

The impact of invasive species on tourism

The case of lionfish in the Cayman Islands

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Contents

Summary	5
1 Introduction	7
2 Background	8
2.1 Trends	8
2.2 Ecological impacts	9
2.3 Economic impacts	10
3 Methodology	12
3.1 Economic valuation of tourism-related ecosystem services	12
3.2 Valuation method: choice experiment	14
3.3 Survey procedure	16
3.4 Sampling and survey strategy	17
4 Survey results	21
4.1 Demographics and sample characteristics	21
4.2 Stay characteristics	24
4.3 Experience in the Cayman Islands	25
4.4 Environmental awareness and willingness to pay (WTP)	26
5 Choice experiment	31
5.1 Choice behaviour and consistency	31
5.2 Estimated choice models	32
5.3 Estimated WTP and value of lionfish management	33
6 Conclusions	36
References	37
Annex A Research priorities from workshop, Anguilla 2013	39
Annex B Questionnaire	40

Summary

Since the first sightings of the lionfish in the Caribbean, the local marine ecosystems have experienced severe problems due to predation and competition by this invasive species. Since 2008, the lionfish problem is also present in the coastal ecosystems of the Cayman Islands. In order to manage this ecological threat, The Department of Environment (DOE) of the Cayman Islands requires both comprehensive ecological and economic information. Although ecological research on the lionfish invasion in the Caribbean region is increasing rapidly, socio-economic studies investigating the societal impact of this ecological threat are still rather lacking. This pilot study aims at providing an insight into the potential impacts of lionfish proliferation in the Cayman Islands on the tourism industry by revealing the perception of the lionfish problem by visitors to the Cayman Islands and measure the willingness to pay (WTP) of these tourists for managing this invasive species. These findings provide important information for the final calculation of the overall economic impact of lionfish on the Cayman Islands as well as providing a basis for possible funding schemes for the management of the lionfish problem.

An extensive visitor survey among 326 visitors shows that on average 60% of the respondents are in principle willing to pay (WTP) an environmental fee, managed by a nature organization, which would contribute to management of the lionfish problem. Depending on the valuation method chosen and taking into account the distinct characteristics of stay-over and cruise tourists, the total potential annual contribution of visitors for lionfish management in the Cayman Islands is determined at a minimum of USD8 million and a maximum of USD 26.3 million. From these findings we conclude that the support among visitors to manage the lionfish problem is already substantial but could be further increased by improving communication to visitors about lionfish related issues.

1 Introduction

Since the first sightings of the Indo-Pacific red lionfish (*Pterios volitans* and *Pterios Miles*) in the Caribbean (Albins et al., 2008) the local marine ecosystems have experienced severe problems due to predation and competition by this invasive species. The main problem of the invasive Lionfish in the Caribbean Ocean is that they affect the local ecosystems by changing the composition of the native fish species due to predation and competition (Albins et al., 2011). The lack of natural predators in this ecosystem allows the lionfish to reproduce and expand in population size (Morris and Whitfield, 2009). Some invaded regions in the Caribbean have reached densities greater than 390 lionfish per hectare (Green and Côté, 2011). This density is much higher than the lionfish density in their native Indo-Pacific habitat where the highest reported densities range around 80 fish per ha (Fishelson, 1997).

The lionfish invasion in the Cayman Islands started with the first sighting in early 2008 on the Island of Little Cayman (Johnson, 2013). The Department of Environment (DOE) immediately responded by removing that fish. In the latter part of 2008, sightings were reported in Cayman Brac and then Grand Cayman. In early 2009, after having multiple sightings around the three Cayman Islands, it became clear that this was an emerging and expanding problem for the coral reefs and fisheries of the Cayman Islands that needs well-informed management intervention. In fact, various studies have already drawn the conclusion that complete eradication of lionfish in Caribbean region is considered impossible, which increases the urgency of developing alternative management strategies (Albins and Hixons, 2011; Morris and Whitfield 2009; Whitfield et al. 2007).

Although ecological research on the lionfish invasion in the Caribbean region is increasing rapidly, socio-economic studies investigating the societal impact of this ecological threat are still rather lacking. Such economic information is crucial for various reasons. First, various economic sectors such as fisheries and tourism may potentially suffer large damages as a result of degradation of the natural resources they depend on. Second, for local managers it is important not only to be aware of the ecological effectiveness of various mitigation measures, but also be informed about the economic feasibility of managing the lionfish problem. Third, local managers also need to get an idea where possible financial resources can be found to fund lionfish management.

This pilot study aims at providing an insight into the potential impacts of lionfish proliferation in the Cayman Islands on the tourism industry. More specifically, we will reveal the perception of the lionfish problem by visitors to the Cayman Islands and measure the willingness to pay (WTP) of these tourists for managing this invasive species. These findings provide important information for the final calculation of the overall economic impact of lionfish on the Cayman Islands. Yet, in order to calculate this total damage to the economy, also the entrepreneurs operating in the tourism industry have to be researched, as well other economic sectors in the Cayman Islands such as fisheries. The study does already provide a solid basis for possible funding schemes for the management of the lionfish problem.

This report is structured as follows. Chapter 2 briefly describes the issue of lionfish in the Caribbean region. Chapter 3 explains the methodology applied to measure the WTP and the costs of lionfish for the tourist sector in the Cayman Islands. Chapter 4 presents the general results of the tourist survey and Chapter 5 reports the outcome of the valuation exercise. Chapter 6 concludes the report.

2 Background

2.1 Trends

The invasion of lionfish (*Pterois miles* and *Pterois volitans*) in the Caribbean ocean has recently been recognized as one of the world's top marine conservation issues and may well prove to be one of the greatest threats of this century to warm temperate and tropical Atlantic reefs and associated habitats (JNCC 2013). The speed at which it has spread is enormous; since a first report in 1985 in Florida waters, lionfish populations have spread across the Atlantic to Bermuda and then southward to and throughout the Caribbean Sea, extending south to Colombia and Venezuela. Lionfish has been recorded in The Bahamas, Turks and Caicos Islands, Cayman Islands, Cuba, Jamaica, Dominican Republic, Puerto Rico, Mexico, Honduras, Costa Rica, Haiti, Virgin Islands, Belize, Panama and Colombia. Expansion of their current range to South America in the near future is not unlikely. The distribution of lionfish will eventually be restricted by thermal tolerance (Kimball et al, 2004) and will include the Gulf of Mexico, the entire Caribbean and down south along the east coast of South America (see Figure 2-1).

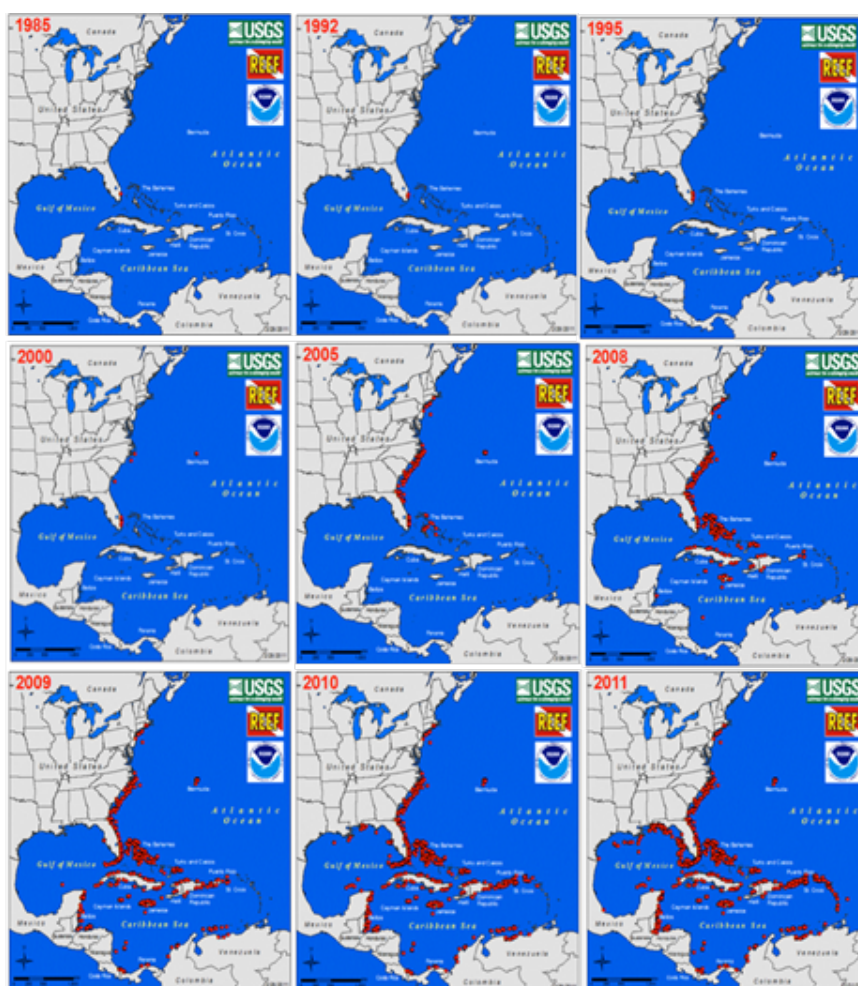


Figure 2-1 Dispersal of lionfish population of the Caribbean from 1985 till 2011.

Source: <http://nas.er.usgs.gov>

It is mostly assumed that the invasion of the first individuals was due to the release of sea-aquarium owners (Whitfeld et al., 2002) and the impact of Hurricane Andrew that destroyed sea-side aquaria, releasing numerous captive lionfish into the Western-Atlantic ocean (Courtenay, 1995; Hamner et al., 2007). The native area for these venomous predatory marine fish is the Indo-Pacific region where the population size is controlled by their natural predators like big groupers, sharks and eels (Green et al, 2011). The environmental conditions of the Caribbean region favour lionfish population growth, due to an abundance of prey, previously not exposed to lionfish predatory behaviour, and to the lack of effective predation on lionfish by Atlantic species (Albins and Hixon, 2011). Additionally, the rapid reproduction rate characteristic of the species, enables a dramatic population increase within a short space of time. The diet of a lionfish consists of juvenile reef fish. As a result, when present in large numbers, lionfish can have a drastic negative impact on the abundance and biodiversity of native reef fish.

