How shark conservation in the Maldives affects demand for dive tourism

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\begin{abstract}
Shark-diving tourism provides important economic benefits to the Maldives. We examine the link between shark conservation actions and economic returns from diving tourism. A combined travel cost and contingent behaviour approach is used to estimate the dive trip demand under different management scenarios. Our results show that increasing shark populations could increase dive-trip demand by 15%, raising dive tourists' welfare by US $58 million annually. This could result in annual economic benefits for the dive-tourism industry of > US$6 million. Conversely, in scenarios where shark populations decline, where dive tourists observe illegal fishing, or if dive operators lack engagement in shark conservation, dive trip demand could decrease by up to 56%. This decline causes economic losses of more than US$24 million annually to the dive tourism industry. These results highlight the dependence of the shark-diving industry on the creation and enforcement of appropriate management regimes for shark conservation.
\end{abstract}

1. Introduction

Ecotourism to watch wildlife is a fast-growing industry worldwide and offers a variety of benefits for those involved. For tourists, these include recreational and educational values such as a sense of well-being and improved environmental awareness (Ballantyne, Packer, & Falk, 2011; Curtin, 2009). For local communities, wildlife tourism supports the economy by providing jobs and income (Tisdell & Wilson, 2003). Within the wildlife tourism sector, shark diving has increasingly gained popularity and is now attracting over 500,000 tourists to shark dive sites in approximately 45 countries around the world (Cineros-Montemayor, Barnes-Mauthe, Al-Abdulrazzak, Navarro-Holm, & Rashid Sumaila, 2013). The benefits for local economies from this industry are substantial (Gallagher & Hammerschlag, 2011). For example, in Palau, shark-diving generates US$18 million in annual business revenue for the national economy (Vianna, Meekan, Pannell, Marsh, & Meeuwig, 2012), while in Australia it generates up to US$25.5 million per year (Huveneers et al., 2017). Typically, the economic returns of these diving tourism industries are many times greater than fisheries that target the same species (Anderson & Ahmed, 1993, p. 51; Gallagher et al., 2015; Topelko & Dearden, 2005).

The economic returns of shark-diving to a country will depend, in part, on the degree of satisfaction that the experience provides to tourists. In welfare economics, this satisfaction (or ‘welfare’) is expressed as the ‘consumer surplus’ (Ward & Loomis, 1986). In the case of shark-diving tourism, visitors’ satisfaction will depend on the quality of the shark-diving operation and the condition of shark populations. For example, in the Maldives, decreasing numbers of sharks at dive sites as a result of fishing caused dive operators to abandon or reduce visits to popular shark-diving sites due to lowered tourist demand. This caused considerable economic losses to the dive-tourism industry (Anderson & Waheed, 1999).

As this example shows, changes in the quality of the shark-diving experience and thus recreational benefits for tourists have implications for the number of trips that dive tourists will plan to make to a particular site. To date, no study has attempted to quantify the type of changes (positive or negative) in the environment or management strategies that might cause tourist demand to alter or the impact that this might have on the economics of the shark-diving industry. Such studies, which typically involve a combined travel cost and contingent
behaviour approach, are commonplace in other contexts, for example in recreation in forest (Simões, Barata, & Cruz, 2013; Starbuck, Berrens, & McKee, 2006) and lake environments (Jeor & Herriges, 2010; Richardson & Loomis, 2004) and in the recreational fishing industry (Layman, Boyce, & Criddle, 1996; Prayaga, Rolfe, & Stoeckl, 2010). Some combined travel cost and contingent behaviour studies have also examined broader aspects of tourism in coral reef environments. Bhat (2003) showed that improvement of coral reef quality in the Florida Keys could increase the trip demand of tourists that visit the area (including dive tourists) by 43–80%. Conversely, Kragt, Roebeling, and Ruijs (2009) found that a decline in coral reef and fish diversity in the Great Barrier Reef could cause a decrease in dive and snorkel trip demand by 80% resulting in major economic losses to the tourism industry.

Given that shark diving is a fast-growing tourism industry that is recognised as providing important economic and social benefits, a change in trip demand due to management strategies that fail or succeed to achieve conservation goals (thereby influencing tourist satisfaction) could have important implications for local communities. Here, we quantify the impacts of both negative and positive scenarios on the economic contribution of the shark-diving industry. We hypothesize that improving the quality of the shark-dive experience through increased shark populations, an absence of illegal fishing activities, and engagement in shark conservation actions by dive operators will enhance the demand for trips by dive tourists, and will thereby generate economic benefits. Conversely, we predict that a decline in shark abundance, the presence of illegal fishing during dive trips, and a lack of engagement by dive operators in actions to improve fishers’ compliance will reduce trip demand by dive tourists, with negative effects on tourism numbers and economic losses for the dive tourism sector and local tourism generally.

