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The past, present and future benefits of the shark-diving industry in Semporna Malaysia

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1 EXECUTIVE SUMMARY

Shark-diving tourism can create considerable benefits for local economies. We surveyed dive operators and dive tourists in the Semporna region to estimate the economic value of the shark diving industry and the willingness of dive tourists to pay a daily fee that could be used for shark and ray conservation measures. Additionally, we estimated the change in demand for dive holidays under the scenario that a shark and ray fishing ban was implemented in Sabah, the state in which the Semporna region lies.

We found the annual business revenue from shark diving for the dive tourism industry to be USD 6.4 million and a tax income of USD 3.6 million per year. Shark diving was associated with the generation of 796 jobs that yielded USD 2.8 million per year in salaries for employees.

Our calculation of business revenues contrasted with Vianna et al (2018) who calculated that in 2012, shark divers contributed USD 9.84 million to local business revenues. The lower value calculated by our study is likely due to the fact that we took into account the multi-purpose nature of tourist trips and only included travel costs for the amount of days that people went diving. When all days were included in calculations (as was the approach Vianna et al., 2018), we found that local business revenue from all divers in Sipadan was USD 56.9 million per year. This compares to the values of USD 49 million (inflation adjusted) calculated by Vianna et al. (2018) in 2012. This result suggests that the economic importance of this industry to the local economy has been increasing since 2012.

We explored the potential for the demand for shark diving to change under scenarios of a continuation of current conditions (the status quo) and the creation of a shark and ray sanctuary in Sabah.

Given increases in shark and ray abundance, species diversity and the opportunity for shark diving experiences in the sanctuary scenario, we found there was likely to be a 20% increase in demand compared to the trip demand in the last five years. This increase could generate economic gains of over USD 2.4 million per year for the dive tourism industry and USD 11.1 million for the local tourism industry in the Semporna region.

However, should current conditions of the dive experience in Semporna be maintained (the status quo scenario), this could cause a decline in dive trip demand of 20%,with about a quarter of tourists not wishing to return to Semporna in the next five years. Under this scenario, the business revenue for the local dive tourism industry would decrease to a total of USD 17.19 million per year, whereas revenue for the local tourism industry would decrease to USD 44.24 million. Tax revenues would decrease to USD 9.73 million.

On average, tourists were willing to pay a daily fee of USD 9.5, which could generate a total of USD 2.7 million per year that would be available for the management and enforcement of a shark and ray sanctuary.

The economic value of the shark dive tourism industry in Semporna is substantial. The implementation of a shark and ray sanctuary in all waters of Semporna could increase economic revenues for the dive tourism industry both by stimulating demand and through the collection of a daily access fee for the park. These increased revenues could be used as mechanism to finance management of the sanctuary.

2 INTRODUCTION

Sharks are subject to extensive global fisheries that have caused many populations to decline rapidly (Fields et al., 2018). The demand for shark fins as a component of shark fin soup, particularly in South East Asia, is a key driver of this fishery. It is estimated that about 100 million sharks are caught annually (Worm et al., 2013), a third of which consists of species that are at risk of extinction (Fields et al., 2018). Mobulids (the genera that comprises manta and devil rays) are also targeted by fisheries, in this case for their gill rakers, a high value commodity in markets supplying traditional Chinese medicines (O'Malley et al., 2017). Similar to sharks, declining catches suggest overfishing and possibly even local extirpations of these species in several sites in South East Asia (Lewis et al., 2015).

There is a widely recognised need for conservation and management strategies to protect populations of sharks and rays from overexploitation (Worm et al., 2013). One type of these involves the creation of sanctuaries where commercial shark (and usually ray) fisheries are prohibited. These can vary in size but in many cases include entire Exclusive Economic Zones. Since the implementation of the first shark sanctuary in 2009, a total of 15 countries or territories have implemented shark sanctuaries comprising about three percent of the total ocean surface (Ward-Paige and Worm, 2017).

A tourism sector that focuses on diving with sharks and rays is a phenomenon common to many of the countries that have created shark sanctuaries, particularly in the island nations of the Indo-Pacific (Ward-Paige, 2017). Studies of these industries highlight the large contribution they can make to local and national economies, which are typically many times the value of fisheries for the same animals (Gallagher et al., 2015; O'Malley et al., 2013). This economic argument underlies the popularity of sanctuaries and the rapid proliferation of this management strategy worldwide.

Although creation of sanctuaries is an increasingly common approach, major challenges remain. One obvious issue is the enforcement of no-take regulations due to a lack of resources (Chapman et al., 2013; Vianna et al., 2016), particularly where sanctuaries might cover many thousands of kilometres of open ocean. User fees have been identified as a potential mechanism to finance the management and enforcement of protected areas (e.g. Gelcich et al., 2013; Thur, 2010) and could be applied to overcome this issue for shark sanctuaries (Vianna et al., 2018). Another concern is the displacement by sanctuaries of fishermen that may have relied on sharks for livelihoods. In some localities, fishers have changed techniques to supply resorts and tourists with reef fish (Ali and Sinan, 2014; Vianna et al., 2012), whereas in others, a lack of alternative sources of income has resulted in engagement in high-risk activities including illegal fishing (Jaiteh et al., 2017). Tourism can sometimes offer a means to overcome this problem, through payment of a user fee for shark diving that compensates former shark fishermen for the loss of fishing rights, as is the case in Fiji (Brunnschweiler 2010).

Here, we investigate the current economic value of the shark and ray dive tourism industry in the Semporna region of Sabah, Malaysia. This work updates earlier economic studies in 2012 in order to examine the rate of growth of the industry. The region hosts Sipadan Island, which is a major draw card for shark divers that in 2012 generated revenue of USD 42 million per year to local businesses (Vianna et al., 2018). However, Malaysia is also one of the leading nations in the trade of shark fins and declining catches likely indicate overfishing of populations (Dent and Clarke, 2015), possibly with dramatic consequences for the dive tourism industry. As a consequence, the local government is considering options for the management of stocks with options for a moratorium on fishing or a shark sanctuary. We explore the willingness to pay of dive tourists for a user fee that could be used to finance such management options. We also examine how the establishment of a shark sanctuary might affect the demand of dive tourists and thus the future economic benefits of shark diving in the region.