2.2 Ecological impacts

The lionfish has several negative impacts on the marine ecosystem. First, lionfish affect local fish populations by reducing fish recruitment and by competing for food. The lionfish has several mechanisms that make him a top predator in the food chain in the Wider Caribbean. For example, the lionfish has a varied diet, which also varies depending on the age of the lionfish. The juvenile lionfish is feeding itself with crustaceans, while the adult lionfish is feeding itself with fish. The lionfish is also an efficient hunter; they can eat 20 little fishes within 30 minutes (Arias-González et al, 2012; Côté and Maljkovic, 2010). The adult lionfish eats fish from a different range of families (± 21) and of different sizes (up to 2/3 of their own length). The prey fish on the menu of the lionfish are also abundant due to the depletion of predators by overfishing in the Caribbean. Lionfish even prey on juvenile groupers and snappers thereby hamper stock rebuilding of these predators (DeBey and Steneck 2009). Lionfish not only affect native and endemic fish populations, but most probably they cause a phase shift to an algal dominated coral community by altering species composition. However, so far, there are no conclusive studies on the disturbance of the reef ecosystem and its food web in the Caribbean due to lionfish presence. As shown in Figure 2-2, Albins and Hixon (2011) propose a worst-case scenario where the lionfish in combination with human overfishing will results in a shift in the composition of the coral reef ecosystem.

Box 1: Lionfish Workshops in the Caribbean

JNCC had organized two workshops enabling UKOTs to address the needs for sustainable control of lionfish in the longer term. The first workshop was held in Anguilla in February 2013 and resulted in the identification of gaps and a list of priority actions needed for effective management, see Appendix A. The second workshop, held in the Cayman Islands in July 2013, aimed to provide the tools for implementing effectiveness of measures and collection of data. This research report contributes to the investigation of the impact of lionfish on tourism industry. The objective is ‘Economic assessment of lionfish impact on the Tourism Industry: Cayman Islands’ to serve as a pilot for similar work in other UKOTs. The anticipated long-term output should assess impact of lionfish on the private sector.

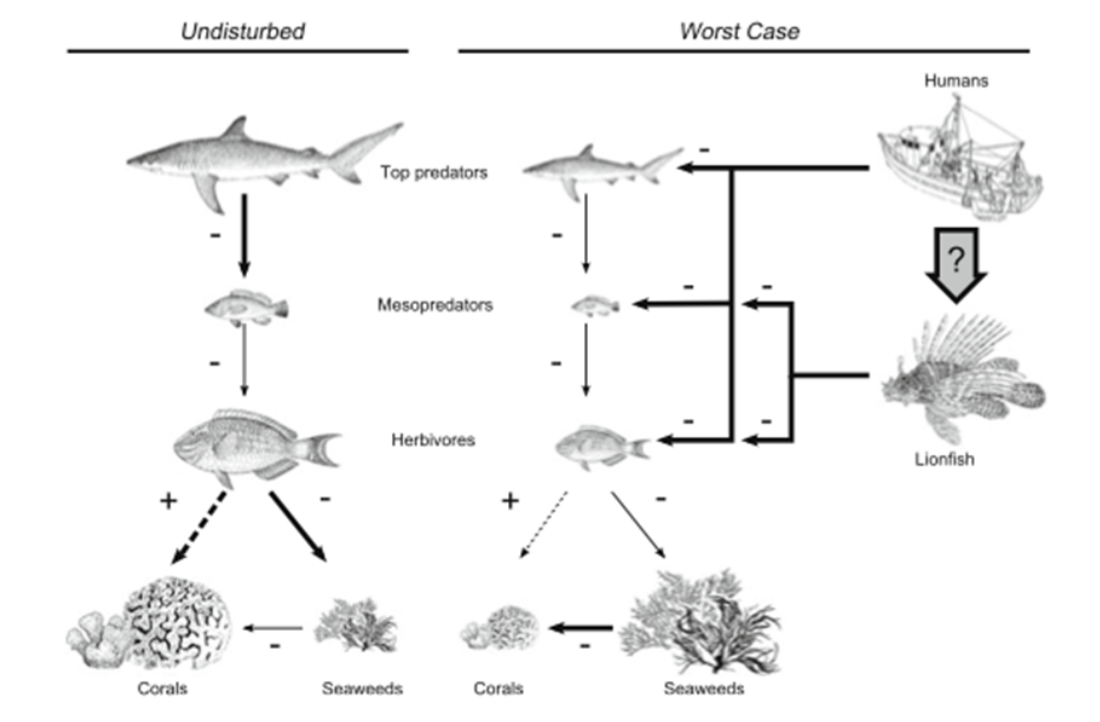


Figure 2-2 The lionfish influences the coral reef food web at different trophic levels

Source: Albins and Hixon, 2011

Throughout the region, various methods and responses are now implemented or being developed to restrain and control the lionfish invasion and population. Local food industries and dive organizations are now cooperating with their capture and usage as a food dish in order to reduce lionfish populations on high valued coral reefs. Marine Protected Areas (MPA's), where natural predators such as sharks, groupers and eels are protected from fisheries are probably more resilient against lionfish population, but this has not yet been scientifically confirmed in the literature, though theoretically conceivable (Albins et al. 2011).

2.3 Economic impacts

If indeed the coral reef ecosystem would be negatively affected, this disturbance could also severely affect a number of economic sectors in the Caribbean, such as recreation (e.g. diving and snorkelling), tourism, and fisheries. Table 2-1 shows a number of the potential economic impacts of the lionfish invasion in the Caribbean. This study focuses, however, on the potential economic impacts of lionfish invasion on tourism and tourists as the main stakeholder.

Table 2-1 Potential economic impacts of lionfish in the Caribbean

Potential economic impact	Impact type
Reduction in landings of commercial and recreational species	Fishery
New fisheries activities	Fishery
Increase/decrease in dive and snorkel industry	Tourism
Incidence of marine envenomation	Tourism, recreation
Decrease in aquarium sales	Aquarium

Source: Adapted from Morris and Whitfield, 2009.

Recreational fishery: The recreational fishery is mostly dependent of the groupers-snappers group. Although overfishing already causes these species to be relatively decimated in the Caribbean seas, the lionfish invasion may further negatively influence the recovering of these fish populations. The lionfish eat a lot of different fish including juvenile groupers and snappers, thereby preventing the recovery of these populations.

Commercial fishery industry: It is likely that commercial fisheries will severely suffer from the abundance of lionfish, as recruitment of commercial species is reduced. Morris and Akins (2009) claim that commercial species only represent a minor component of the lionfish its diet. They do emphasize that lionfish feed primarily on small-bodied teleost fishes, which are an important component of the diet of commercial species (Morris and Akins, 2009). Whereas there may be uncertainties about the pace at which these effects take place, the possibility that lionfish could have a great impact on the growth and feeding of higher trophic levels is certainly conceivable.

New fisheries activities: As densities of lionfish increase, lionfish cullers will be able to catch a sufficient amount in a day; this could be a new kind of fisheries, which can create an economic return. The question is, however, if this industry can be profitable. It is a labour-intensive process and not without risks, due to the fact that the lionfish has venomous spines. Special handling precautions are needed to avoid envenomation during fishing with a spear or small harpoon (Morris and Whitfield, 2009).

Tourism: The reef is an important asset for most countries in the Caribbean, such as the Cayman Islands. It attracts tourists throughout the year, who enjoy the beaches and actively dive and snorkel during their holidays. Caribbean islands derive on average, 25%-30% of their GDP from the tourism industry (ESO, 2013). Additionally, in 2011, the total contribution of tourism to employment, including jobs indirectly supported by the industry, was 25% of total employment (e.g. 8,000 jobs) (World Travel and Tourism, 2012). Although, this cannot be entirely attributed to diving activities and coral reefs, diving is a key component of tourism and recreation. Furthermore, it has been estimated that a 2-5% loss of growth in the Caribbean diving industry due to reef degradation would result in a region-wide loss of annual net benefits of between \$100 and \$300 million (Burke and Maidens, 2004).

Health hazards: The lionfish have venomous spines to protect themselves. A sting of the lionfish can result in a range of injuries to human. It can result in pain, fever, vomiting, breathing problems, dizziness, convulsion, numbness and redness on the injured place. Sometimes it can even result in more serious injuries; heart failure, (temporary) paralysis and death. Also, serious allergic reactions are known to occur after a sting from a lionfish. Although, a sting of the lionfish is rarely fatal to humans it can be unpleasant for a couple of days (Haddad et al. 2003). This health issue is decreasing the perception of safety of divers in the Caribbean region. This could possibly impact the number of diving tourists.

3 Methodology

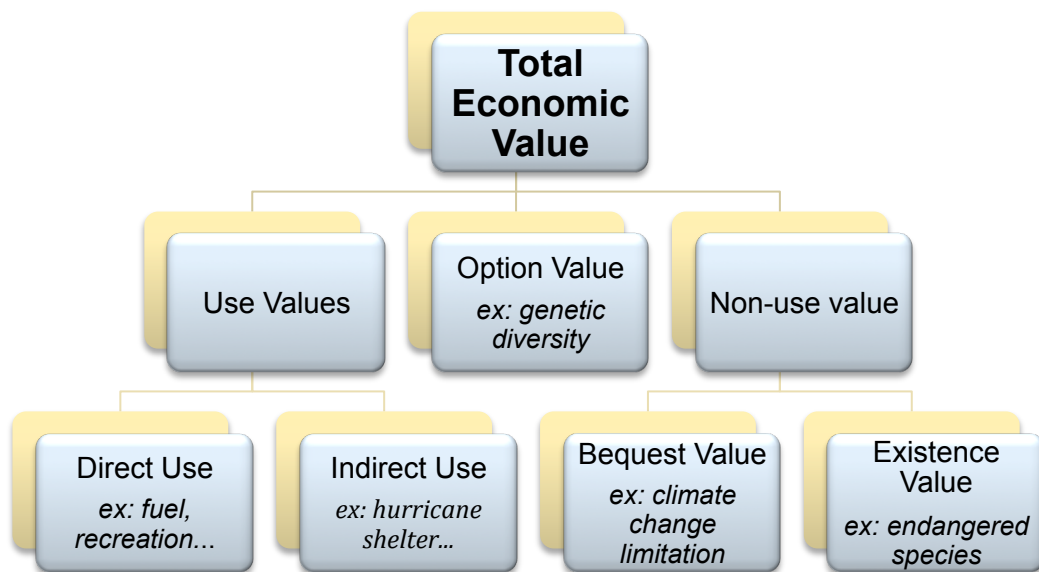
As stated earlier, the aim of this study is to reveal the perception of the lionfish problem by visitors to the Cayman Islands and measure their willingness to pay (WTP) for managing this invasive species. A tourist survey was designed, containing a series of questions, targeted at gathering extensive information about the tourists; revealing the visitors' preferences concerning the environment in the Cayman Islands and concerning the activities they take part in. We are particularly interested in understanding what respondent characteristics determine the WTP for lionfish management. In this Chapter, the valuation methodology is explained after first explaining the general nature of economic valuation of tourism-related ecosystem services.