2. Methods

2.1. Study site

The Republic of the Maldives is a small island nation in the central Indian Ocean (Fig. 1). The country is composed of about 1200 islands of which 200 are inhabited, around 122 are assigned as resort islands, and the remainder are uninhabited.

The Maldives provide an excellent case study because tourism dominates the nation's economy and accounted for 27% of the gross domestic product in 2014. Diving and snorkelling are the most popular activities of tourists in the Maldives (Statistics and Research Section, Ministry of Tourism Republic of Maldives 2017) with 184 dive schools registered in the country (Dive Schools - Ministry of Tourism n.d.). Watching marine mega fauna such as rays and sharks is an essential element of the diving tourism industry (Anderson, Shiham Adam, Kitchen-Wheeler, & Stevens, 2011; Cagua, Collins, Hancock, & Rees, 2014). In 1991, shark diving in the Maldives generated about US$2.3 million in direct annual business revenue, compared to a revenue of US $0.5 million per year from the reef shark fishery (Anderson & Ahmed, 1993, p. 51). Anderson and Ahmed (1993, p. 51) estimated that the value of a living grey reef shark may be one hundred times higher than when it's dead as a fisheries resource. These numbers are likely to be much higher today, as in 2013 an estimated 78,000 tourists accounted for $9.4 million direct expenditures solely for tourism focused on whale sharks in the South Ari Atoll (Cagua et al., 2014).

In 2010, a shark sanctuary was implemented in the Maldives when the declining status of shark fisheries and concerns over decreased shark sightings from divers encouraged the government to announce a total ban on shark fisheries in its waters (Ali & Sinan, 2015). Today, shark populations are recovering in most, but not all, atolls (Sattar, Wood, Ushan, & Ali, 2013). An overall increased shark abundance indicates that the implementation of the shark sanctuary is achieving its intended objectives to some extent. Nevertheless, the Maldives are facing a number of challenges that could disturb the effectiveness of the ban. Occasionally, scuba divers have complained about observing illegal shark fishing activities during their dive trips (Ali & Sinan, 2014). These claims are further strengthened by the sale of shark jaws and teeth in most souvenir shops (first author’s observation). The lack of an import ban allows shop sellers to claim souvenirs were imported, whereas there are indications that jaws and teeth have been extracted from local shark populations in at least some cases (fourth author's observation). Reef fishermen, in turn, complain about growing shark populations that depredate on their catch (Ali & Sinan, 2014). This drives some fishermen to kill sharks (fourth author's observation).

Many dive operators in the Maldives engage in some sort of shark conservation action. Some resorts host marine biologists who create awareness and teach best practices during dive operations (Cagua et al., 2014). The long-term citizen science programme “Shark Watch” is conducted by dive guides who monitor their shark sightings and help to assess population trends in the area (Sattar et al., 2013). Some resorts report illegal fishing activities to authorities and refuse to buy fish from fishermen that have landed sharks (first author's observation).

2.2. Survey

We designed a tourist survey to estimate how the quality of the shark-diving experience influences the trip demand of dive tourists in the Maldives and subsequent economic returns to the local economy. Prior to data collection, surveys were tested in a pilot study with 12 experienced divers in Western Australia. For data collection in the Maldives, all 184 registered dive operators in the study area were contacted by phone and email and asked for permission to conduct surveys with their clients. For logistic reasons, a subsample of 19 different dive operators (seven on resort islands, 11 on local islands, and one on a dive cruise boat) who agreed to collaborate were included in the study. From September to November 2016, surveys were conducted with dive tourists on 13 different islands and six different administrative atolls in the Maldives (North Male, South Male, North Ari, South Ari, Lhaviyani, and Baa—Fig. 1). We considered this sample to be representative of dive operators in the Maldives, given that these central atolls receive approximately 95% of tourist arrivals. Once on site, dive tourists were personally approached in the dive centres and provided with a brief overview of the project. They were asked if they were willing to participate and were given a digital survey on an electronic tablet or an equivalent paper-based survey.

Each survey consisted of five sections that first asked about the dive tourist’s purpose for visiting the Maldives and the importance that sharks played in their decision to visit, and second, their satisfaction with the shark-diving experience. The third section asked about respondents’ future plans to visit the Maldives in the next ten years under the status quo scenario and seven alternative scenarios (Table 1).

