characteristics

Respondent characteristics	**Mean WTP_{ENF} (MYR)**	**Std.err.**	**Confidence interval**
Sample average	35.73	1.49	(32.81 – 38.64)
Female, < 21 yrs. age, income of 20-50K, definitely won't return, no effect on recommendation	97.19	16.20	(65.45 – 125.93)
Male, 21-30 yrs. age, income of 80-120K, definitely won't return, little/positive effect on recommendation	68.00	9.00	(50.37 – 85.64)
Male, 41-50 yrs. age, income of 80-120K, likely to return, little/positive effect on recommendation	38.32	6.00	(26.57 – 50.07)
Female, > 50 yrs. age, income of > 120K, may return, little/positive effect on recommendation	42.46	8.64	(25.52 – 59.40)
Male, 31-40 yrs. age, income of 50-80K, will definitely return, no effect on recommendation	15.54	6.26	(3.27 – 27.81)

Average individual WTP_{ENF} estimates were aggregated over the total number of divers per year (*D*) and the average number of diving days (*A*) to obtain the potential annual revenues from a daily park fee, converted to USD using a currency rate of 0.33. Based on the mean WTP_{ENF} from respondents, the shark sanctuary could generate an estimated annual revenue (REV_{ENF}) of USD 2.1 million (confidence interval: 1.9 - 2.2 million) from park entry fees. The cumulative distribution of WTP_{ENF} responses (Figure 2) shows that nearly 20% of respondents were willing to pay more than MYR 60 (USD 20.00), which was

the highest bid offered on the payment card. This indicates that annual revenues could potentially be higher than the estimates reported here, as the upper bound of the WTP_{ENF} for these individuals is unknown. Approximately 10% of respondents were not willing to pay a daily user fee to enforce the proposed shark sanctuary (Figure 2).

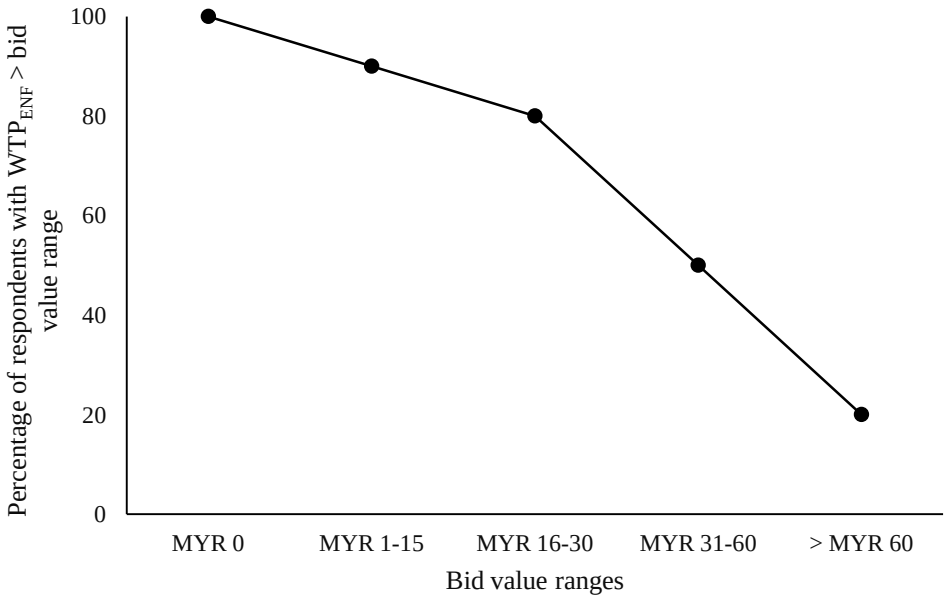

Figure 2: Cumulative distribution of WTP_{ENF} responses showing the percentage of respondents who were willing to pay the amount specified by each bid range category.