3.1 Economic valuation of tourism-related ecosystem services

Ecosystem services are defined as the benefits derived from natural ecosystems by humans, either indirectly or directly (Costanza et al., 1997). It can therefore be useful to value specific ecosystem services in monetary terms, which is the way all goods are universally considered, so they can then be compared to other goods. Many environmental goods do not exhibit any market price, and must therefore be valued in an alternative way. The WTP for a good or service, or the amount of money an individual would be willing to spare for a defined service, can be used in environmental valuation. Alternatively, the willingness to accept (WTA), measuring the compensation that would be required for an individual to renounce an environmental good or service, is often used in economic valuation, although to a lesser extent (Farber et al., 2002).

The total economic value (TEV) of an environmental resource is a complex concept, and is composed of various different elements (see Figure 3-1). To determine the economic value of an environmental service or good, several different valuation methods are available. Determining which technique is the most suitable depends on the nature of the good to be valued. Tourism, considered as a direct-use value of the environment cannot be valued according to market prices only, unlike industries of timber for example, it does not imply the extraction or consumption of any marketable resource (Hein, 2010; van Beukering et al., 2007a). We could argue that the ecosystems provides the tourism industry with services that have an indirect-use value (e.g. water filtration by the mangroves keeping the coastal waters clean), and even option (e.g. providing recreation areas for future use) and non-use values (e.g. tourists might visit a destination knowing it hosts a rare species).

When applied to the issue of tourism impacts of the lionfish problem, a number of potential values seem relevant. First, tourist may positively or negatively value the presence of lionfish in Caribbean waters. Positively, because the lionfish is a colourful and beautiful fish. Negatively, because it is generally known as a detrimental invasive species cause damage to the local marine ecosystem. Second, tourist may also like or dislike the option of hunting lionfish. Some divers that hunt may enjoy the activity and at the same time consume the caught lionfish. Other divers may consider hunting as a disturbing activity which doesn't fit in a pristine marine environment. Third, divers may be indirectly affected by the potential decline in fish population and coral reef health caused by the lionfish invasion. It is a challenge to capture all of these effects in one valuation exercise.



Use values: the value of a good used by one or several individual(s)

- Direct use: the value of a good directly used by an individual, which represents the most straightforward value category. Many natural resources are solely directly used
- Indirect use: the value of an environmental good or service that is not harvested or marketed, but provides useful economic benefits

Non-use values: a value assigned to environmental good that is not used by one or several individuals

- Bequest value: the value derived from knowing that an environmental good is conserved for future generations (Pearce and Moran, 1994)
- Existence value: the value that people derive from knowing that an environmental good exists

Option value: the value of knowing that an environmental good will be available for future use. Can be considered as an insurance value.

Figure 3-1 Elements composing the total economic value (TEV). Adapted from van Beukering et al. (2007a), Freeman (2003) and Pearce and Moran (1994)

Several studies have investigated the economic value of coral reef-related tourism which is the main context in which the lionfish problem is analysed. van Beukering et al. (2011) provides a review of these articles (see Table 3-1). Results from these studies differ significantly with the type of technique used. This can be explained by the fact that these various methods use different approaches. For example, the Net Factor Income method considers coral reefs as part of the production of a marketed service, such as a diving trip, and therefore aims at measuring the producer surplus. On the other hand, methods such as Contingent Valuation or Choice Experiments, aim at evaluating the WTP of visitors for the preservation of coral reefs, and therefore measure the consumer surplus (van Beukering et al., 2007a). In this study, we use the choice experiment methodology, which we shall describe in the next section. To our knowledge, no general economic valuation of the natural environment of the Cayman Islands has yet been carried out.

Table 3-1 Review of recent articles concerning the valuation of coral reef-related tourism. Adapted from van Beukering et al. (2011)

Authors (year)	Location	Valuation technique
Schep et al. (2012)	Bonaire	Net Factor Income Choice Experiment
van Beukering et al. (2009)	Bermuda	Travel Cost Method Net Factor Income Contingent Valuation
van Beukering et al. (2007b)	Guam (USA)	Benefit Transfer Production Function
Carr and Mendelsohn (2003)	Great Barrier Reef (Australia)	Travel Cost Method
Ngazi et al. (2004)	Zanzibar (Tanzania)	Contingent Valuation
Seenprachawong (2003)	Phi Phi Islands (Thailand)	Travel Cost Method Contingent Valuation
Burke et al. (2006)	Indonesia	Based on other studies
Cesar and Van Beukering (2004)	Hawaii (USA)	Travel Cost Method Contingent Valuation
Nam and Son (2001)	Hon Mun Islands (Vietnam)	Travel Cost Method Contingent Valuation

3.2 Valuation method: choice experiment

As shown above, several recurrent methods are used to value ecosystem-related tourism. In this study, the method used is choice modelling (CM), which falls into the category of stated preference (SP) methods: the value of an environmental good is estimated by asking respondents to display their preferences for different environmental goods or services or different states of the same service, which reveals the value they attach to these goods and services (Carson and Louviere, 2011). In addition we will analyse the expenses of the tourists to determine which part of these expenses can be regarded as net factor benefits of the threatened marine ecosystems on the Cayman Islands.

Within a choice experiment (CE) an environmental good is described in terms of its attributes. Different levels of attributes are presented to the respondent, who is asked to choose his favoured scenario, or rank the different alternatives by making trade-offs between different combinations of attributes. As indicated by Hanley et al. (1998), several aspects can be inferred from a choice experiment:

- which of the attributes influence the respondent's preferences;
- the marginal WTP for a significant rise in one of the attributes;
- the preference for a scenario in which several attributes change simultaneously.

The WTP can be indirectly deduced from the respondents' choices by including a monetary attribute to the environmental good (Bennett and Blamey, 2001). Choice experiments are particularly suited for valuation of tourism-related ecosystem services, since trade-offs between several alternatives have to be made by the respondents in a multi-dimensional situation (Hanley et al., 2001).

The choice experiment was designed for this study, taking into account the particularities of the Cayman Islands, the environmental threats and types of visitors. As indicated by Caussade et al. (2005), the design of the choice experiment is important as it impacts the consistency of the choice. It was therefore, relevant not to include too many attributes into the model. The attributes were represented by small drawings or pictograms in order for the experiment to be more

figurative to the respondents. Following the choice of the attributes, their various levels are defined.

As presented in Table 3-2, five different attributes were chosen, as being the most relevant and applicable for this specific experiment, as well as being important to local environmental policy. More specifically, in the choice experiment, respondents were asked for their preferences for lionfish management alternatives. Similar to a tourist tax, a lionfish management fee was introduced that visitors would have to pay to control the abundance of lionfish, and hence increase reef diversity and coral quality. In addition, visitors would be allowed to hunt and eat lionfish (e.g. allowed on the menu in restaurants). The management fee consisted of 5 levels (2-25 USD per day), while the four non-monetary attributes had either two (hunting or eating) or three levels (lionfish abundance and coral quality).

Table 3-2 Choice experiment design

Attribute	Level
1) Hunting allowed	Yes, no (baseline)
2) Eating allowed	Yes, no (baseline)
3) Lionfish abundance	Not abundant, medium, abundant (baseline)
4) Coral quality	High, low, medium (baseline)
5) Management fee	25, 15, 5, 2, 0 (baseline)

The five attributes are explained to the respondents in the following manner:

1. *Lionfish hunting* refers to two situations: A situation in which spearfishing for lionfish is allowed for tourists and a situation in which it is not.
2. *Lionfish as food* refers to the availability of lionfish in restaurants on the Cayman Islands.
3. *Reef fish diversity / lionfish abundance* refers to the diversity of different reef fish and the abundance of lionfish on the reefs around the Cayman Islands. The more lionfish, the less abundant other fish species will be.
4. *Coral quality* refers to the health of the benthic part of the reef (e.g. corals, sponges etc.). This takes into account coral cover, coral diversity etc. It is assumed that the abundance of lionfish has a negative impact on the coral quality.
5. The *lionfish management fee* is a daily payment that all tourists would have to pay and would be earmarked for the management of the lionfish invasion on the Cayman Islands. Note that this fee is part of your holiday: money spent on the fee reduces your budget for other things!.

The choice experiment consists of several cards displaying different scenarios in which the levels of the attributes vary. The respondents are asked to choose their most preferred alternative. Figure 3-2 presents a typical choice card; this card is used as an example to explain the experiment to the respondent. Eight different sets of choice cards were designed, each containing 6 choice cards. In total, 48 different choice cards were created. In order to test choice consistency, the first card was shown also again to respondents at the end of the choice sequence as a seventh card without telling them. All respondents were shown the same instruction card, which served to explain the purpose of the choice experiment. After they were informed and instructed about the choice experiment, respondents were randomly shown one of the 8 choice sets and asked 7 times to choose their most preferred alternative.

In view of the fact that respondents cannot be shown all possible combinations of attribute levels, a D-efficient, balanced overlap design was generated using the software package Sawtooth, consisting of 8 versions of 6 cards each. Each card consisted of two unlabeled alternatives and the option to choose none of the two. In the latter case, respondents were informed that nothing would change, the coral reef quality would remain at its current medium level, with a risk of further deterioration to a low level. Hunting and eating lionfish would not be allowed and visitors would not pay the management fee.

In total we have interviewed 326 respondents, leading to 2,282 choices made by the respondents. With a multi nominal logit regression we have created estimates of a relative utility score for each level of each attribute. We have used the average amount chosen by all respondents as the total WTP, and divided the total WTP according to the relative utility of each attribute.
