3 METHODS

3.1 Study area

The study focused on the Semporna district in the southeast of Sabah, Malaysian Borneo (Figure 1).Semporna hosts Malaysia's largest dive tourism industry and the main attraction for divers to visit the region is the island of Sipadan, which lies on the edge of the continental shelf with steep drop-offs around the reef to depths around 600 m. Here, divers can observe large pelagic fishes such as white-tip (Triaenodon obesus) and grey (Carcharhinus amblyrhynchos) reef sharks, scalloped hammerhead sharks (Sphyrna lewini) and manta, devil (Mobula spp), and eagle rays (Aetobatus narinari). In order to protect Sipadan from environmental impacts, 168 km² around the island was declared a no-take zone for fisheries and in 2004, all tourist operators on the island were relocated to the mainland or surrounding islands. Today, there is a limit of 120 diving licenses available per day to visit the island. Adjacent to Sipadan, the islands of Mabul, Pom-Pom, Kapalai, Mataking and Ligitan and the Tun Sakaran Marine Park are popular diving destinations in Semporna (Figure 1).

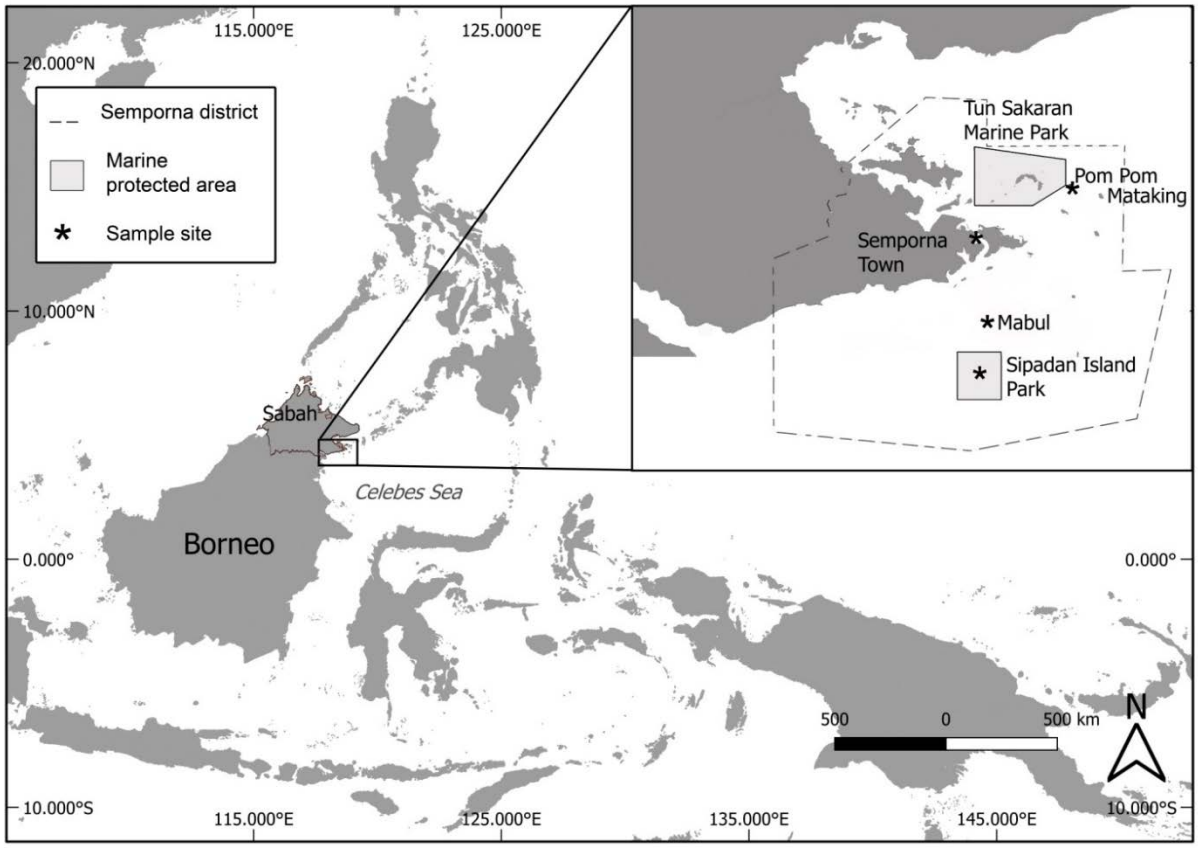

Figure 1: Map of the Semporna region with sample sites

In addition to tourism, fishing remains an important source of income for many people. In 2006 approximately 42,000people (1.2% of the population) relied on fishing activities for their livelihoods in Sabah (Teh et al., 2011). Local, small-scale fisheries mostly target medium and large pelagic fishes including sharks (Teh et al., 2011). Mobulids are also captured and sold in local markets in the Semporna region (first author's observation), although the extent of this fishery is difficult to determine as there are no formal records of catches.

In response to declines in abundances of sharks, in 2017 the Government of Sabah declared six marine parks as shark sanctuaries, including the Tun Sakaran Marine Park and the Sipadan Island Park in the Semporna region. However, ongoing concerns about the wider impact of fishing on shark and ray populations in the region have resulted in a proposal to ban shark and ray fishing and implement a shark sanctuary in the waters of the entire state of Sabah.

Figure 2: Left: Fishing boats with manta and mobula rays on Mabul Island; right: shark jaws in a souvenir shop on Mabul Island. Photo credits: Emil Wittern

4 SURVEYS

In February 2018, self-administered surveys with dive tourists and face-to-face surveys with dive operators were conducted at four tourist sites in the Semporna district (Figure 1). The surveys were designed to elicit the market and non-market values generated by shark-diving tourism in the region. Tourist surveys were distributed to respondents in a digital version on tablets after dive trips.

The surveys contained five sections. In the first, dive tourists were asked about the principal objective of their current trip and recent history of vacations such as the number of visits they had made to Semporna in the last five years, the duration of their stay, the number of days they went diving, and the number of dives they made, in addition to the places in Sabah they were visiting. They were then asked to rank their interest in different dive attractions (high abundances of fishes, sharks and rays, turtles, coral reefs, and macro life) in the Semporna region. They were also questioned regarding the number of dives made specifically to see sharks, how many sharks they had seen in total and their satisfaction with the shark-diving experience, which was measured on a Likert scale from one (very unsatisfied) to five (very satisfied). Lastly, this section asked respondents about alternative activities they might undertake if for some reason they could not go diving with sharks in Semporna.