These alternative scenarios were of a qualitative nature and were as follows: (i) fishing absent: respondents would not observe illegal fishing activities or trade in shark products, (ii) fishing present: respondents would observe illegal fishing activities or trade in shark products, (iii) abundance increase: the number of sharks would increase, (iv) abundance decrease: the number of sharks would decrease, (v) sharks absent: there would be no sharks, (vi) conservation present: a dive operator would take actions against illegal fishing activities, and (vii) conservation absent: a dive operator would not take actions against illegal fishing activities. Participants were provided with examples of different actions that dive operators could engage in to reduce illegal fishing. Those actions were: patrol dive sites during dive operations, help fishermen financially through employment or compensation schemes, support fishermen socially through educational programs or infrastructure, and integrate fishermen in the management of sanctuaries by mediating between fishermen and other stakeholders. For each scenario, participants were asked how many times they expected to visit the Maldives, and whether or not they would recommend the
Maldives as a shark-diving destination. They were reminded to consider their budget when answering the first questions, because each future trip would be associated with certain travel costs.

The fourth section in the survey asked about the travel costs during the current trip including expenses on dive activities, accommodation, food and beverages, international and domestic travel. Section five asked about respondents’ demographic characteristics, namely their gender, age, nationality, and combined annual household income. Finally, participants had the opportunity to comment on the survey design and content.

2.3. Travel cost and contingent behaviour model

The travel cost (TC) method is a revealed-preference technique that is commonly used to evaluate the economic value associated with recreational sites (Ward & Loomis, 1986). It is based on the idea that different tourists bear different costs (time and travel expenses) to attend a recreation site and that the number of trips made to the site is likely to depend on their costs or attending. The link between the number of trips and the travel costs defines the demand curve for the particular recreation site (Fletcher, Adamowicz, & Graham-Tomasi, 1990). The estimated demand curve can then be used to measure consumer surplus; a rigorous measure of the benefits to users of that recreation site (Ward & Loomis, 1986).

The contingent behaviour (CB) method uses tourists’ stated preferences for visits to a recreational site contingent on hypothetical changes in the price or quality of that site. The underlying utility function is then able to be estimated based on an assumption that an individual tends to maximize the utility from consumption of a good or service i and is described as $U_i = V_i + \epsilon$ where $U$ is the overall utility, $V$ the observed utility and $\epsilon$ the unobserved utility. TC and CB methods have been successfully combined by a number of studies (e.g. Englin & Cameron, 1996; Grijalva, Berrens, Bohara, & Douglass Shaw, 2002) and the combined approach is suitable for our study because the conditions upon which tourists might change their behaviour are not currently observed (i.e. are hypothetical) or at least cannot be controlled (Grijalva et al., 2002).

To measure the change in dive-trip demand under different shark-dive qualities, we first estimated current tourism demand (number of

Table 1
Description of contingent behaviour scenarios.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Description</th>
<th>Expected change in trip demand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Status quo</td>
<td>Status quo</td>
<td>No change</td>
</tr>
<tr>
<td>Fishing absent</td>
<td>Dive tourists do not observe illegal shark fishing activities or trade in shark products</td>
<td>Positive</td>
</tr>
<tr>
<td>Fishing present</td>
<td>Dive tourists observe illegal shark fishing activities or trade in shark products</td>
<td>Negative</td>
</tr>
<tr>
<td>Abundance increase</td>
<td>Shark abundance increases</td>
<td>Positive</td>
</tr>
<tr>
<td>Abundance decrease</td>
<td>Shark abundance decreases</td>
<td>Negative</td>
</tr>
<tr>
<td>Shark absent</td>
<td>There are no sharks</td>
<td>Negative</td>
</tr>
<tr>
<td>Conservation</td>
<td>Dive operator engages in actions against illegal fishing</td>
<td>Positive</td>
</tr>
<tr>
<td>Conservation absent</td>
<td>Dive operator does not engage in actions against illegal fishing</td>
<td>Negative</td>
</tr>
</tbody>
</table>

Fig. 1. Map of the Maldives showing sample locations.
visits made to the Maldives in the last five years) and the recreational value of dive trips at current conditions with a TC model. We then use the CB model to estimate future demand (measured as the number of planned visits for the next ten years) and recreational value at changed shark-dive qualities under the seven hypothetical scenarios. To estimate the welfare effects, we compare the planned visits under the future status quo scenario with the planned visits under the alternative future scenarios. This is preferred over using the current number of visits to reduce estimation bias in favour of current conditions (Kragt et al., 2009; Simões et al., 2013).

In order to avoid overestimation of the consumer surplus that is associated with diving trips, we only included the travel costs (in thousand US$) that tourists incur purely for their shark dive experience (namely international flights, domestic flights and ferries, and dive trip costs).

The software R (R Development Core Team, 2008) was used for the statistical analysis of the TC model and the Stata 14.2 (StataCorp, 2015) was used to for the CB model. We analysed the data using Poisson and negative binomial models which are suitable for count data and are commonly used in studies of recreational values (Haab & McConnell, 2002). The Poisson regression is used when data show equidispersion, which describes a data distribution where the mean and the variance are equal (Bhat, 2003). However, trip demand data often do not follow this distribution and have a higher variance than the mean. This is called overdispersion (Hilbe, 2011, pp. 836–839). Negative binomial models are more flexible with the treatment of equidispersion of the dependent variable and can deal with overdispersion (Loomis, 2002).