	Option A	Option B	Expected future without lionfish management
Lionfish Hunting	 Allowed	 Not allowed	 Not allowed
Lionfish as Food	 Available	 Not available	 Not available
Lionfish Abundance/ Reef Diversity	 Not abundant	 Medium abundance	 Abundant
Coral Quality	 High	 Medium	 Medium
Lionfish Management Fee	 25 US\$ per day	 5 US\$ per day	 No payment

Figure 3-2 Example of a choice card

3.3 Survey procedure

The choice experiment is part of a more extensive survey aimed at understanding what drives tourists to the Cayman Islands, how they have experienced different activities related to the environment, and at gathering demographic information. The survey has been designed as follows (The entire questionnaire can be found in the Appendix B):

- **Introduction:** contains basic questions concerning the origin of the respondents.
- **Chapter I:** contains questions relating to the characteristics of the visitors' stay, such as tourist category, duration, and expenses.
- **Chapter II:** contains environmental awareness-related questions and the choice experiment.
- **Chapter III:** contains questions relating to the tourists' experience in the Cayman Islands, such as activities, and sites visited.
- **Chapter IV:** contains questions relating to how visitors perceive present and future environmental threats in the Cayman Islands.
- **Chapter V:** contains questions related to personal and household information.

3.4 Sampling and survey strategy

Initially, we aimed at reaching a sample size of 400 respondents, with 200 questionnaires for each tourist category: stay-over and cruise tourists. To obtain a sufficient subsample of divers in the survey, divers were targeted specifically as well. Aim was to interview 100 divers within the subsample of cruise tourists and 100 divers within the subsample of stay-over tourists. See Table 3-3 for an overview of the different subsamples. Concerning the choice experiment, the eight different sets of choice cards were equally distributed among the different interviewers, in order to get a representative sample of all the different cards. The sets were used approximately equally in numbers.

To target respondents within the subsamples randomly and after they have experienced the island, it was chosen to interview on the location of their departure: the airport for stay-over tourists and the port for cruise tourists. However, the port itself proved to be a difficult surveying location due the short periods that cruise passengers have to wait. It was therefore decided cruise tourists in areas around the cruise terminal could be interviewed as well. All interviews were carried out on Grand Cayman.

Table 3-3 *Subsamples in the survey*

	Cruise	Stay-over
Diver	100	100
Non-diver	100	100

Due to several complication and time constraints, only 326 questionnaires were completed, with a slightly unequal distribution across the two tourist categories. These numbers were, however, still sufficient to obtain significant results in the multi nomial logit regression. The distinction between stay-over and cruise tourists is important because cruise tourists only visit the Cayman Islands for one day, while stay-overs remain longer on the islands. However, we have excluded the day-tourists since they are not taken into account in this study. For the average annual number of tourists we have used the average of the years between 2000 and 2013 (see Figure 3-3).

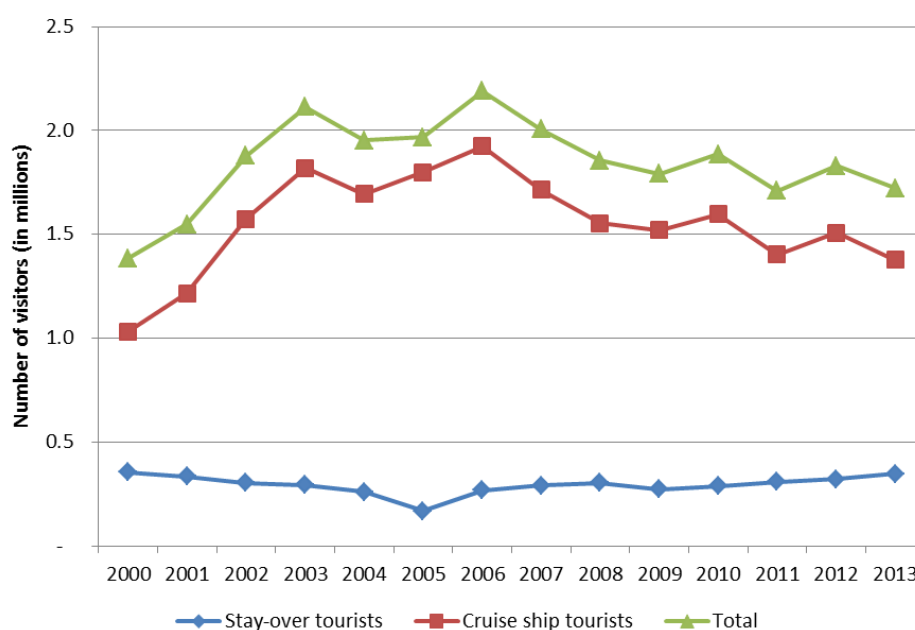


Figure 3-3 Visitor arrivals in the Cayman Islands in the period 2000-2013 (in millions)

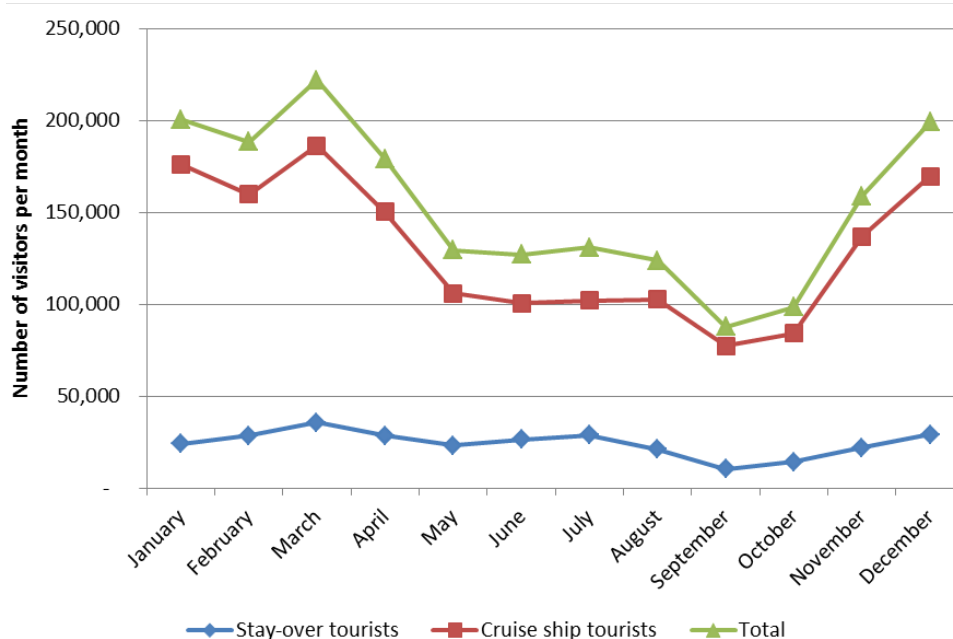


Figure 3-4 Visitor arrivals in the Cayman Islands in 2013 (per month)

Source: Cayman Islands Department of Tourism (2014)

We have tried to randomize the locations of our interviews to reduce locational bias. However, we had to adjust our sampling strategy to have a more equal distribution of the two types of tourists. Stay-over tourists were mainly interviewed at the airport, on the beaches and in front of hotels. Cruise tourists could only be interviewed on specific dates when the cruise ships were in the Cayman Islands.

A team of employees of the Department of Environment of the Cayman Islands was trained to conduct the interviews. Tourists were approached, and the goal of the questionnaire and general study were explained to them. The interviewers were trained to stay neutral during the entire survey by not stating any personal preferences in order for the questionnaire to remain as unbiased as possible. The whole questionnaire lasted around 15-20 minutes including the choice experiment.

4 Survey results

In this section, we describe the results of the survey conducted among two different types of tourists: stay-over and cruise tourists.

4.1 Demographics and sample characteristics

In total 326 tourists were interviewed of which 183 stay-overs and 143 were cruise tourists. This slight unbalance is due to the fact that the interviews were conducted between April to the end of September, which is the “low-season”, and cruise ships embark less often in the Cayman Islands. A larger number of interviews among cruise tourists could have been achieved during the “high-season”, earlier in the year.

Across the sample of 326 respondents, 44% were females and 56% males. Despite the relative balance between the two genders, bias may have occurred as many tourists interviewed responded to the questionnaire as a couple, and would therefore indicate either “male” or “female” randomly. Figure 4-1 shows the gender balance for stay-over and cruise tourists respectively.

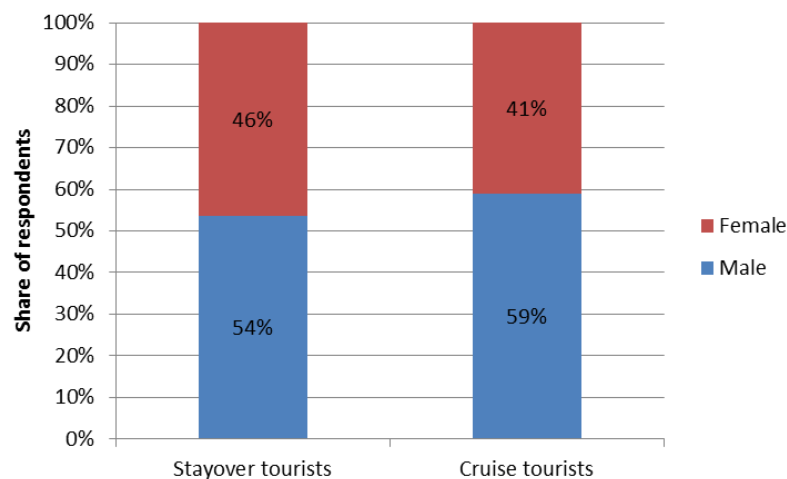


Figure 4-1 Gender of the respondents across the overall sample

As displayed in Figure 4.3, most tourists are aged between 40 and 50 years. Cruise tourists are slightly younger (i.e. 42 years) and stay-overs tourists (i.e. 46 years) with an average of 44 years, however this difference is not statistically significant.