The second section explained the current protection status of sharks and rays in Sabah and informed the respondent that the government was considering establishment of a shark and ray sanctuary throughout the Exclusive Economic Zone of Sabah. Respondents were then asked if they thought that a sanctuary would protect sharks and rays and whether they had observed the fishing or trade of sharks and rays in Sabah. Tourists were then asked about their future plans to make more dive trips to Semporna in the next five years. This question was posed in the context of two different scenarios: firstly, if current conditions remained the same (the "status quo" scenario), and secondly a scenario where a shark and ray sanctuary was established in Sabah. In the latter, the sanctuary had

three hypothetical effects on the shark dive experience for tourists: (i) sharks and ray populations increased by 30%, (ii) it was possible to see one additional species of shark and ray, and (iii) sharks and rays could be observed at more dive sites, increasing the number of shark dives it was possible to make at different sites during a trip by 25%. For both status quo and shark sanctuary scenarios, tourists were asked to state the total number of trips they would be likely to take to Semporna in the next five years and the number of days they would stay per trip. They were also asked to rank the three effects of the sanctuary (shark abundance, diversity and number of shark dives) in their importance from one (most) to three (least important) as a consideration for return visits. Those respondents that stated that they would not return to Semporna in the next five years were asked why this was the case. Finally, this section asked divers about their maximum WTP for a daily fee to provide funds to support the management of a shark and ray sanctuary (see below). Respondents were asked about their preference on how this fee should be used; either for the enforcement of the fishing ban or to support local communities.

Section three elicited information about travel costs during the current trip, including expenses on international air fares, domestic travel, accommodation, food and beverages, dive activities, and others (e.g. souvenirs and gifts). Those tourists that had bought a travel package were asked to specify items covered by the package and their spending on excluded items. All other respondents were asked for expenditures on each item. In section four, tourists answered questions about age, gender, nationality, their annual net household income, the total number of dives made in their lifetime, whether they were member and/or supporter of an animal welfare organization and whether they were aware of shark and ray conservation programs.

The survey for dive operators contained two sections. The first enquired about the current characteristics of (shark) dive operations including main attractions for dive tourists, shark-diving sites and species that could be seen at these sites. The second elicited information about the number of tourists taking dive trips, numbers of local and foreign employees, and expenditures on operational costs, employee wages and taxes.

4.1 Market value of shark diving

The direct economic benefits from general dive tourism and shark-diving tourism in Sabah were estimated through (i) the direct business revenues; (ii) tax revenues; and (iii) the revenues to the local community in the form of salaries. All formulas and variables used in the calculations are shown in Tables 1 and 2 and are described below.

Table 1: Variables that are used to estimate the economic value of the diving and shark-diving industry

Variable	Description	Source
D	Total number of divers that visit Semporna per year	Dive tourist survey
SDF	Fraction of divers that are shark divers	Dive tourist survey
TD	Median number of days per trip	Dive tourist survey
DD	Median number of days diving	Dive tourist survey
TTC	Average total travel costs (local travel costs plus international airfares) per person and day	Dive tourist survey
LTC	Average expenses on domestic transportation, accommodation, dive activities, food and beverages, and extras per person and day	Dive tourist survey
DTC	Average costs spent on dive activities per person and day	Dive tourist survey
BT	Minimum tax rate contribution	World Development Indicators | Data Bank, 2018
SEF	Daily entrance fee for the Sipadan Island Park	Dive operator survey
SPL	Annual number of Sipadan Park licenses	Malaysia Tourism, 2016
E	Number of employees in the dive tourism industry	Dive operator survey
DO	Total number of dive operators in Semporna	WWF Malaysia
$\overline{SL}$	Average salary of employees	Dive operator survey

Table 2: Abbreviations and formulas for revenue categories

Code	Description	Formula
Business revenues		
TBR_D	Total business revenues from divers	$D \times TTC \times DD$
TBR_{SD}	Total business revenues from shark divers	$TBR_D \times SDF$
LBR_D	Local business revenues from divers	$D \times LTC \times DD$
LBR_{SD}	Local business revenues from shark divers	$LBR_D \times SDF$
DBR_D	Dive business revenues from divers	$D \times DTC \times DD$
DBR_{SD}	Dive business revenues from shark divers	$BRD_D \times SDF$
Tax revenues		
BRT_D	Business revenues tax from diving	$LBR_D \times BT$
BRT_{SD}	Business revenue tax from shark diving	$BRT_D \times SDF$
SIP	Annual income from the Sipadan Island Park	*SEF * SPL*
Salaries		
SL_D	Salaries from diving industry	$S_D = (E_{foreign} \times DO \times \overline{SL}_{foreign}) + (E_{local} \times DO \times \overline{SL}_{local})$
SL_{SD}	Salaries from shark-diving industry	$S_D \times SDF$

4.2 Business revenues

The direct revenues generated by dive tourists for businesses were calculated in three ways: firstly as total trip costs (*TTC*) that dive tourists spent during their trip, designated as total business revenues from divers (TBR_D). Secondly, we estimated all economic revenues that dive tourists spent only on local businesses (local trip costs; *LTC*), which corresponded to total trip costs minus international airfares (designated as local business revenues from divers; LBR_D). The third estimated revenues for dive businesses (designated as dive business revenues from divers; DBR_D), which was based only on expenditures for dive activities (*DTC*). Business revenues from divers in these three calculations were estimated as the product of the average expenditure per person and day, the total number of dive tourists visiting Semporna per year (*D*), and the median number of days that each tourist went diving (*DD*). We used median dive days because data were highly skewed and to account for the fact that many tourists were engaged in multi-purpose trips. Consequently, we did not include any expenditure for days where tourists were engaged in activities other than diving. As only the number of dive licenses for Sipadan was known (44,140 in 2016), we extrapolated *D* using the fraction of tourists that visited Sipadan in the tourist survey to the total population of divers. The business revenue from *shark divers* was estimated in each of the three calculations as the product of the business revenue and the fraction of dive tourists who stated that they would go diving with sharks and rays elsewhere if they could not do so in Semporna (designated as *SDF*).

4.2.1 Tax revenues

Tax revenues from businesses that could be associated with divers (BRT_D) and shark divers (BRT_{SD}) was estimated as the business tax rate (*BT*) from the annual local business revenues from divers (LBR_D) and shark divers (LBR_{SD}), respectively. The annual income from the Sipadan Island Park was calculated as the Sipadan entrance fee (*SEF*) of USD ten times the number of dive tourists that visited Sipadan in 2016 which corresponds to the number of Sipadan Park licenses (*SPL*).