The demand for dive trips to the Maldives is estimated by:

\[ DT = \beta_0 + \beta_1 p + \beta_2 inc + \beta_3 X_i + \ldots + \beta_4 X_n \]

where \( DT \) is the expected number of dive trips, \( p \) is the travel cost per dive trip, \( inc \) is the annual household income, and \( X_i \) represent other individual characteristics. Economic theory suggests that respondents should make fewer visits to the Maldives as travel costs increase or annual income decreases.

### 2.4. Welfare measures

Welfare effects are presented as a monetary value by estimating the consumer surplus (CS) associated with dive trips to the Maldives. CS for an individual dive tourist is the difference between the actual price paid for a dive trip to the Maldives and the highest amount that the tourist is willing to pay for the trip (derived from the travel cost model). Average individual CS is calculated as the inverse of the coefficient of the dive trip price variable (Eq. (1)). The CS that individual dive tourist \( i \) derives from diving at a site of quality \( q_i \) is estimated by:

\[
CS_i = \int_{p_0}^{\infty} y_i(p, q_i, X_i)dp = \frac{y_i(p_0, q_i, X_i)}{\beta_p} 
\]

(2)

where \( y \) is the number of dive trips, \( \beta_p \) is the coefficient of the dive trip price variable, \( p_0 \) is the market price of a dive trip, and \( p^{\infty} \) is the choke price at which the demand for dive trips in the Maldives at quality \( q_i \) becomes zero. Assuming that the marginal utility of the trip costs (represented by the price coefficient) does not change when the quality of the shark dive trip changes from the status quo \( q_{SQ} \) to the CB scenarios \( q_{CB} \), the change in the consumer surplus of individual \( i \) is estimated by (Whitehead, Haab, & Huang, 2000):

\[
\Delta CS_i = \int_{p_0}^{\infty} y_i(p, q_{SQ}, X_i)dp - \int_{p_0}^{\infty} y_i(p, q_{CB}, X_i)dp = \frac{y_i(p_0, q_{CB}, X_i)}{\beta_p} 
\]

(3)

where \( p^{SQ} \) and \( p^{CB} \) are the choke prices of dive trip demand at the status quo and changed qualities respectively. Total CS is estimated by multiplying average individual CS by the total number of dive tourists that currently visit the Maldives per year or the total number of predicted visits under different management scenarios. The annual income for the diving industry is the product of the number of annual dive visitors, the average price these visitors pay per day for diving activities, the average number of dive days they are making, and the average number of dive trips per year depending on the current and changed qualities. Similarly, the annual income for the local tourism industry can be estimated by multiplying the number of annual dive visitors with the average daily expenditure by these visitors on local goods and services, the average number of days they are staying in the Maldives, and the average number of trips per year.

### 3. Results

#### 3.1. Descriptive statistics

A total of 341 dive tourists were approached by the researchers and asked to participate in the survey. Of these tourists, 307 agreed to participate (90% response rate). Seven respondents did not give information about their income, travel costs, or future plans to visit the Maldives, which resulted in 300 valid surveys (95% confidence level, 5.65 confidence interval) for data analysis. Characteristics of the sample are provided in Table 2. Approximately 60% of respondents were men and 40% women, which is typical of the gender ratio of

<table>
<thead>
<tr>
<th>Table 2: Demographic characteristics of survey sample.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respondents’ characteristics (n = 300)*</td>
</tr>
<tr>
<td>Age (mean years ± SD)</td>
</tr>
<tr>
<td>Annual net household income (mean US$ ± SD)</td>
</tr>
<tr>
<td>Diving was the main purpose of the trip (diver, % of respondents)</td>
</tr>
<tr>
<td>Gender (% female)</td>
</tr>
<tr>
<td>Knows about shark sanctuary (knowledge, % of respondents)</td>
</tr>
<tr>
<td>Origin of respondents (% of respondents)</td>
</tr>
<tr>
<td>Europe</td>
</tr>
<tr>
<td>Asia</td>
</tr>
<tr>
<td>Others</td>
</tr>
<tr>
<td>Accommodation type (% of respondents)</td>
</tr>
<tr>
<td>Resort</td>
</tr>
<tr>
<td>Other</td>
</tr>
<tr>
<td>Has observed illegal shark fishing or trade (observed, % of respondents)</td>
</tr>
<tr>
<td>Satisfaction with shark dive experience (Likert scale 1 = very unsatisfied to 5 = very satisfied ± SD)</td>
</tr>
<tr>
<td>Has visited other shark-diving sites (substitutes, % of respondents)</td>
</tr>
<tr>
<td>Stayed in accommodation with shark-diving spot close by (shark dive spot, % of respondents)</td>
</tr>
<tr>
<td>Travel cost per person trip (mean US$ ± SD)</td>
</tr>
</tbody>
</table>

