

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

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41 **Abstract**

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

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

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71 1. Introduction

72 Shark-diving is a fast-growing tourism industry that at a global scale has been estimated to engage around
73 600,000 participants every year [1]. In 2013, established shark-diving operations could be found in
74 approximately 45 countries spread throughout tropical and temperate waters around the world and many
75 generated significant economic benefits to local economies. For example, in Fiji shark diving inputs over
76 USD 42 million annually to the country's economy, whereas in Palau, Micronesia, the industry generates
77 around USD 18 million per year, accounting for approximately 8% of the Gross Domestic Product [2,3].
78 In Australia and French Polynesia, shark diving generates annual revenues of USD 25.5 and 5.4 million
79 per year, respectively, while at the small archipelago of Fernando de Noronha, Brazil, this activity
80 generates USD 2.6 million annually [4,5,6]. Worldwide, the most valuable shark-diving industry occurs
81 in the Bahamas, where it generates annual revenues of over USD 109 million [7]. The financial benefits
82 of shark-diving are distributed across several sectors of the local economy, because tourists spend money
83 on both diving and also on a variety of other goods and services such as accommodation, food and
84 transport. Shark-diving tourism also generates income through tax revenues, enabling governments to
85 provide services and infrastructure to communities [2,3].

86

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

95

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

105 [15,16]. Despite the importance of enforcement, many of the small island countries that have
106 implemented sanctuaries lack the economic and logistic means to effectively police regulations, a
107 situation exacerbated by the large areas of open sea encompassed by many sanctuaries.