4.2.2 Salaries

Revenues from the dive tourism industry in Semporna also flow on to the local community through employee salaries. We estimated the total sum of salaries that were associated with the diving industry (SL_D) as the product of the estimated number of employees that were associated with diving (E) and their average annual salaries ($\overline{SL}$) for both local and foreign employees. The numbers were obtained from dive operator surveys and extrapolated to all registered dive operators in Sabah (DO). Assuming that the proportion of jobs related to shark-diving (relative to the total jobs in the dive tourism industry) was directly proportional to the fraction of shark divers (*SDF*), the salaries from employees in the shark-diving industry (SL_{SD}) was calculated as the total salary of employees in the dive tourism industry multiplied by the fraction of shark divers.

4.2.3 Willingness to pay for tourist fees

We used a contingent valuation method to estimate the willingness to pay (WTP) of dive tourists of a fee for enforcement and/or community support in the advent of the creation of a shark sanctuary in Sabah. This technique to estimate the WTP of individuals is commonly applied in situations involving environmental non-market goods or services and potential future policies (e.g. Portney, 1994). In our study, it involved a payment card approach that asked respondents the amount of a daily fee they would be willing to pay and provided options in Malaysian Ringgit (MYR)(0, 5, 10, 15, 20, 25, 30, 40, 50, 60, >60) to choose from. This identified the lower and the upper bound of the respondents' WTP. Those respondents that chose MYR >60 were asked to state their real WTP in an open-ended question in order to avoid right censoring of the data (a respondent's true WTP could be any value between 61 and infinity). The range in amounts was selected based on a previous contingent valuation study in the Semporna region (Vianna et al., 2018). We used an interval regression model (intreg) in Stata 14.2 (StataCorp, 2015) to estimate the probability that the WTP of a respondent lay between the observed interval values. The WTP of each individual was defined as a linear additive function of the characteristics of each individual and error with an independently and identically distributed and zero mean. Characteristics were tested as independent variables and included age, dive experience, annual net household income, number dive days, whether or not the respondent was a member of an animal welfare organisation, had observed shark or ray fishing during their stay, was aware of shark conservation programs, the main purpose of the trip, and if the respondent was a shark diver. We expected that respondents with higher income would have a higher WTP. Finally, we estimated the potential annual revenues gained from implementing this daily tourist fee by aggregating the WTP of respondents over the total number of dive tourists that visit Semporna per year and the median number of dive days per trip.

4.2.4 Travel Cost and Contingent Behaviour method

The travel cost (TC) method is a revealed-preference approach that is widely used to determine the non-market value related to recreational sites (Ward and Loomis, 1986). This method assumes that the number of trips that different tourists make to a specific recreational site likely depend on the costs (in terms of time and money) of each visit. The demand curve for that particular site is described by the function that characterises the relationship between the number of trips and travel costs and is used to measure the consumer surplus (CS) of tourists (Fletcher et al., 1990). The CS is a monetary measure of the benefits or enjoyment that users gain by visiting that site (Ward and Loomis, 1986) and is calculated as the inverse of the travel cost variable.

The contingent behaviour (CB) method is a stated preference technique that measures the trip demand of tourists for a recreational site subject to hypothetical changes in the quality or the price of visiting the site. TC and CB methods have been combined by a number of studies (e.g. Englin and Cameron, 1996; Grijalva et al., 2002), an approach that was suitable for our study because the conditions for which tourists might change their behaviour were hypothetical or could not be controlled (Grijalva et al., 2002).

We used the software R (R Development Core Team, 2008) to calculate the demand curve for the TC model based on the number of dive trips that tourists made to the Semporna region in the last five years and their individual travel costs. We only included the travel costs (in thousands of USD) required to arrive at the shark dive site (international flights, domestic flights and ferries, and dive trip costs) to prevent overestimation of the CS for the shark dive. We then used the software Stata 14.2 (StataCorp, 2015)to calculate the CB model to estimate tourist demand for shark diving given the changes of the shark sanctuary scenario. In this model, demand was based on the number of dive trips to Semporna that tourists planned to do in the next five years.

For both TC and CB approaches (TC and CB), we applied Poisson models when count data had a distribution with equal mean and variance (also called equidispersion) (Bhat, 2003) and negative binomial models (Haab and McConnell, 2002) when count data for trip demand had a higher variance than the mean (over dispersion) (Hilbe, 2011; Loomis, 2002).

4.2.5 Welfare measures

Welfare effects caused by a change in demand for dive trips in the shark sanctuary scenario (as described in section 2.2) were estimated in monetary terms for (i) the consumer surplus (CS) associated with dive trips to Semporna, (ii) annual business revenues (for local and dive businesses), and (iii) tax revenues.

The CS is an economic measure of consumer satisfaction with a good or service and is defined here in monetary terms as the difference between the actual costs that a tourist paid for a dive trip to Semporna and the highest amount that this tourist would be willing to pay for the trip. The average CS of individuals under the status quo scenario was calculated as the inverse of the coefficient of the dive trip price variable in the travel cost model. Total CS was estimated by multiplying average individual CS by the total number of dive tourists that visit Semporna each year.

Annual income for the diving industry could be calculated by multiplying the annual number of dive visitors with the average price these visitors paid per day for diving activities, the median number of dive days and the median number of dive trips per year, for each of the status quo and shark sanctuary scenarios. Similarly, the annual income for the local tourism industry could be estimated by multiplying the annual number of dive visitors with the average daily expenditure by these visitors on local goods and services, the median number of days in Sabah, and the median number of trips per year.

5 RESULTS

5.1 Tourist profile

A total of 451 tourist surveys and 11 dive operator interviews were compiled. Diving tourists had an average age of 33 (± 8.62 SD) years and came mainly from Asia (49%) or Europe (39%) (Table 3). Slightly over half of the tourists were female, had made on average 96 dives in his/her lifetime and had an annual net household income of USD 49,232 (± 34,322 SD).About a third of respondents stated that they would go diving with sharks and rays at other locations if this experience was not available in Semporna and were therefore classified as shark divers. The median dive trip was four days, during which time respondents averaged 14.64 (± 23.86) dives. Of these, an average of 3.51 (± 6.23) dives was made specifically to see sharks and rays and during which they observed on average a total of 5.18 (± 9.78) sharks. On a Likert scale from not satisfied at all (-2) to very satisfied (2), respondents classified their satisfaction with the overall shark diving experience on average as 0.55 (corresponding to a state between neutral and satisfied). About 15% of respondents had observed some sort of shark or ray fishing during their trip. Almost three quarters of respondents believed that the creation of a shark and ray sanctuary in Sabah would have a positive effect on shark and ray populations in the region. Around 37% of tourists were members of or supported animal welfare organisations and over half were aware of shark or ray conservation programs (Table 3).