4. Discussion

The economic value of shark diving in the Semporna district is substantial, with results from this study suggesting that in 2012, the industry contributed USD 9.8 million (23%) of a total of USD 43 million in business revenues generated by diving tourism to the region. Additionally, shark diving maintained approximately 460 jobs that generated a direct annual income of USD 1.4 million to the local community. Expenditure on shark diving also had flow-on effects for the local economy, benefitting businesses that might not be directly involved in the industry. These figures contrast with the value of the reported shark catch in the same region. In 2012, landings of sharks caught by commercial and traditional fishing gear totalled 462 tonnes, a total annual value of the catch of USD 457,000 (based on an average market value of RM 3/kg [22], or less than 5% of the value of the revenues generated by shark-diving tourism in the region each year. Shark populations are highly sensitive to fishing pressure [8] and in many popular shark-diving destinations, fishing has caused localised depletion of sharks, with reported economic losses

for the diving industry [10,11,29]. The potential loss of revenues associated with a reduction in the abundance of sharks makes a strong argument for the need to carefully manage shark stocks in the region.

The economic value of the shark-diving industry in Semporna (USD 9.8 million) is comparable to the value of similar industries in other countries in the Indo-Pacific. For example, in 2010, shark diving in Palau generated USD 18 million in revenues [3], whereas in Australia, where four regional shark-diving industries are well established, this activity generates between USD 1.9 and 11.6 million per industry, with the estimated national value of USD 25 million per year [5]. Similarly, in Fiji, which also offers a variety of shark-diving tourism, the industry is valued at USD 42 million per year, with regional industries generating between USD 3.2 and 10.2 million [2]. This variation in income among countries partially reflects differences in the scale and popularity of tourism industries, but is also a related to the seasonality and type of diving (shore-based, boat-based etc.) and the economic profile of each country. As more standardised valuation studies become available, these data may assist the development of models that could predict the potential of diving tourism to finance the implementation of management and conservation strategies.

Any management strategy that seeks to ensure sustainability of shark populations, which might range from fisheries management to the creation of MPAs or moratoriums on shark fishing, requires that the administering agency (government fisheries department etc.) has sufficient funds to enforce regulations. In the Caribbean, McDonald et al. (2017) have shown that tourist fees generated sufficient funds to finance an enforcement strategy for an MPA that benefited both tourism and artisanal fisheries. This study also suggests that the tourism industry could provide an effective source of funds for this goal. In the Semporna region, the willingness to pay survey suggested that divers could generate annual revenues of more than USD 2 million. This might remove a major political/economic barrier to the implementation of management strategies that could sustain the populations of sharks on which diving tourism is dependent.

Future income from shark tourism at Semporna relies on the continued existence of abundant populations of sharks, which at present are threatened by both legal and illegal fishing. The sustainable exploitation of shark stocks is inherently difficult because these animals have life history traits that make populations highly susceptible to overfishing and population recovery very slow [8]. This is complicated by the fact that many coastal developing countries where shark tourism occurs have very low enforcement capabilities due to a lack of funds. In this situation, illegal, unreported and unregulated (IUU) fishing is often rampant and has been responsible for depletion of shark populations in many regions around the world [8]. This has also been an issue in Semporna, where the large number of IUU fishers and the

widespread use of destructive fishing practices result in habitat degradation and further difficulties for fisheries management in the region.

Captures of sharks in the Semporna region are frequent, but represent only a small fraction of total landings in the area. Although shark fins are traded legally in the region as a valuable product, the value of the shark meat is generally very low. However, sharks are part of a multi-specific group of species that can be part of the livelihood and an important source of protein for subsistence fishers in the region [30]. For this reason, the implementation of any conservation measurement such as a ban of shark fishing or landing imposed by a sanctuary, needs to take into account the potential impacts on the livelihood of local communities and balance conservation needs with mitigation of socio-economic impacts whenever possible [31,32]. Shark sanctuaries typically ban targeting, retention and landing of sharks, while still permitting exploitation of other fish stocks [33]. Therefore, it is unlikely that the creation of the sanctuary would cause considerable displacement of local artisanal fishers as these would still be able to target other groups of fish.

In the Semporna district, fishers are known to supplement their income by working in the diving industry [30]. This suggests that the shark-diving industry in the region can be a viable alternative to support the livelihood of at least some stakeholders who benefit from the consumptive use of sharks. This has been the case in other popular destinations for shark diving. For example, in Fiji, a MPA created to protect sharks has also been effective in improving the livelihood of local communities [34]. This reserve is supported by the local community, which benefit from revenues of over USD 650,000 annually in direct salaries (e.g., dive guides) and fees for the right of operating at the shark-diving sites [2]. Socio-economic analyses at other localities where the shark-diving industry is well established suggest that fishers may also gain better livelihoods by supplying tourists with reef-fish catches than by targeting sharks [3].