108

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

125

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

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134 **2. Methods**

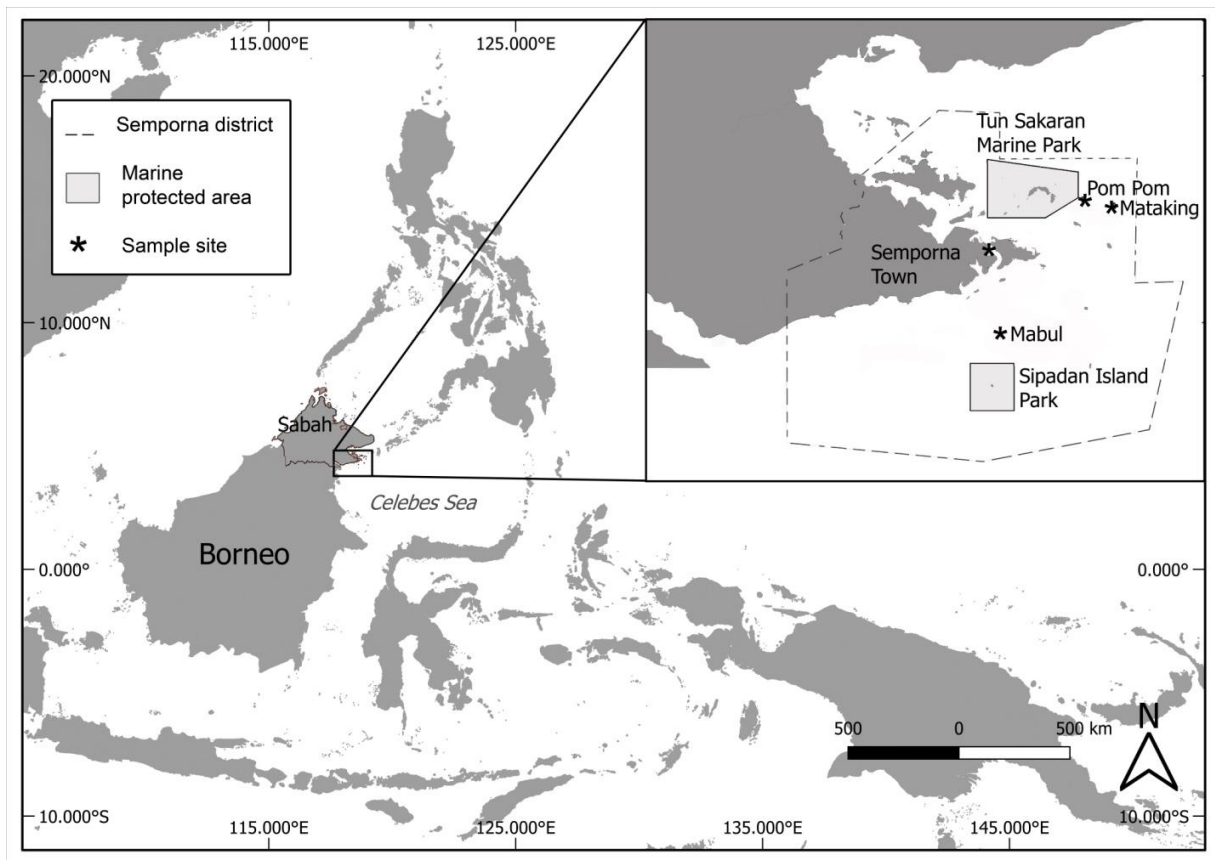
135 2.1 Study site

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

138 fauna in the world [20,21]. The Semporna region maintains Malaysia's largest dive tourism industry, with
139 its islands (e.g. Mabul, Pom-Pom, Kapalai, Matakang and Ligitan) and the Tun Sakaran Marine Park as
140 popular diving destinations. According to the local diving industry, the main drawcard for divers to visit
141 the area is the island of Sipadan, which received about 43,900 divers in 2012 (Sabah Parks - Personal
142 comm.). Around Sipadan, divers have the opportunity to interact with large predatory fishes such as
143 sharks. Common reef shark species such as the white-tip reef (*Triaenodon obesus*), grey reef
144 (*Carcharhinus amblyrhynchos*) and scalloped hammerhead (*Sphyrna lewini*) sharks are regularly sighted
145 around the island. Although less frequent, other species such as the Borneo shark (*Carcharhinus*
146 *borneensis*) and the whale shark (*Rhincodon typus*) can also be observed. The Sipadan Island Park (168
147 km²) and the Tun Sakaran Marine Park (350 km²) are both largely no-take zones; however, hook and line
148 fishing is allowed in specific zones of the latter park.

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

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158

159 *Figure 1: Map of the Semporna region*

160

161

2.2 Surveys

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

169

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

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

177

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

182

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

191

192 2.3 Economic revenues from shark diving

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

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

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

210

211 *Table 1: Description of constants and parameters used to estimate revenues generated by the shark-*
212 *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

213

214 *Table 2: Formulas to calculate the economic value and distribution of revenues from shark diving in the*
215 *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	$D \times DET$	Tourist questionnaire
BRS	Business revenues from shark diving	$BRD \times SDP$	Tourist questionnaire
Community benefits from shark diving			
DCID	Direct community income from diving	$W \times E$	Operators questionnaire
DCISD	Direct community income from shark diving	$W \times SDP \times E$	Operators questionnaire
Tax revenues from shark diving			
BRTD	Business revenues tax from diving	$BRD \times BT$	Operators questionnaire
BRTSD	Business revenue tax from shark diving	$BRS \times BT$	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	$WTP_{ENF} \times D \times A \times \text{currency rate}$	Tourist questionnaire
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216 * For a detailed explanation of calculations see [3].

217

218 2.4 Willingness to pay

219 Contingent valuation is a well-established method to determine the WTP of individuals for the provision
 220 of non-market environmental goods or services, or for public policies that have not yet been implemented
 221 [26,27,28]. This study estimated the WTP of dive tourists for the enforcement of a hypothetical shark
 222 sanctuary (here called WTP_{ENF}). The contingent valuation question used a payment card, that showed
 223 tourists five categories of daily user fees in Malaysian ringgit (MYR) of 0, 1-15, 16-30, 30-60, >60. The
 224 bids were chosen based on local knowledge of dive operators about user fees from surrounding marine
 225 reserves. Respondents were asked to select their maximum WTP_{ENF} from the offered bid amounts. The
 226 payment card approach allowed us to observe the lower and upper bound of respondent *i*'s WTP_{ENF} . The
 227 statistical model estimated on contingent valuation data was based on the probability that respondent *i*'s
 228 WTP_{ENF} lay between the observed interval values; $\Pr(B_L < WTP_{ENFi} < B_U | X)$. The highest category
 229 (MYR>60) was right censored as a respondent's true WTP can be any value between 61 and infinity;
 230 $\Pr(WTP_{ENFi} > B_H | X)$. An interval regression (*intreg*) model was estimated in Stata13 software where
 231 individual WTP_{ENFi} was specified as a linear additive function of individual characteristics X_i and an
 232 independently and identically distributed error ε_i with zero mean.

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

240

241 **3. Results**

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

244 16 of the 22 dive operators identified in the region, sampling the town of Semporna and islands of Mabul,
245 Pom Pom and Mataking.

246 3.1 Tourist profile

247 Most diving tourists came from Europe (49%), followed by divers from domestic localities (17%) (Table
248 3). Most divers were relatively young (21-30 years old) males, with a low level of diving experience (5-
249 49 dives), and an annual income between USD 20,000 and 49,999 (Table 3).

250

251 *Table: 3 Summary of respondents' characteristics*

Variable	N	Percentage
<i>Age (years old)</i>	<i>Mean ± St. Dev</i>	<i>34 ± 9.5</i>
< 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	
<i>Annual income (USD)</i>	<i>Mean ± St.Dev</i>	<i>57.5 ± 37.4</i>
<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	
<i>Dive experience(number of dives)</i>	<i>Mean ± St.Dev</i>	<i>118 ± 147</i>
< 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	
<i>Gender</i>		
Female	129	45.4
Male	155	54.6
Total	284	
<i>Region of origin</i>		
Europe	136	47.9
Asia	100	35.2
Others	48	16.9
Total	284	
<i>Likeliness to return to the region</i>		
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	

252
 253 Interviews with divers showed that the principal motivation to visit the area was to engage in general
 254 diving activities (37%). A total of 25% of divers came to the Semporna specifically to dive at Sipadan,
 255 and 23% of the divers stated that they would not have chosen the region as a destination if there were no
 256 sharks to be sighted during the dives. Based on this percentage, it was estimated that about 10,000 divers
 257 are visiting Semporna annually mainly to see sharks and were classified as shark divers. Although not the
 258 sole motivation for diving in the region, 73% of divers stated that they were interested or very interested
 259 in diving with sharks.