Table 3: Characteristics of dive tourists

Characteristic	Min	Max	Average	SD	%
Age			33.12	8.62	
Gender (% female)					50.79
Continent					
Americas					9.76
Asia					49.08
Europe					38.52
Others					2.64
Income (USD)					
<20,000					21.84
35,000					41.32
65,000					18.16
100,000					9.21
120,000					9.47
Dive experience			95.97	146.72	
Shark diver					29.97
Visited Sipadan					60.82
Dive days	1	100	6.67	11.37	
Dives	1	250	14.64	23.86	
Shark dives	0	50	3.51	6.23	
Sharks observed	0	85	5.18	9.78	
Satisfaction	-2	2	0.55	0.92	
Observed shark fishing					15.35
Believes in sanctuary effect					72.38
Member of animal welfare organisation					37.37
Heard of shark conservation before					55.94

5.1.1 Ranking of dive attractions

Sharks and rays were the most sought after dive attraction in the Semporna region (Figure3) with 41% of dive tourists ranking them as the highest priority. Sharks and rays also obtained the highest relative ranking of 2.4 (2.2 - 2.5, 95% CI), followed by high abundance of fishes and turtles, both of which had the same relative ranking of 2.94 (2.8 – 3.1, 95% CI). The dive attractions that were least interesting to divers in Semporna were coral reefs and macro life, which obtained relative rankings of 3.3 (3.2 - 3.5, 95% CI) and 3.4 (3.3 – 3.6, 95% CI), respectively.

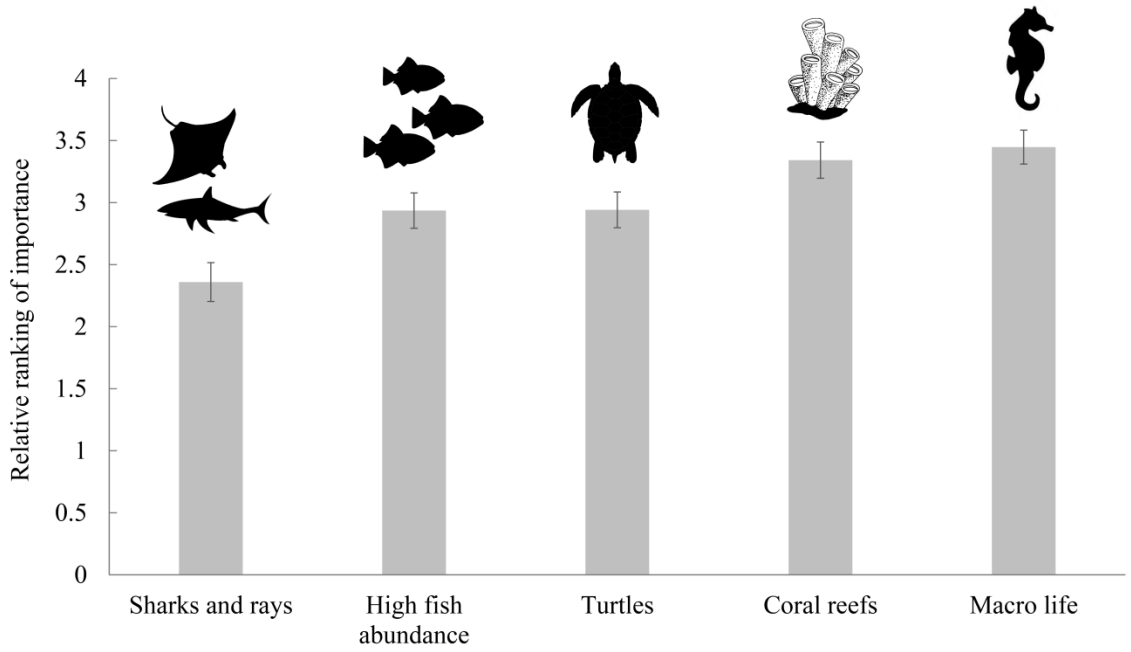

Figure 3: Relative importance of different dive attractions for divers in the Semporna region base on a ranking from 1 (most important) to 5 (least important): Relative importance of different dive attractions for divers in the Semporna region base on a ranking

5.1.2 Market value of shark diving

5.1.2.1 Business and tax revenues

We estimated business revenues generated by both all dive tourists and by shark divers including: (i) total travel costs (all local and non-local travel costs for the trip), (ii) local travel costs (costs paid to local businesses), (iii) dive costs (costs for dive trips only), and (iv) revenues from taxes (Tables 4 and 5). Approximately 29% of all tourists were classified as shark divers (those divers who would go elsewhere if the experience of diving with sharks was not available Semporna), thus business revenues from shark diving constituted approximately one third of revenues generated by all dive tourists. Shark divers generated total business revenues of USD 21.52 million per year. For local and dive businesses, this revenue was estimated as USD 16.58 million and USD 6.44 million per year, respectively. The annual revenues provided by shark divers through business taxes were estimated to be USD 2.2 million.

Table 4: Estimations of variables

Variable	Description	Values
SPL	Number of Sipadan park licenses (#/year)	44,140
D	Number of divers in Semporna (#/year)	72,575
SDP	Shark dive parameter (%)	29.98
$\overline{SL}$	Average salary of employees in dive industry (USD/month)	314
BT	Minimum tax rate contribution (%)	22
SEF	Sipadan entrance fee (USD/person and day)	10
E	Estimated number of employees in the dive industry (#)	2,567
TD	Median number of trip days (#)	10
DD	Median number of days diving (#)	4
TTC	Total travel costs (USD/person and day(95% CI))	247.28 (225.65 – 269.02)
LTC	Local travel costs (USD/person and day(95% CI))	190.50 (173.07 – 207.94)
DTC	Diving expenses(USD/person and day(95% CI))	74.02 (66.67 – 81.37)

Table 5: Business and tax revenues from all dive tourists and shark divers in the Semporna region.