* Variable name used in models in italic.
divers worldwide, two thirds of whom are male (PADI, 2016). The average age of participants was 42 years. Respondents from Europe originated mainly from Germany, Great Britain and Switzerland, whereas respondents from Asia mostly originated from China. About six percent of respondents came from other locations. The average respondent had a mean net annual household income of US$87,617. The average per person trip expenditure was US$3937. Dive tourists stayed on average 11.9 days in the Maldives, spent 6.6 days diving, and went for 13 dives.

Most respondents (74%) visited the Maldives with the primary purpose of diving. Seeing sharks was the main reason for their trip for 5% and very important for 24% of respondents. Forty respondents had observed shark fishing, the trade in shark products, or both while in the Maldives. Dive tourists rated their satisfaction with the current shark-diving experiences in the Maldives on a Likert scale from one (very unsatisfied) to five (very satisfied). The average satisfaction of dive tourists was 3.62. One third of dive tourists were aware that the Maldives are a shark sanctuary and about 19% of all respondents stated that this knowledge influenced their decision to choose the Maldives as their diving destination. Half of the respondents had visited other shark-diving destinations, mostly Egypt, Australia, Indonesia, and Mexico. About 35% of respondents rated the Maldives as a better shark dive experience, 27% as a worse shark dive experience, and 38% stated that the shark dive experience in the Maldives was about the same as at other sites. About 72% of respondents chose accommodation where a shark-diving spot was accessible in the direct vicinity.

Although 40% of participants were visiting the Maldives for the first time, repeat visitors had come to the Maldives on average 2.3 (± 2.34) times during the last five years. Almost two thirds (58%) of the sample came to the Maldives because it was recommended to them by friends, family or over the internet. We asked participants about their future plans to make in the next five years. About 51.1% of respondents would not return to the Maldives and that would not recommend the Maldives as a shark-diving destination contingent on the status quo and the seven alternative scenarios presented.

Assuming that all conditions stayed the same, participants planned to make an average of 1.63 (± 1.36) trips in the next five years, about 25% said that they would not recommend the Maldives as a shark-diving destination, and 6.2% said that they would not visit the Maldives again in this time period. When presented with the CB scenarios, 87% of the respondents changed the number of trips that they were planning to make to the Maldives in the next five years. If shark abundance was to increase or dive operators engaged in actions against illegal fishing, respondents would make 1.88 or 1.74 trips, respectively. Under these conditions, only 9.5% and 6.4% of respondents would not recommend the Maldives as a shark-diving destination and only 4.2% and 5.9% would not return to the Maldives for shark-diving. Conversely, if tourists were to observe illegal fishing activities during their holidays, about 51.1% of respondents would not return to the Maldives and of those who would, they would plan only 0.71 trips for the next five years. Additionally, about 82.7% would not recommend the Maldives as a shark-diving destination. Similarly, if there were fewer sharks, no sharks, or if the dive operator did not engage in actions against illegal fishing, respondents reduced their number of planned trips to an average of 1.16, 0.81, or 0.94 trips, respectively.

3.2. Travel cost model

There was significant overdispersion (dispersion = 1.697, p-value = 0.0014) in the data, confirming that the negative binomial model had a better fit than the Poisson model. Likelihood ratio and Hausman tests showed that a panel data, random effects model that took into account the error correlation between a respondent’s answers was superior to a fixed-effects model with pooled data. The variables for gender, shark diver, origin, and overall satisfaction were not significant at the 90% confidence level and were omitted from the model. The estimation results of the best fit model are shown in Table 3.

The estimated TC coefficient was negative as expected and was significantly correlated with the number of dive trips that respondents made in the last five years, indicating that those who paid higher prices made fewer trips (see Table 4). Respondents who came to the Maldives...
with the primary purpose of diving made more trips than those divers who had another main purpose of the trip. The income variable was not significant in explaining dive trip demand. Surprisingly, respondents who knew that the Maldives are a shark sanctuary were likely to make less dive trips to the Maldives than those who were not aware of this status. Another unexpected result was that the dive trip demand was positively correlated with respondents having observed any kind of illegal shark fishing activities or trade in shark products. This may represent an endogenous relationship where divers who have visited the Maldives more often are more likely to have observed illegal activities. Respondents who stayed on resort islands were likely to make more trips to the Maldives, compared with those who stayed in guesthouses on local islands or on live-aboard vessels. The negative and significant coefficient on the substitution variable indicates that those respondents who travel to other shark-diving sites around the world make less dive trips to the Maldives.