Although the adoption of fees on shark diving could raise concerns that these will have a negative impact on the number of visitors to the region, 90% of the diving tourists were willing to contribute financially to the enforcement of management strategies such as sanctuaries. Visitors who stated that the implementation of a shark sanctuary in Semporna would positively influence the way they recommended the destination to others were willing to pay significantly more than those who stated that the shark sanctuary would have a neutral or negative effect on the way that they recommend the destination. However, the analysis also showed that returning visitors were willing to pay significantly less than visitors who were not planning to return to the region. This finding suggests that the implementation of any fee payment scheme must consider the visitation and return rates of individual tourists.

Willingness-to-pay studies have been widely used to investigate the acceptance and optimal value of hypothetical marine park fees, including shark sanctuaries, and inform decision makers of the financing potential of fee implementation [7,35]. However, to avoid biases, WTP studies need to be carefully designed to present clear and objective explanations of the purpose of the survey, contextualize the destination of the resources and avoid overestimates or unrealistic bids associated to the hypothetical nature of the fee [35]. This study minimised the potential biases inherent in WTP studies by providing discrete categories of fee value options (as opposed to open-ended questions) based on fees that already existed for other reserves in the region. Moreover, an explanation of the purpose of the research was given prior to interviews, which provided context for respondents to understand the implications of establishment of the proposed fee [35].

The total number of divers is key element to estimate the value of a shark-diving industry [3,5,7]. To overcome the absence of reliable official statistics of these figures the number of divers visiting Sipadan was used as a proxy for the total number of divers visiting the Semporna district in 2012. However, due to the limited number of permits issued per day to visit Sipadan (120 permits), the total number of divers (and therefore shark divers) was likely to be higher. For this reason, this study represents an underestimate of the direct value of the shark-diving industry in Semporna. Estimates focused on the direct and indirect revenues generated by shark diving, which is a labour-intensive industry that relies on several accessory services such as catering, equipment maintenance, transport etc. Although some of the revenues generated by these services may also be considered as part of total economic value of the shark-diving industry, the contribution of shark divers to the total value of the services could not be accurately partitioned and for this reason they were not included in our estimates.

5. Conclusion

The analysis has shown that the value of the shark-diving industry in the Semporna district is high, with socio-economic benefits flowing from the industry to the local community and government through taxes. The contingent valuation analysis shows that the shark diving industry could assist financial resourcing of management strategies such as the establishment of a shark sanctuary through park fees. Besides safeguarding the shark-diving industry, the enforcement structure implemented by such management measures could also provide the logistics necessary to improve management of local artisanal and subsistence fisheries through the establishment of landing monitoring and enforcement programs that would otherwise not be financially viable. For this synergy to be possible, local managers and decision-makers need to be particularly careful to develop an integrated management plan that takes into account

the considerations of all local stakeholders, while clearly addressing conservation and socio-economic needs.

Acknowledgements

The authors would like to thank Ric, Rohan Perkins and Guido Capezzuoli for logistic support and Isabel Ender for the assistance with data collection. We would like to express our thanks to the managers and staff of Scuba Junkie, Borneo Divers, Billabong Scuba, Celebes Beach Resort, Uncle Chang, Seaventures Rig Resort, Sipadan Scuba, Sipadan.com, Borneo Speedy Dive, Sphere Divers, Sipadan Water Village Resort, Global Divers, Big John Scuba, Sipadan Pom-Pom Resort, Singamata Adventures and Reef Resort, Borneo Unlimited Marine Sport and Perfect Diver. We would also like to thank Borneo Conservancy, in particular Mr. Daniel Doughty. Thanks also to Sabah Tourism Board and WWF Malaysia for providing data. This work would not be possible without the collaboration of the tourist divers who kindly took their time to answer the questionnaires.

Funding

Additional support has been provided by the Australian Research Council Centre of Excellence for Environmental Decisions.

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