Business revenues (million USD/year (95% CI)		
TBR_D	Total business revenues from divers	71.79 (65.51 – 78.10)
TBR_{SD}	Total business revenues from shark divers	21.52 (19.64 – 23.41)
LBR_D	Local business revenues from divers	55.30 (50.24 – 60.36)
LBR_{SD}	Local business revenues from shark divers	16.58 (15.06 – 18.10)
DBR_D	Dive business revenues from divers	21.49 (19.35 – 23.62)
DBR_{SD}	Dive business revenues from shark divers	6.44 (5.80 – 7.08)
Business tax revenues (million USD/year (95% CI))		
BRT_D	Business tax revenues from diving	12.06 (10.95 – 13.16)
BRT_{SD}	Business tax revenues from shark diving	3.61 (3.28 – 3.95)

5.1.2.2 Salaries

In addition to creating business and tax revenues, dive tourism also generated jobs in the Semporna region. Interviews with dive operators revealed that there was an approximate total of 82 dive operators in the Semporna region. We estimated that these operators employed a total of 2567 employees of which the majority (91%) were locals from Malaysia (Table 6). These jobs generated USD 8.54 million in salaries per year and included dive instructors, dive masters, skippers, equipment maintenance and tank filling, administration, and others (e.g. housekeeping and kitchen). The average annual salary of employees was MYR3767. There was no substantial salary gap between local and foreign staff per job category with exception of foreign dive instructors, who on average earned USD 1,460 per year more than locals with the same job. Assuming that the number of employees in the dive tourism industry depended on the demand for dive trips, the salaries that were associated with shark diving were directly related to the proportion of shark divers involved in dive tourism (29%). Thus, shark diving activities in the Semporna region were estimated to generate 769 jobs and USD 2.48 million in annual salaries.

Table 6: Number of employees and annual salaries of employees in the dive tourism industry in the Semporna region.

Position	Locals		Foreigners		Total	
	Number of employees	Average annual salary (USD)	Number of employees	Average annual salary (USD)	Number of employees	Average annual salary (USD)
Dive instructor	230	6,902	98	8,362	328	7,632
Dive Master	246	3,338	8	3,097	254	3,218
Skipper	385	2,795	66	2,896	451	2,846
Maintenance	131	2,757	0	N/A	131	2,757
Administration	279	2,917	16	2,942	295	2,929
Others	1,066	3,221	41	N/A	1,107	3,221
Total	2,337	3,655	230	4,324	2,567	3,767
SL_D		8,541,652		992,897		9,668,648
SL_{SD}		2,477,079		287,940		2,803,908

5.2 Willingness to pay tourist fees

Daily fees tourists were willing to pay ranged from USD 0 (6.98% of respondents) to USD 125 and averaged USD 6.47 (± 7.94 SD). The preference to use this fee either for the enforcement of a fishing ban (37.28%) or financial support of local communities (38.30%) was nearly equally distributed among respondents. The remaining 24.42% of respondents showed no preference for either option. Interval regression models (Table 7) indicated that the WTP for daily tourist fees of a respondent with all demographic variables at reference levels (annual income of USD <20,000, not a supporter of an animal welfare organization, from the Americas, had not previously dived at Sipadan) was MYR 27.03 (USD 6.98) per day. The model found that a threshold of divers with an income in the two highest income categories was willing to pay significantly more than the lower income categories.

Dive tourists from Asia had a significantly lower WTP for a tourist fee than Americans, Europeans, and tourists from other continents. Additionally,those tourists that supported an animal welfare organisation or had already visited Sipadan were willing to pay MYR 6.83 (USD 1.76) and MYR 7.59 (USD 1.96) more for daily tourist fees, respectively. The number of days respondents were diving during their trip had a significant and positive influence on the maximum WTP. All other sample characteristics were not included in the final model as they were not significant predictors of the WTP of respondents.The WTP of the sample mean was estimated as MYR 36.58 (95% CI 30.11 – 43.05), corresponding to USD 9.45 (95% CI 7.78 – 11.12).

Table 7: Results of the final contingent valuation model including all significant variables. NGO refers to those respondents who were supporting an animal welfare organization, dive days are the number of days that respondents went diving. Measures of the goodness of fit are given as the log-likelihood, the pseudo-R2 and the Akaike information criterion (AIC).

Variable	Coefficient	Std. Error	P-value	95% CI	
Income					
35000	1.79	4.46	0.69	-6.94	10.53
65000	1.57	5.42	0.77	-9.05	12.18
100000	21.33	6.83	0.00	7.94	34.72
120000	11.76	6.76	0.08	-1.49	25.01
NGO	6.83	3.50	0.05	-0.02	13.68
Continent					
Asia	-17.81	6.20	0.00	-29.96	-5.67
Europe	-0.80	6.12	0.90	-12.80	11.20
Others	-8.51	12.12	0.48	-32.26	15.24
Sipadan	7.59	3.51	0.03	0.71	14.47
Dive days	0.30	0.16	0.06	-0.01	0.60
Constant	27.03	7.24	0.00	12.84	41.23
Log likelihood	-1147				
Pseudo-R^2	0.02				
AIC	2318				
Observations	375				

5.2.1 Dive trip demand

Divers spent a median total number of ten days at Semporna in the last five years (Figure 4). In the status quo scenario, respondents stated that they would return to the Semporna for a median total of eight days in the next five years. A total of 95 tourists (23.9%) stated that they would not return to Semporna in the next five years as they first wanted to visit other places (75%), or because the current trip was too expensive to return (7.4%). Other reasons for not returning included pollution, overcrowding, a lack of large marine life, fear of kidnappers and bad service. When presented with the scenario of improved dive experiences through the creation of a shark and ray sanctuary, the median total number of days that divers would spend in the next five years in Semporna increased to12 days.

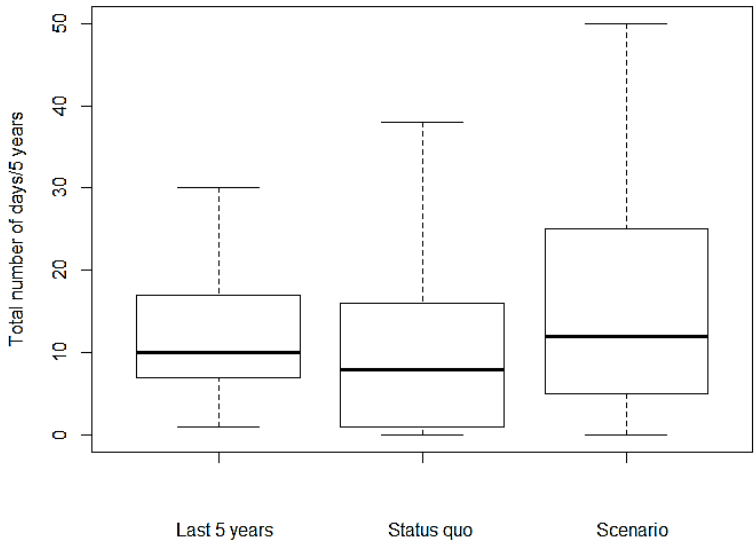

Figure 4: Median number of days that tourists stayed in Semporna in the last five years and would stay in the next five years under scenarios of the status quo and the creation of a shark and ray sanctuary. 12 outliers were omitted from this graph.