260

261 3.2 Revenues from shark-diving

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

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

271

272 *Table 4: Estimated revenues and income generated by the diving industry in the Semporna district in*
 273 *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

274

275 3.3 Willingness-to-pay

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

281

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

295

296 *Table 5: Interval regression results of divers' WTP_{ENF} a daily access fee to enforce a shark sanctuary (n*
 297 *= 259)*

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

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	**
<i>Annual income(USD, < 20,000 = ref)</i>			
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
<i>Likeliness to return to the region (1 = ref)</i>			
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	***
<i>Effect on recommendation</i>			
$\ln(\sigma)$	3.11	0.05	***
Log-likelihood		- 457.51	
Pseudo-R ²	0.147		
AIC	947.03		

298 Notes: ***, **, * = significant at 1%, 5% and 10% respectively; ns = not significant; R² calculated against a constant-only model
 299 (LL = -536.395)

300

301

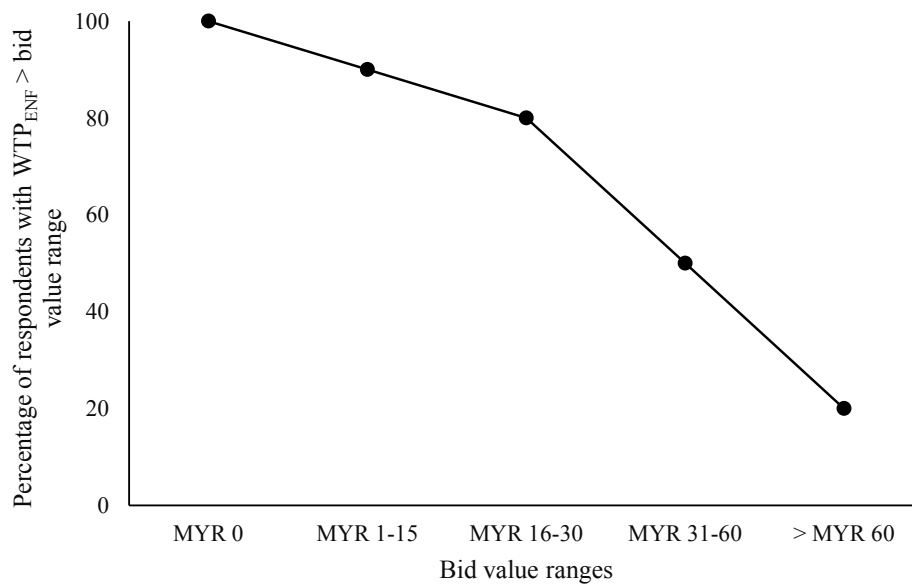
302 *Table 6: WTP_{ENF} of divers with differing socio-demographic characteristics*

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)

303

304 Average individual WTP_{ENF} estimates were aggregated over the total number of divers per year (*D*) and
 305 the average number of diving days (*A*) to obtain the potential annual revenues from a daily park fee,
 306 converted to USD using a currency rate of 0.33. Based on the mean WTP_{ENF} from respondents, the shark
 307 sanctuary could generate an estimated annual revenue (REV_{ENF}) of USD 2.1 million (confidence interval:
 308 1.9 - 2.2 million) from park entry fees. The cumulative distribution of WTP_{ENF} responses (Figure 2)
 309 shows that nearly 20% of respondents were willing to pay more than MYR 60 (USD 20.00), which was

310 the highest bid offered on the payment card. This indicates that annual revenues could potentially be
311 higher than the estimates reported here, as the upper bound of the WTP_{ENF} for these individuals is
312 unknown. Approximately 10% of respondents were not willing to pay a daily user fee to enforce the
313 proposed shark sanctuary (Figure 2).
314



315
316 Figure 2: Cumulative distribution of WTP_{ENF} responses showing the percentage of respondents who were
317 willing to pay the amount specified by each bid range category.
318

319 4. Discussion

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

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

333

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

346

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

356

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

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

367

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

379

380 In the Semporna district, fishers are known to supplement their income by working in the diving industry
381 [30]. This suggests that the shark-diving industry in the region can be a viable alternative to support the
382 livelihood of at least some stakeholders who benefit from the consumptive use of sharks. This has been
383 the case in other popular destinations for shark diving. For example, in Fiji, a MPA created to protect
384 sharks has also been effective in improving the livelihood of local communities [34]. This reserve is
385 supported by the local community, which benefit from revenues of over USD 650,000 annually in direct
386 salaries (e.g., dive guides) and fees for the right of operating at the shark-diving sites [2]. Socio-economic
387 analyses at other localities where the shark-diving industry is well established suggest that fishers may
388 also gain better livelihoods by supplying tourists with reef-fish catches than by targeting sharks [3].

389

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

399

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

410

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

422

423 **5. Conclusion**

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

433 the considerations of all local stakeholders, while clearly addressing conservation and socio-economic
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435

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451 **References**

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