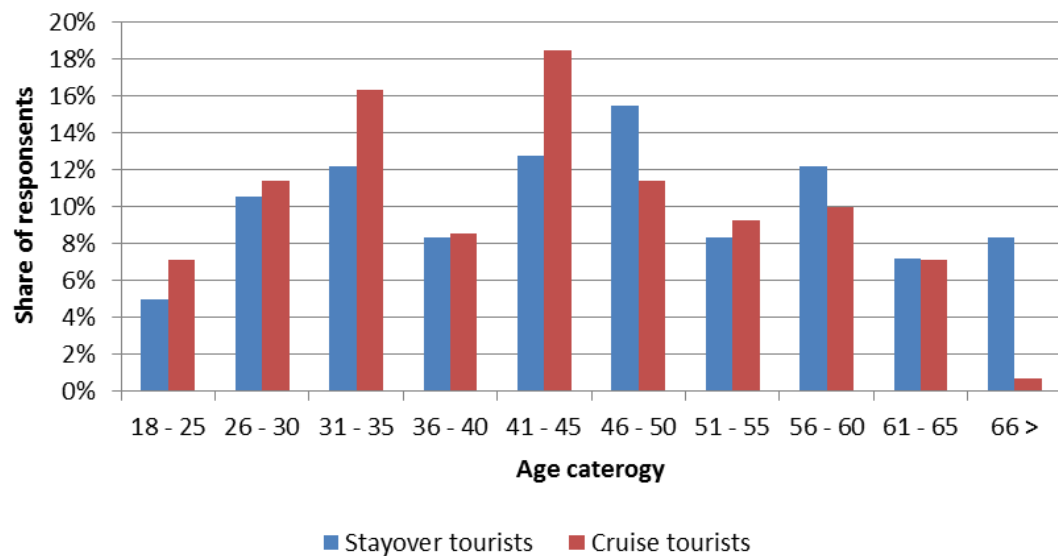


Figure 4-2 Age of the respondents across the overall sample

The great majority (78%) of tourists interviewed live in the United-States, as indicated in Figure 4-3. This share is in line with the actual US visitors in the Cayman Islands which varies between 80% in 2012 and 78% in 2013 (ESO 2014). These results were consistent among the different categories of tourists, although we see slightly more visitors from outside the United States among stay-over tourists.

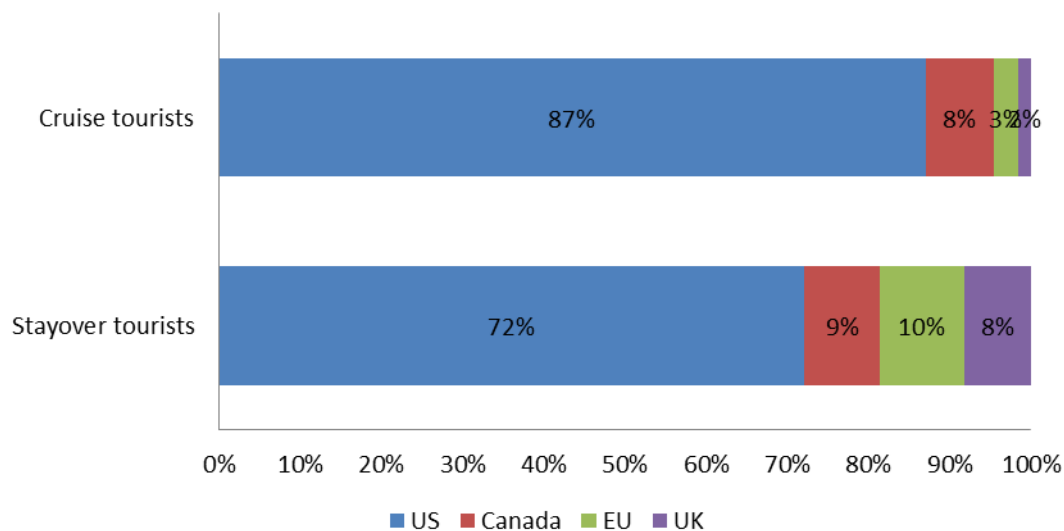


Figure 4-3 Country of origin of the respondents

Most tourists interviewed (72 %) were employed, which is consistent across all two visitor categories. Most of visitors in the Cayman Islands have achieved high-level education, as the large majority of the overall tourist sample went to college or university (see Figure 4-4).

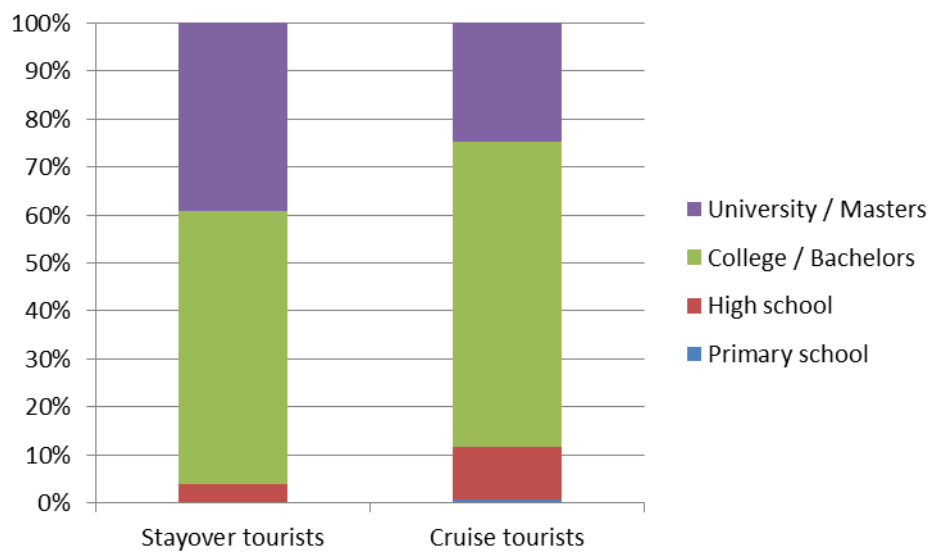


Figure 4-4 Employment categories (a) and education level (b) of respondents across the overall sample

The income distribution of the two different categories is shown in Figure 4-5. The income levels are presented in USD per annual before taxes. The income levels of the two different tourist categories differ significantly (p value = 0.007). Around 55% of the cruise tourists have an annual income of less than \$150,000, while percentage is less than 40% for stay-over tourists. The average income of stay-over and cruise tourists is \$167,000 and \$155,000, respectively, which can be considered more than modal incomes.

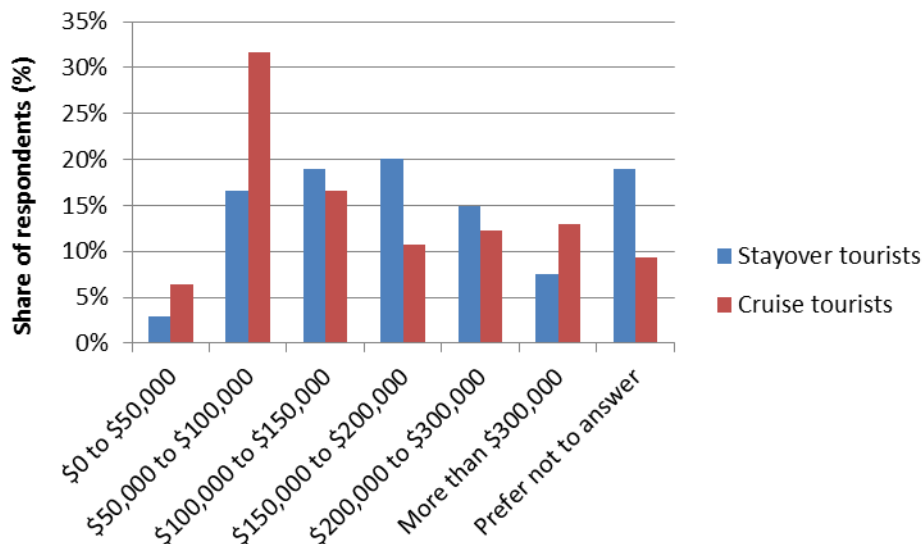


Figure 4-5 Total household annual income (before taxes) across the two tourist categories

4.2 Stay characteristics

Most stay-over tourists stay in the Cayman Islands for about a week (i.e. 6.7 days), as demonstrated by the peak between 4 and 7 days in Figure 4-6. Cruise tourists are not displayed in the figure, as only one of them indicated to have remained longer on the islands than one day. On average a Cayman Island tourist, excluding the cruise tourists, remains within the boundaries of the Cayman Islands for 7.7 days. The variation between the different nationalities is significant, however, with US citizens and Canadian citizens staying for 5.7 and 7.3 days only, while European and UK visitors stay as long as visitors 10.6 and 10.9 days, respectively. Supposedly, visitors tend to stay longer in the Cayman Islands the further away they live.

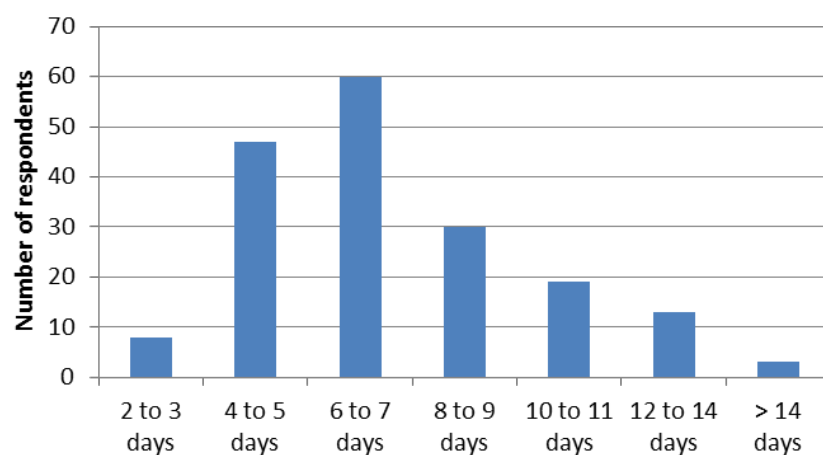


Figure 4-6 Duration of stay-over visitors' trip in the Cayman Islands (cruise tourists are not shown)

With an average of 36% across all visitors, around 40% of the stay-over tourists and 32% of the cruise tourists were coming to the Cayman Islands for the first time; this difference is not very significant though (p value > 0.1). As shown in Figure 4-7, also the history of earlier visits is not very different between both types of visitors.