3.3. Contingent behaviour model

Table 5 presents the results of the contingent behaviour model that fitted our data best. A likelihood ratio test confirmed significant over-dispersion (χ² = 1564.58, p-value = 0.000) in the data and suggested that the negative binomial model was preferred over the Poisson model. Results of a Hausman test supported the use of a random effects model (χ² = 0.82, p-value = 0.997), in line with previous CB studies that applied negative binomial models (Hanley, Bell, & Alvarez-Farizo, 2003; Kragt et al., 2009; Kosenius & Horne, 2016). The variables for observation, resort, diver, origin, and substitute sites were not significant at the 90% confidence level and were not included in the final model.

The estimated TC coefficient was negative and significant as expected. This indicates that those who paid higher prices planned to make fewer trips in the next five years. The income variable was found to be insignificant in determining dive trip demand. Respondents who knew that the Maldives were a shark sanctuary were likely to make more dive trips to the Maldives in the next five years than those who were not aware of this fact. The overall satisfaction of the shark dive experience in the Maldives was also positively correlated with the number of trips that tourists plan to do in the next five years. Tourists who stayed in accommodations with a shark dive site nearby were likely to make fewer dive trips in the next five years than those for whom shark dives were further away.

The model showed that most of the alternative future scenarios had a significant influence on dive trip demand. The coefficient of the scenario representing an increase in shark abundance was significant and positive, indicating that respondents would make more trips to the Maldives if shark abundance was higher. Fewer trips would be made if illegal fishing activities were observed, if there were fewer or no sharks, or if the dive operator would not engage in actions against illegal shark fishing, as indicated by the significant negative coefficients. The coefficients on the scenarios ‘no illegal fishing observed’ and ‘dive operators engage in actions against illegal shark fishing’ were not significant, suggesting that there was no predicted effect of these two scenarios on future visits, compared to the status quo situation.

3.4. Welfare estimates

Consumer Surplus estimates and changes in income from shark-diving for the diving industry under the alternative scenarios are shown in Table 5. The average CS per dive tourist per day was calculated using the estimated coefficient on TC of −1.338 from the TC model (Table 3). The average CS per person per day was US$747. This estimate can be used to calculate the total welfare that tourists receive from diving in the Maldives. We calculated a conservative estimate using the average number of days spent diving (6.6—Section 3.1), rather than the average length of stay in the Maldives (11.9—Section 3.1). In 2015, the Maldives recorded a total of 1,286,138 tourist arrivals (Tourism Yearbook 2016), of which 6% (77,168 dive visits) came with the main purpose of diving (Tourist survey 2016). Multiplying individual daily CS with the average number of dive days and the number of visitors who came mainly for diving, gave an annual CS of all dive tourists of US$380.45 million.

The annual income from shark-diving for the diving industry was estimated as the product of the average daily dive trip cost, the average number of dive days per tourist, and the total number of dive trips that tourists made per year. At an average price of US$885 per dive day, an average number of 6.6 dive days per trip, and a total of 77,168 dive visits per year, the annual income for the diving industry in the Maldives was approximately US$43.29 million. We also estimated income for the broader local tourism industry (including hotels, transfers, restaurants and souvenir shops) by using the same formula and including all local travel costs with domestic flights and ferries, accommodation, food and beverages, diving trips, and souvenirs. With an average of US$304 that tourists spent on local businesses per day, the annual income from diving for the tourism industry in the Maldives was estimated to be approximately US$154.83 million.

When tourists were presented with the alternative future scenarios, the demand for dive trips changed (Table 5). The largest change in trip demand occurred when respondents were presented with a scenario where they observed illegal shark fishing activities during their stay. Under this scenario, total dive visits per year decreased by 56.3%. If the

Table 4

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>P-value</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>15.903</td>
<td>0.941</td>
<td>7.536</td>
</tr>
<tr>
<td>Travel Cost</td>
<td>−0.978</td>
<td>0.046</td>
<td>0.489</td>
</tr>
<tr>
<td>Income</td>
<td>0.041</td>
<td>0.264</td>
<td>0.037</td>
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<tr>
<td>Knowledge</td>
<td>0.424</td>
<td>0.000</td>
<td>0.099</td>
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<tr>
<td>Satisfaction</td>
<td>0.099</td>
<td>0.066</td>
<td>0.049</td>
</tr>
<tr>
<td>Shark dive spot</td>
<td>−0.254</td>
<td>0.017</td>
<td>0.107</td>
</tr>
</tbody>
</table>