5.2.2 Travel Cost and Contingent Behaviour models

As a dispersion test found significant over dispersion in the data (dispersion = 62.62, p-value = 0.00), negative binomial models were used for data analysis. The log-likelihood ratio suggested that both final models (Table 8) performed better than the constant-only model.

As expected, travel costs were negatively correlated with the number of trips that respondents had made in the last five years (see TC model) and would make in the next five years (see combined TC and CB model). Older respondents with higher annual net household income categories were found to have made significantly fewer trips to Semporna in the last five years than younger respondents with lower incomes. However, age and income were not correlated with the number of future trips to Semporna in the combined TC and CB model.

The level of dive experience and support of an animal welfare organization was positively correlated to the number of trips to Semporna taken in the past and intended in the next five years. Those respondents who had heard of shark and ray conservation programs prior to their trip had made more trips to Semporna in the last five years, but these factors had no influence on the number of trips planned in the future. Surprisingly, we found a positive correlation between those tourists that had observed shark or ray fishing activities and the number of trips to Semporna. Another unexpected outcome was that respondents that had visited Sipadan intended to come fewer times to Semporna in the future than those who had not been to Sipadan. The combined TC and CB model showed that tourists whose main purpose of the trip was diving, who were classified as shark divers and those who originated from Asia planned significantly more future trips to Semporna than tourists from other locations. Importantly, the number of planned trips to Semporna in the shark sanctuary scenario was significantly higher than under the scenario of the status quo.

Table 8: Results of final TC and CB models including all significant variables. NGO refers to those respondents who were supporting an animal welfare organization, shark conservation refers to those who have heard of shark conservation programs prior to this survey. Measures of the goodness of fit are given as the log-likelihood, the pseudo-R2 and the Akaike information criterion (AIC).

	Travel Cost Model				Contingent Behaviour Model			
Variable	**Coefficient**	**P-value**	**95% CI**		**Coefficient**	**P-value**	**95% CI**	
Constant	3.473	0.000	3.063	3.883	2.347	0.000	2.035	2.660
Travel costs ('000)	-1.877	0.000	-0.002	-0.001	-0.896	0.004	-0.002	0.000
Age	-0.014	0.019	-0.026	-0.002				
Income								
35000	-0.340	0.006	-0.585	-0.076	0.082	0.533	-0.176	0.341
65000	-0.375	0.014	-0.674	-0.076	0.093	0.559	-0.219	0.405
100000	-0.800	0.000	-1.170	-0.429	-0.388	0.054	-0.783	0.006
120000	-0.717	0.000	-1.088	-0.346	0.216	0.275	-0.172	0.603
Dive experience	0.002	0.000	0.001	0.003	0.003	0.000	0.002	0.003
NGO	0.250	0.017	0.044	0.456	0.406	0.000	0.206	0.606
Observed shark fishing	1.550	0.000	1.254	1.846	1.291	0.000	0.988	0.159
Shark conservation	0.175	0.084	-0.024	0.374				
Continent (Asia as ref.)					-0.471	0.000	-0.689	-0.254
Diver					0.341	0.010	0.080	0.601
Shark diver					0.360	0.001	0.146	0.573
Sipadan					-0.327	0.006	-0.563	-0.092
CB Scenario					0.403	0.000	0.212	0.594
Log likelihood	-1476				-2945			
AIC	2976				5920			
Pseudo R^2	0.121				0.047			
Observations	377				756			

The shark sanctuary scenario had three major impacts on sharks and we asked respondents to rank these in importance for their dive experience. An increased abundance of sharks was ranked as the most important by 51% of respondents, followed by an increase in the number of species of sharks and rays that could be observed, which was ranked as the most important by 41% of respondents. The opportunity to make more shark dives during a trip was ranked as the least important by 77% of respondents.

5.2.3 Welfare estimates

The consumer surplus was calculated using the inverse of the coefficient of the travel cost variable in the TC model (Table 9) of -1.877 and was USD 532.85 per person and day. Thus, the annual CS under status quo for the entire population of dive tourists in Semporna (72,575) over the median days that a tourist was diving in Semporna (4 days) was estimated to be USD 154.69 million.

Under the status quo scenario, the demand of tourists for dive trips to Semporna in the next five years decreased by 20%. This change in demand would have an effect on the CS of dive tourists in addition to economic benefits gained by the tourism industry. The business revenue for the local dive tourism industry would decrease to a total of USD 17.19 million per year, whereas the local tourism industry would decrease to USD 44.24 million. Tax revenues would decrease to USD 9.73 million.

In the shark sanctuary scenario, the dive trip demand of tourists would increase by 20%. This change in demand would result in increased business revenues of USD 25.79 million for the local dive tourism industry and USD 66.36 million for the local tourism sector. Revenues from taxes would increase to USD 14.60 million per year (Table 9).

Table 9: Welfare estimates based on the dive trip demand to Semporna in the last 5 years, and in the next 5 years under status quo and shark and ray sanctuary scenarios.

	Observed	Status quo	Shark sanctuary
Difference in dive trip demand (%)	N/A	-20.00	20.00
Number of dive trips/year	72,575	58,060	87,090
CS (million USD/year)	154.67	123.75	185.62
LBR_D(million USD/year)	55.30	44.24	66.36
DBR_D(million USD/year)	21.49	17.19	25.79
BTR_D(million USD/year)	12.17	9.73	14.60

6 DISCUSSION

Our study evaluated the economic benefits associated with shark dive tourism in the Semporna region in Malaysia. Although diving in Semporna is renowned for a variety of attractions including large schools of fish and macro life, our study identified sharks and rays as the principal feature of most interest to dive tourists. This result is consistent with earlier studies by Teh et al. (2018) who also found that dive tourists ranked sharks as the principal attraction for diving in Semporna; manta rays ranked third (out of four).