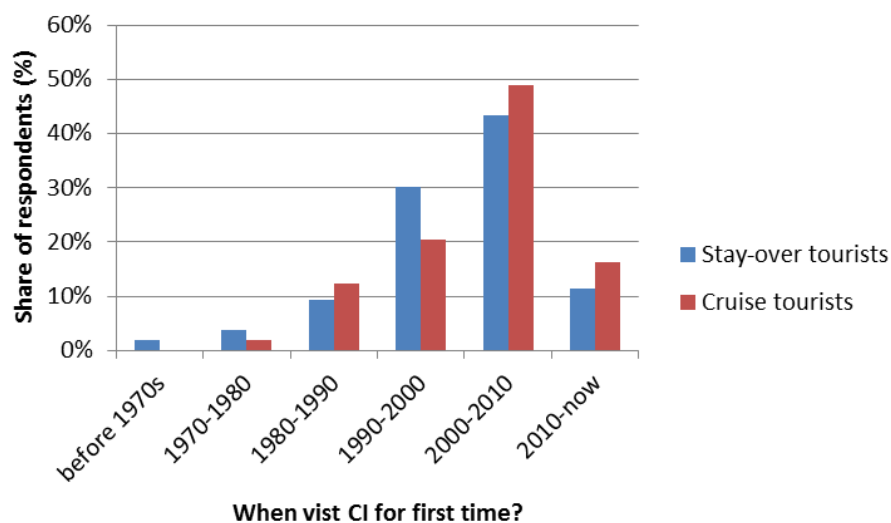


Figure 4-7 Year of first visits to the Cayman Islands

4.3 Experience in the Cayman Islands

In this section, we investigated the nature-based activities and features of the Cayman Islands that were the most enjoyed and valued. Figure 4-8 presents general trends, across all tourist types to what extent different aspects of the Cayman Islands were participated in and enjoyed most. The most important activities on tropical islands such as the Cayman Islands are generally, visiting the beach and snorkelling or diving. Important is to see the flora and fauna of the Caribbean Sea, particularly when there is coral reef along the coast. Clearly, some activities are hardly participated in, such as deep sea, reef and lionfish fishing.

The general trend appears to be to enjoy everything ‘very much’. Most activities were very much enjoyed by all tourists. The activities that stand out are diving and beach visits, and to a lesser extent the snorkelling and other water sports. However, the respondents did not give real negative scores. We may prudently conclude that the tourists appear to enjoy their holidays rather much on Cayman Islands, including the natural landscape.

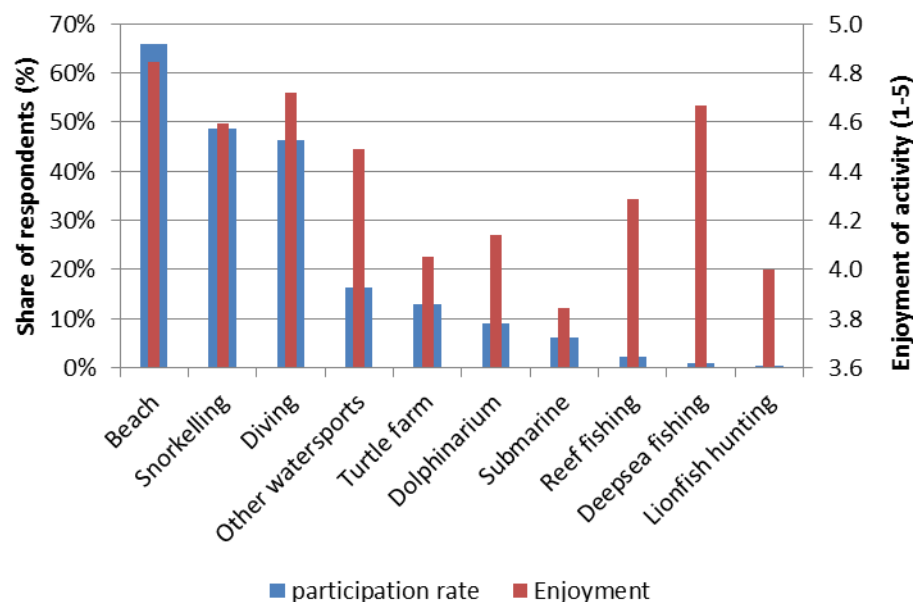


Figure 4-8 Overall enjoyment of various activities and characteristics of the Cayman Islands for stay-overs and cruise tourists

Table 4-1 shows what percentage of each tourist category participated at least once. Not surprisingly, stay-over tourists participated in more activities than cruise tourists, given the fact that they stay substantially longer on the islands and possibly because of different interests of the two visitor categories. Snorkelling is popular, more than 60% of stay-overs go snorkelling during their vacation, and almost all of them visit at least one beach. More than 70% of the cruise-tourists, however, leave the Cayman Islands without visiting a beach, and therefore also do not snorkel.

Table 4-1 Percentage of tourists participated at least once in these activities

Activity	Stay-over tourists	Cruise tourists	Sign. P value (2-sided)
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Beach	95%	27%	0.000
Snorkeling	61%	31%	0.000
Diving	46%	48%	0.569
Turtle farm	17%	8%	0.065
Dolphinarium	13%	5%	0.021
Submarine	7%	6%	0.264

Table 4-1 also indicates that although diving is not the most popular activity among tourists on the Cayman Islands, it still scores very high among cruise visitors. This remarkable finding can be partly explained by the fact that the respondents seem to be rather experienced divers, with 43% having dived before (see Figure 4-9). On average, divers take 3 dives during their stay and snorkelers go snorkelling 2.4 times during their visit to the Cayman Islands.

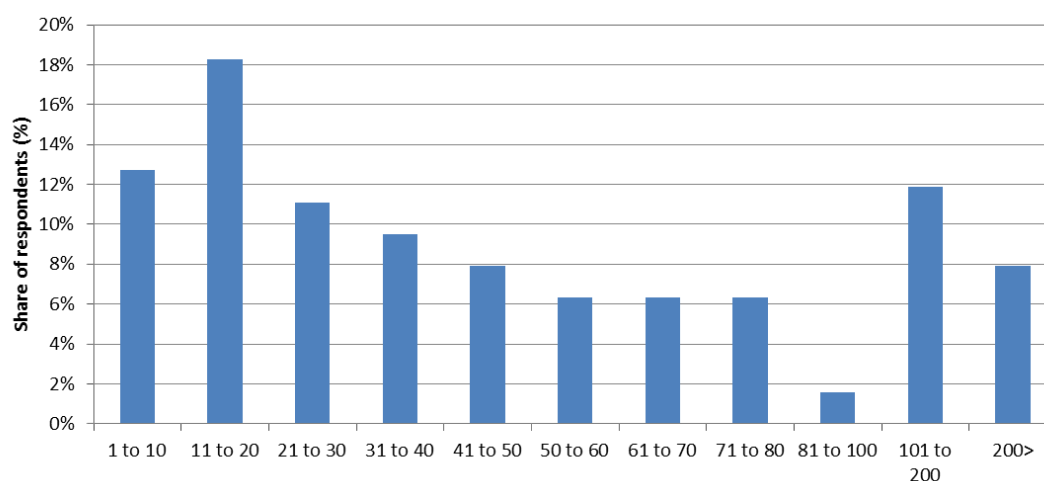


Figure 4-9 Total number of dives in the life-time of the respondent

4.4 Environmental awareness and willingness to pay (WTP)

It is important to see how tourists rate their own awareness of environmental issues in general, in order to see whether this coincides with their appreciation and concern of natural and environmental assets of the Cayman Islands. According to Figure 4-10, the majority (35%) of tourists overall consider themselves at least average environmentally aware while more than 50% considers themselves as more environmentally aware than average. Despite this being a subjective rating, it is interesting to see that most of the visitors interviewed, across the two tourist categories, think they care more about the environment than the average person. Overall, cruise tourists rate themselves slightly more environmentally aware than stay-over tourists.

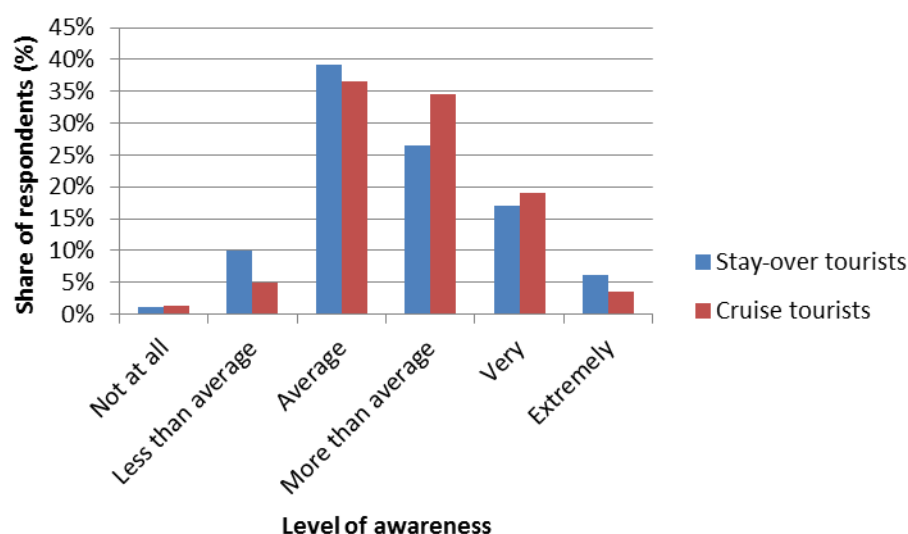


Figure 4-10 General environmental awareness of the visitors

Prior to the choice experiment, the respondents were asked whether they are in principle willing to pay (WTP) an environmental fee, managed by a nature organisation, which would contribute to the improvement of the environment in the Cayman Islands. This general question is complementary to the choice experiment. As demonstrated in Figure 4-11, most tourists, across both categories with no significant difference among the different tourist types, are willing to pay an environmental fee. Overall, 60% of the respondents stated to have a positive WTP.



Figure 4-11 Willingness to pay for an environmental fee in the Cayman Islands, across the three different tourist categories

The respondents, who replied “no” to the “in principle willing to pay” question, were asked the reason for their choice. Figure 4-12 present these results. Most respondents who did not want to pay an environmental fee are unable to provide a reason for their zero WTP. Furthermore, the reason was indicated that they cannot afford it. Respondents also feel environmental management should be taken care of by local authorities or they have doubts about whether the payment will be spent effectively.