Table 5

<table>
<thead>
<tr>
<th>Status quo</th>
<th>Fishing present</th>
<th>Abundance increase</th>
<th>Abundance decrease</th>
<th>Shark absent</th>
<th>Conservation absent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Difference in dive trip demand (%)</td>
<td>56.25</td>
<td>+15.47</td>
<td>−29.01</td>
<td>−50.55</td>
<td>−42.13</td>
</tr>
<tr>
<td>Aggregate CS for dive tourists (million US$/year)</td>
<td>380.45</td>
<td>166.45</td>
<td>439.32</td>
<td>270.07</td>
<td>188.13</td>
</tr>
<tr>
<td>Income for diving industry (million US$/year)</td>
<td>43.29</td>
<td>18.94</td>
<td>49.99</td>
<td>30.73</td>
<td>21.41</td>
</tr>
<tr>
<td>Income for local tourism industry (million US$/year)</td>
<td>154.83</td>
<td>67.74</td>
<td>178.79</td>
<td>109.91</td>
<td>76.56</td>
</tr>
</tbody>
</table>

* Scenarios “fishing absent” and “conservation present” are not shown because these scenarios do not have a significant effect on future trips.
shark abundance increased, decreased, or when no sharks were present, respondents would return 15.5% more, 29% less, or 50.6% less frequently to the Maldives, respectively. Respondents also stated that they would make 42.1% fewer dive trips if dive operators did not engage in any actions against illegal shark fishing.

Applying the change in dive trip demand to our welfare estimates, we estimated that under the worst case scenario (when tourists observed illegal shark fishing), the annual CS of dive tourists in the Maldives could decrease to US$166.45 million per year (Table 5), representing a welfare loss to dive tourists of US$214 million compared to the status quo. The change in demand under this scenario would cause a decline in expenditure on diving trips in the Maldives, in turn resulting in an income reduction to the diving industry of approximately US $24.35 million per year, to US$18.94 million. A scenario of increased shark abundance improved the average CS of dive tourists. Under these circumstances, average CS could increase by US$58.86 million per year to US$439.32 million. The increased demand for dive trips under this scenario, moreover, could result in an extra US$6.7 million income for the dive-tourism industry and could benefit the local tourism industry with an extra US$23.96 million.

4. Discussion

Our study investigated how a change in the quality of dive trip experience affected the welfare of divers and the economic benefits of the dive tourism sector. We evaluated how potential changes in shark abundance, the presence of illegal fishing activities, and dive operators engaging in actions against illegal shark fishing influenced tourists’ demand for dive trips to the Maldives.

Our study suggests that increasing shark abundance can increase dive trip demand by 15% and increase the CS of dive tourists to over US $439 million compared to the status quo situation of US$380 million. Moreover, higher shark abundance can generate economic gains of over US$6 million for the local dive tourism industry and of almost US$24 million for the broader local tourism industry. Our CS estimate is comparable to the results of (Bhat, Bhatta, & Shumais, 2013) who found a total annual CS of dive tourists of approximately US$380 million.

Our results showed a substantial decrease in demand for dive trips if divers were to observe illegal fishing activities or the trade in shark products, a decline in shark populations, or if the dive tourism industry failed to engage in actions against illegal shark fishing. Our results further suggested that the drop in trip demand under these conditions can cause considerable economic losses not only to the dive tourism industry, but also for the broader local tourism sector. The highest impact on dive trip demand occurred when divers observed illegal fishing activities. Such a scenario could lead to a 56% decline in trip demand and lowered the CS of dive tourists in the Maldives by US$214 million per year compared to the status quo. We estimated that annual income for the dive tourism industry would be reduced by US$24 million when divers observed illegal fishing activities. Declining shark abundance and a lack of dive operator engagement in actions against illegal fishing also had a significant negative impact on dive trip demand, with resulting welfare effects on dive tourists and on the tourism sector in the Maldives. This result is consistent with a study of the satisfaction of shark dive tourists in Mexico, where the environmental commitment of boat crew and the abundance of sharks were among the most important factors influencing satisfaction of shark divers with the tourism experience (Ziegler, Dearden, & Rollins, 2012).

About half of the participants of our study had also visited other shark-dive destinations throughout the world. It therefore seems reasonable to suggest that the behaviour of respondents will be indicative of results for many other shark-dive locations. Given that many shark sanctuaries sustain extensive shark-diving industries that generate high revenues across a variety of sectors and governments (e.g. Gallagher & Hammerschlag, 2011; Gallagher et al., 2015; Topelko & Dearden, 2005; Vianna et al., 2012), our results have implications for the management of other shark sanctuaries that are susceptible to illegal shark fishing activities and declining shark abundance.

The scenarios in our surveys only changed one factor at a time, whereas it is very likely that the presence of illegal fishing activities or a lack of conservation efforts from dive operators would occur together, combining conditions that would result in an even lower demand for dive trips by tourists. Likewise, the absence of illegal shark fishing activities and dive operators engaging in actions against illegal shark fishing may also occur simultaneously, suggesting the potential for synergistic positive effects that might result in our study under-estimating the impacts of these factors.