We found that the annual business revenues generated by all dive tourists were substantial and were estimated to be in the order of USD 55.3 million for local businesses. This corresponds to 0.02% of the national GDP of Malaysia in 2016 (World bank, 2018). Similarly, Teh et al. (2018) estimated the business revenues of dive tourism industry in Semporna to be USD 69-85 million per year. Although their study did not specify which expenditures were included in this estimate, our highest estimate of USD 71.8 million per year (including total trip costs) overlapped these values.
Business revenues to local businesses that were associated with shark divers totalled USD 6.4 million. This contrasts with Vianna et al (2018) who calculated that in 2012, shark divers contributed USD 9.84 million to local business revenues. The lower value calculated by our study is likely due to the fact that we took into account the multi-purpose nature of tourist trips and only included travel costs for the amount of days that people went diving. Days when tourists undertook activities other than diving were excluded from our calculations. When all days were included in calculations (as was the approach Vianna et al., 2018), we found that local business revenue from all divers in Sipadan was USD 56.9 million per year. This compares to the values of USD 49 million (inflation adjusted) calculated by Vianna et al. (2018) in 2012. This result suggests that the economic importance of this industry to the local economy has been increasing since 2012.

The economic benefits of shark dive tourism are mainly driven by the demand of dive tourists. We explored the potential for this demand to change under scenarios of a continuation of the status quo and the creation of a shark and ray sanctuary in Sabah. Given increases in shark and ray abundance,

species diversity and the opportunity for shark diving experiences in the latter scenario, we found there was likely to be a 20% increase in demand compared to the trip demand in the last five years.

This increase could generate economic gains of over USD 2.4 million per year for the dive tourism industry and USD 11.1 million for the local tourism industry in the Semporna region. At the same time, our outcomes suggested that should current conditions of the dive experience in Semporna be maintained (the status quo scenario), this might cause a decline in dive trip demand of 20%,with about a quarter of tourists not returning to Semporna in the next five years. Under this scenario, the business revenues for the local dive tourism industry would decrease to a total of USD 17.19 million per year, revenue for the local tourism industry overall would decrease to USD 44.24 million and tax revenues would decrease to USD 9.73 million.

For tourists who were not interested in returning to Semporna, the principal reason was the desire to explore other places, although overcrowding, pollution and the fear of kidnappers were also important. Since 2000, kidnapping events have resulted in severe reductions in tourist arrivals (Hampton et al., 2018). Similarly, overcrowding and pollution have been identified as serious threats to the local tourism sector (Hampton et al., 2018; Musa, 2002). As dive trip demand depends on shark populations, our results stress the importance of tourism developments that take ecological limits of target species and their habitats into consideration. In this context, the implementation of a shark sanctuary might need to be part of a broader conservation program in the region.

Most dive tourists in Semporna had also visited other sites throughout Sabah. For this reason it is likely that the scenarios of change outlined for Semporna might have similar impacts on demand in these other sites and could (depending on the management and conservation measures) either stimulate or inhibit the growth of tourism. However, our results represent the dive trip demand from a sample of tourists who were in the process of visiting the Semporna region. For practical reasons, we could not include those tourists that had not visited but were planning to do so in the future and we cannot exclude the possibility that tourists who have experienced shark dives in Semporna have a different demand than those who plan to visit in the future. Consequently, our predictions only apply to future return visitors and not to future first-time visitors. This is important to note because, depending on the number of first time visitors arriving each year, it may inflate the proportion of divers not intending to return to Sipadan, and thus the amount of economic losses predicted under the scenario of the status quo.

In addition to economic benefits through business and tax revenues, we found that shark dive tourism also generated considerable benefits to local communities in form of the provision of an estimated 769 jobs that generated a total of USD 2.9 million in salaries per year. In comparison to estimates from 2012 (460 jobs and USD 1.7 million, inflation adjusted) this confirms an increasing importance of dive and shark dive tourism as a source of income for locals in the region. Moreover, we found that the majority of employees (91%) in this business were locals from Malaysia, which is unusual in comparison to other popular dive destinations in developing countries where these positions are often occupied by foreign workers (Shakeela and Cooper, 2009). The high percentage of local workers may be the result of a government youth education program in Sabah that trains locals as dive masters and dive instructors (Daldeniz and Hampton 2013).

The annual average salary of approximately MYR 15,000 for employees in the dive tourism industry was well below the country's average annual salary (MYR 26,438;"Department of Statistics Malaysia

Official Portal," 2016), but more than twice the average annual income of small-scale fishermen (MYR 5,304 in Sabah; Teh et al., 2011). Hampton et al. (2018) found strong interethnic inequalities and vulnerability of local workers in the dive tourism industry on Mabul Island. The two main ethnic groups on Mabul Island (Suluk and Bajau Laut) are refugees from the Philippines and experience uncertainty over permits to stay and work in Malaysia. This makes the Suluk community reliant on fishing as their main livelihood (Hampton et al., 2018), which has implications for local shark populations and the associated dive tourism industry. The Suluk community on Mabul Island owns the largest shark fishing fleet in Sabah, although boat numbers have declined considerably (from approximately 50 to 5 boats) during the last six years.

In addition to the creation of more sustainable alternative livelihoods, one possible solution to aid the situation of local fishing communities might be financial compensation for abandoning shark and ray fisheries, an approach that has been successful in other places such as Fiji (Brunnschweiler, 2010). The necessary funds could be (at least partly) generated through a dive tourist fee for managing a potential shark sanctuary in the area. Elsewhere in the region, fee schemes cover parts of management and enforcement costs in the Sugud Island Marine Conservation Area in Malaysia and the Tubbataha Reef National Park in the Philippines (Teh et al. 2008). In the Caribbean, management of the Bonaire Marine Park is entirely funded through tourist fees (Dixon 1993). We found that the majority of dive tourists were willing to pay a dive tourist fee that could offer a revenue stream of USD 2.7 million per year in the Semporna region alone. A similar result was recorded by Vianna et al. (2018) that who estimated the potential revenues of a new park fee in 2012 as USD 2.3 million per year (inflation adjusted). In addition to supporting conservation initiatives and/or the enforcement of regulations, such user fees can also help to control demand and ease pressure from overcrowding (Emang et al., 2016; Lück, 2016).

7 CONCLUSIONS

Sharks and rays are a key element of the diving experience of tourists in the Semporna region. Diving with these animals generates large economic benefits that include direct business and tax revenues. Moreover, the dive tourism industry employs many locals who make up the majority of workers in this business. The implementation of a shark sanctuary in Sabah could increase the dive trip demand in Semporna and thus increase the associated economic benefits of this dive tourism sector. The management and enforcement of such a sanctuary could be at least partly financed by a fee paid by dive tourists. Such fees might also fund a broader management program to aid sustainable development of the dive tourism industry by tackling environmental, social and economic challenges in the Semporna region.

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