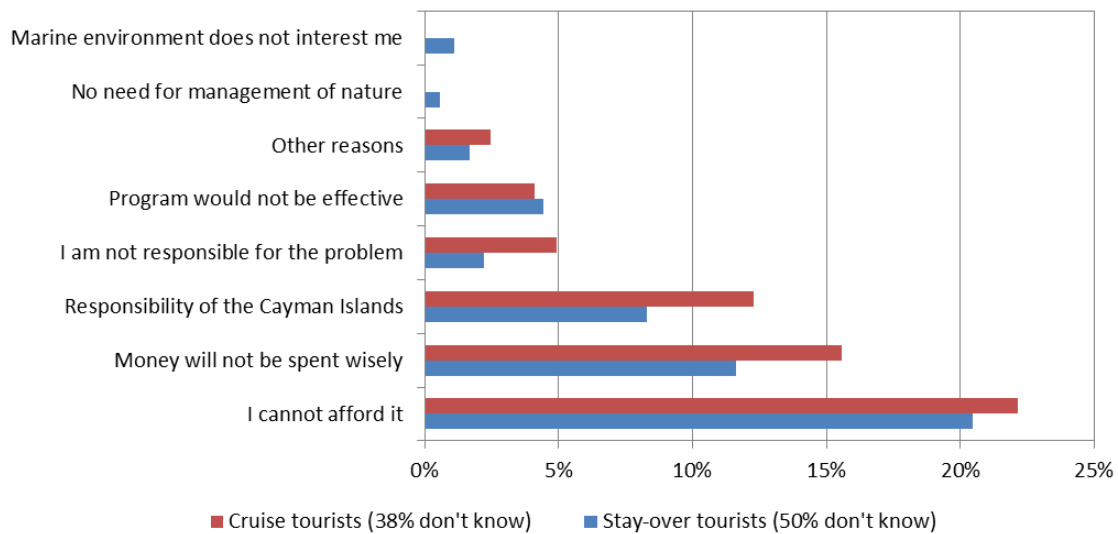


Figure 4-12 Reason explaining why some of the respondents would not be willing to pay an environmental fee in the Cayman Islands

A possible correlation between environmental awareness and WTP was investigated. As shown in Figure 4-13, we observe plausible link: the more environmentally aware the respondent is, the more likely the respondent will elicit a positive WTP. However, this relationship is rather weak, in fact much less prominent than in most other WTP studies on environmental management. We suspect that the lionfish management is still relatively unknown to most respondents, thereby depressing potential WTP manifestation.

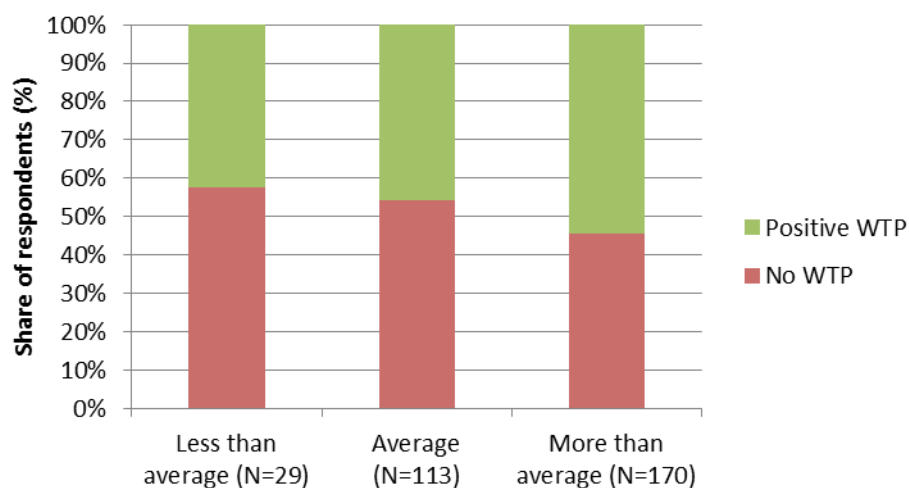


Figure 4-13 Relation between environmental awareness and WTP for an environmental fee in the Cayman Islands

The relationship between the WTP and tourist type is presented in Figure 4-14. The average WTP of stay-over tourists of \$2.70 is significantly lower than the WTP of cruise tourists of \$5.38 (p value > 0.001).

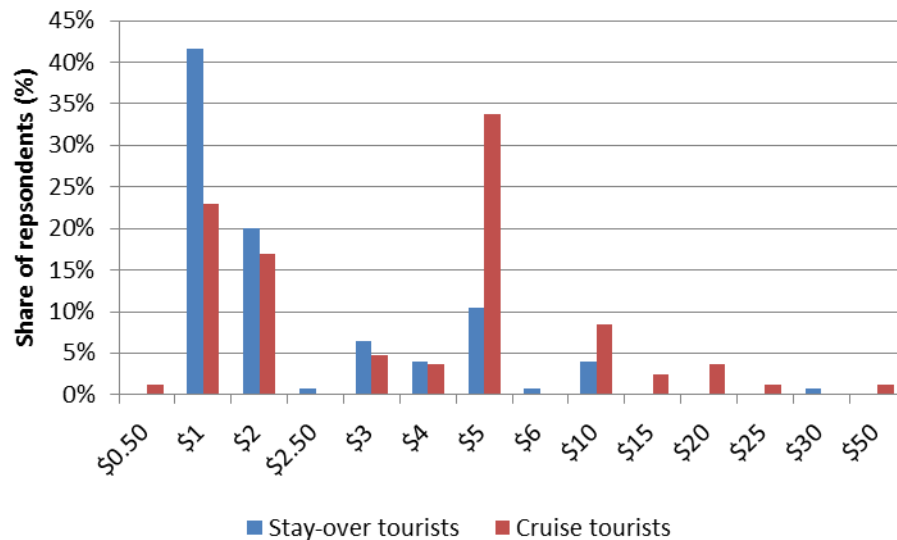


Figure 4-14 Relation between WTP an environmental fee in the Cayman Islands and tourist type

Seven statements, relating to the environmental quality and economic development of the Cayman Islands were presented to the visitors, with which they had to agree or disagree on a 5-level Likert scale. A score of 1 implies total disagreement with the statement, and a score of 5 reflects total agreement with the statement. Before we present the outcome of the average scores, the level of uncertainty for each statement is shown in Table 4-2, which proves that the issue of lionfish is still unfamiliar to most visitors to the Cayman Islands. For example, 80% of the respondents never tasted lionfish before and 65% is uninformed about lionfish management efforts in the Cayman Islands. It is important to keep this in mind when interpreting the results rating of the statements. For example, as shown in Figure 4-15, the statement “lionfish is delicious” is strongly supported by the 20% of the respondents that tasted this delicacy. Overall, one can also conclude that lionfish hunting is an accepted practice in the eyes of tourists. Moreover, increasing environmental fees to manage the problem of lionfish is also strongly supported by both stay-over and cruise tourists.

Table 4-2 Level of uncertainty about seven statement

Statement	Don't know
Lionfish are delicious	80%
Current efforts to manage lionfish on the CI are sufficient	65%
I enjoy seeing lionfish when I am in the water	38%
Lionfish pose a risk to the safety of people	31%
Environmental fee that is currently paid should be higher	31%
I have experience with lionfish hunting	21%
Hunting/killing lionfish is a horrible practice	11%

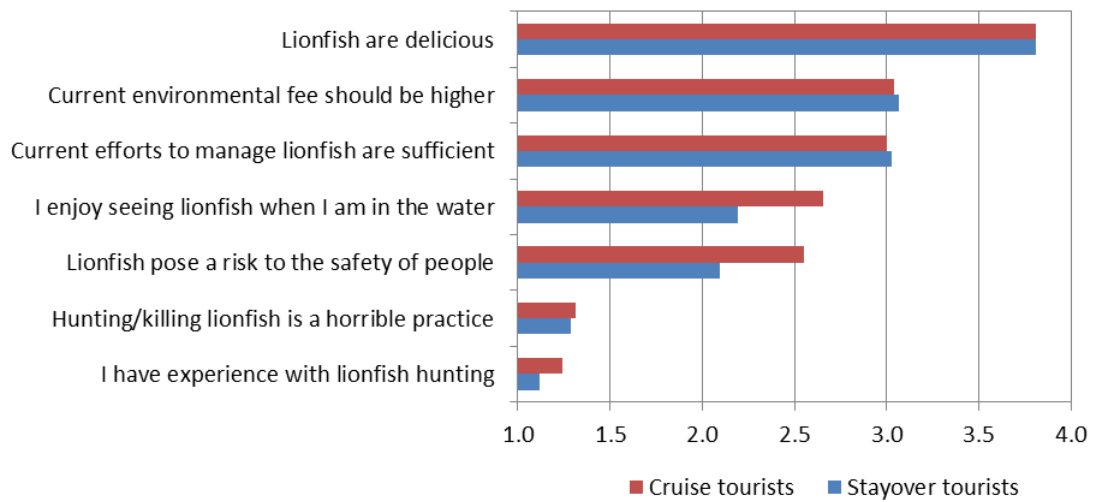


Figure 4-15 Level of agreement with environmental statements on a scale of 1 (totally disagree) to 5 (totally agree)

5 Choice experiment

5.1 Choice behaviour and consistency

The number of respondents who consistently chose none of the two across all choice cards was limited to 8.9 percent. Most of these respondents stated that it was too hard for them to make a choice. These respondents did not belong to a specific social class or group. That is, they were both men and women from different age groups and education levels. Only one of these respondents protested because he did not believe that the money would actually be spent on lionfish management. This is shown in Figure 5-1 in which the respondent's choices across the choice tasks are examined, respondents prefer option A slightly more often than option B, while the opt-out is chosen, on average, in 18 percent of all the choice occasions. This implies that no ordering biases are recorded (i.e. more or less equal shares of people choosing A or B) and that respondents do not necessarily choose the socially most preferred option A and B supporting management (i.e. people do occasionally select the opt-out without management).