Our results reflect the trip demand from a sample of divers who were already visiting in the Maldives and therefore had already experienced the quality of shark diving there. It is possible that divers who had not yet visited the area may have a different (higher) trip demand, even under scenarios with negative management outcomes, because they have not experienced the current conditions as a reference point. Forty percent of our sample were first-time visitors, so there is high potential for more new visitors with a higher trip demand to come to the region. However, respondents also changed their stated behaviour in recommending the Maldives as a shark-diving destination to friends, family or in internet reviews contingent on the different scenarios. In this context it is important to note that “word-of-mouth” reports and reviews on the internet are the most important sources of information for tourists selecting the Maldives as a destination (Ministry of Tourism, 2016). Our results indicated that, for example, 74% of divers would recommend the Maldives for shark-diving given no change in conditions, whereas 94% of divers would recommend the Maldives if dive operators were to engage in actions against illegal shark fishing. Conversely, only 14% of divers would recommend the Maldives if there were no sharks. As approximately 58% of respondents came to the Maldives because it was recommended to them by other divers, it is likely that the number of first-time visitors would also decrease if the quality of the shark dive experience deteriorated. Correspondingly, the number of first-time visitors would probably increase if the quality of the shark-dive experience improved.

The long-term success of shark fishing bans, especially in developing countries, depends on the provision of alternative sources of income to local communities. The Maldives have tackled this issue with a series of compensation schemes that recompensed fishers for their loss in fishing rights for sharks and to enable them to find alternative sources of income (Ali & Sinan, 2014). There are indications that livelihoods of former shark fishermen have diversified, but also that their income has decreased since the implementation of the shark sanctuaries (Ali, unpublished data). Other places manage this challenge by collecting user fees from dive tourists that are given to local communities which seems to be a reasonable strategy as scuba divers have shown to be willing to pay user fees (e.g. Brunnschweiler, 2010; Haas, Fedler, & Brooks, 2017; Vianna et al., 2018). The tourism industry itself in these places has become a major supplier of jobs (Vianna et al., 2012).

Our results are based on a survey of a large part of the Maldives. Shark populations, illegal fishing activities, and positive or negative dive operator behaviours are probably not equally distributed throughout the country. Under negative scenarios, it is possible that divers would not return to a specific area in the Maldives but still would come back to another part of the country, switch to another dive operator, and/or return to see other attractions. If divers find other substitutes (in terms of other attractions or locations) within the Maldives, the welfare effects presented here might be overestimated. However, given the number of factors above, we are confident that our estimates are more likely to be at the lower bound of welfare effects.

We did not find a significant change in dive trip demand when dive operators are engaged in actions against illegal shark fishing or when dive tourists did not observe illegal fishing activities during their holidays. This might be explained by the fact that these scenarios were too close to the status quo situation of most respondents. Dive
operators’ cooperation with this research (surveys were collected at their business locations) may indicate a degree of engagement in conservation actions. Also, about 87% of respondents had never observed illegal shark fishing activities or the trade in shark products in the Maldives.

5. Conclusions

Our results suggest that increasing abundance of sharks can raise demand for dive trips significantly and generate economic gains for both dive and local tourism industries. Conversely, reduced abundance, the presence of illegal fishing, or if dive operators do not engage in conservation actions against illegal fishing can result in a substantial reduction in the demand for dive trips and economic losses not only to the dive industry, but also to the broader local tourism market. Our results have implications for the management of shark populations in locations where shark-diving tourism is an important contributor to local economies, which includes many small island nations throughout the Indo-Pacific. Our work shows that the perceptions of tourists undertaking shark-diving are very important to the future of the industry. Poor compliance with regulations and dive operators who appear unconcerned about illegal fishing activities can have major impacts on the economics of the industry via the word-of-mouth recommendation of the location as a destination for shark-diving. In contrast, operators that appear to be engaged in supporting compliance and management strategies may gain future business via the same mechanism. Our results also imply that promotion by shark-diving operators of conservation goals may further increase demand.

Declarations of interest

None.

Authors’ contribution

Johanna Zimmerhackel contributed to this paper by designing the research, collecting the data, conducting the data analysis, and writing and reviewing the manuscript.

Dr. Mark Meekan was involved in the design of the research, and writing and reviewing the manuscript.

Dr. Abbie Rogers was involved in the design of the research, the data collection, provided critical background knowledge about the research area and reviewed the manuscript.

Khadeeja Ali was involved in the data collection, provided critical background knowledge about the research area and reviewed the manuscript.

Dr. Marit Kragt was involved in the design of the research, the data analysis, and writing and reviewing the manuscript.

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References


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