When asked how they made their choices, most respondents reported that they considered all attributes (34%) or a few attributes (33%). Only 5 respondents claimed to make random choices (1%). The self-reported importance of the attributes in their choices shows that coral quality was considered very important by most respondents (75%), followed by a reduction in the abundance of lionfish (65%). Whether or not lionfish could be eaten was considered important by least respondents (25%). Approximately 30 percent considered hunting and the management fee very important. Although the latter cannot be interpreted as attribute non-attendance, the relatively low share for the payment attribute is slightly worrying. After all, for the choice experiment to report realistic results, respondents need to seriously consider the payment of the management fee in order to make real trade-offs between changes in the levels of the various attributes.

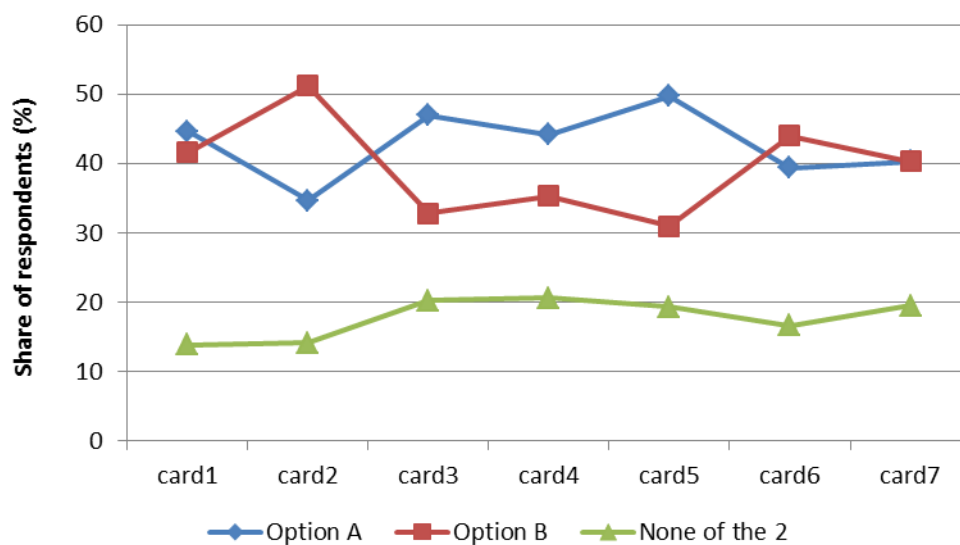


Figure 5-1 Respondent choices across the seven choice cards

When asked to indicate how certain they are about their 6 choices on a scale from 1 to 10, where 1 means not certain at all and 10 very certain, half of the sample scored a 7. The mean score is 5.9. A quarter indicated not to be certain at all (1), while 29 percent stated to be very certain of

their choices (10). Applying an ordered probit model to regress self-reported choice certainty on a number of socio-demographic and other visitor characteristics, differences only appear to be influenced by travel mode: respondents travelling to the island as part of a cruise appear to be more certain than other visitors.

Similar to previous studies (Brouwer et al., 2010), the share of respondents choosing the same alternative in the first and last card is 72 percent. No systematic patterns can be detected here either when trying to explain consistent or inconsistent behaviour across respondent groups in a binary logistic regression analysis. Only household income appears to have a significant positive influence on consistent choice behaviour. That is, respondents with a higher income level were, all else being equal, significantly more consistent in their choices than respondents with a lower income. However, the explanatory power of the estimated model is very low.

5.2 Estimated choice models

The estimated multinomial logistic (MNL) choice model is highly significant as can be seen from Table 5-1. All choice attributes furthermore exhibit significant unobserved preference heterogeneity. The estimated mixed logit model controls for the panel data structure (i.e. 6 choices by the same respondent) and estimated using 1000 Halton draws. No significant correlation can be detected between alternatives when including an error component. The distribution of the standard deviation around mean ASC and the management fee is normal, while the dummy variables for hunting, eating, abundance of lionfish and coral quality have a uniform distribution following recommendations by Hensher et al. (2005). The difference between the coefficient estimates for not abundant and medium abundant is not statistically significant based on the Wald test. Hunting is valued significantly higher than eating, but only at the 10 percent significance level.

As expected, all coefficient estimates have a positive sign except low coral quality and management fee. Hunting and eating lionfish is valued positively, as well as lower levels of abundance. High coral quality is valued positively too, whereas low coral quality is valued negatively compared to the medium baseline level. Higher management fees are, as expected, valued negatively. The positive sign on the ASC coefficient indicates that respondents prefer a move away from the status quo and a future state without lionfish management. However, the large significant coefficient on the standard deviation around the mean estimate suggests that there exists a lot of variation in preferences across respondents, with some share of the sample preferring the status quo instead one of the two hypothetical management alternatives.

When introducing additionally also the sources of observed preference heterogeneity into the model, only the interaction between coral quality and whether or not a respondent is a diver appears to have a significant impact on choice behaviour. Respondent gender, age, household composition, employment status, disposable income, country of origin, travel mode, travel package and expenditures do not have any influence on stated choices.

Table 5-1 Estimated mixed logit choice model

Choice attributes	Coefficient estimate	Standard error	Marginal WTP	Standard error
ASC	3.313***	0.429	75.836	17.930
Hunting	0.512***	0.096	11.730	2.825

Eating	0.289***	0.084	6.615	2.333
Not abundant	0.581***	0.119	13.302	3.515
Medium abundant	0.581***	0.107	13.298	3.279
High coral quality	0.353***	0.107	8.083	2.778
Low coral quality	-1.013***	0.154	-23.182	6.060
Management fee	-0.044***	0.008		
Standard deviation of random parameters				
ASC	4.604***	0.519		
Hunting	1.112***	0.278		
Eating	1.053***	0.238		
Not abundant	1.580***	0.315		
Medium abundant	0.679	0.464		
High coral quality	0.917**	0.391		
Low coral quality	1.910***	0.311		
Management fee	0.070***	0.011		
Summary statistics				
Log likelihood	-1525.867			
Wald chi-square	1241.642			
McFadden R2	0.289			
Respondents	326			
Observations	1956			

5.3 Estimated WTP and value of lionfish management

Marginal WTP values are presented in Table 5-2. Corresponding with self-reported attribute attendance, eating lionfish is valued lowest (USD 6.6/day). The disutility associated with a further deterioration of coral quality from medium to low levels is valued highest in monetary terms (USD 23.2/day). Moving from current abundance levels to medium or non-abundance of lionfish is valued equally (USD 13.3/day). Respondents are willing to pay, on average, USD 11.7/day to be able to hunt lionfish.

Table 5-2 Average respondent preferences expressed in the choice experiment measured as mean WTP (USD/day)

Attribute	Marginal value
Prevent decline in quality of coral reef from medium to low levels	USD 23.2/day
Reduce lionfish from high abundance levels to	USD 13.3/day

medium or non-abundance	
Be allowed to hunt lionfish for recreational purposes	USD 11.7/day
Be offered the possibility to consume lionfish	USD 6.6/day

Mean WTP for the outcome of an optimal management policy where lionfish is not abundant in the future, coral quality is high, and lionfish can be hunted and eaten is presented in Table 5-3. The mean WTP value is relatively compared to the highest bid level in the design. This is mainly due to the fact that the bid vector has a relatively fat tail. That is, at the highest bid level of USD 25, still 81 percent of all respondents chose one of the hypothetical management alternatives. A distinction is furthermore made in Table 5-3 between visitors who are on a cruise and visitors who visit the island via the air, and between divers and non-divers.

Table 5-3 Mean WTP (USD/day) for optimal marine management policy, including effective lionfish strategy

Type of respondent	Mean WTP	St error	95% confidence interval
All respondents	48.5	8.8	31.2 – 65.7
Visit via air	43.6	17.0	10.3 – 77.0
Visit via cruise	50.4	13.8	23.5 – 77.4
Non-divers	53.2	18.6	16.8 – 89.6
Divers	45.3	13.3	19.3 – 71.4

Finally, before the choice experiment respondents were asked whether they would be willing to pay in principle for the management of the lionfish problem on the Cayman Islands. Fifty-nine percent said yes to this question. Mean willingness to pay (WTP) of these respondents is lower than the marginal WTP values presented in Table 5-2, namely USD 3.9 per day. Median WTP is about half of this amount, namely USD 2 per day. Most respondents who are willing to pay in principle state one dollar (37%), followed by 2 dollar (20%) and 5 dollar (21%). No significant difference can be detected between mean WTP for respondents who dive (USD 3.9) and respondents who do not (USD 3.8). However, respondents who visit the Cayman Islands on a cruise are willing to pay significantly more (USD 5.4) than respondents who visit the island by air plane (USD 2.7).¹

Table 5-4 shows how the above marginal values can be used for the calculation of the aggregate potential contribution of visitors for effective lionfish management in the Cayman Islands. In doing so, several aspects need to be taken into account. First, the distinction in visitor preferences has to be taken into account because especially the difference in stay-over visitors and cruise ship tourists is significant, in terms of length of stay as well as in expressed marginal values. Second, we need to recognise that the valuation method used for the elicitation of the marginal values of both groups may have a large impact on the overall value. When accounting for these influences, a minimum potential contribution of visitors for lionfish management is determined at USD8 million per year, based on the contingent valuation method (CVM). Using the choice experiment as the preferred valuation method, a maximum value of lionfish management in the Cayman

¹ Test results are available from the authors upon request.

Islands is determined at USD26.3 million per year. Obviously, these aggregate number need to be treated with care because of its hypothetical nature and the fact that the implementation costs of collecting these contributions may be high as well, thereby lowering the net revenues. Nevertheless, this valuation study highlights the potential of extracting funds from tourists for managing the severe problem of the lionfish invasion.

Table 5-4 Aggregate potential contribution of visitors for effective lionfish management in the Cayman Islands

Variable	Unit	Cruise tourists	Visitors by air
Marginal value based on CVM	<i>USD/pp/day</i>	\$5.40	\$2.70
Marginal value based on CE	<i>USD/pp/day</i>	\$13.82	\$11.96
Share with positive WTP	<i>%</i>	57%	61%
Number of visitors	<i>Visitors</i>	1,480,589	307,272
Number of visitor days	<i>Days</i>	1,480,589	2,058,721
Length of stay	<i>Days/visitor</i>	1	6.7
Potential contribution - lower bound	<i>million USD</i>	\$4.6	\$3.4
Potential contribution - upper bound	<i>million USD</i>	\$11.7	\$15.0

6 Conclusions

Research has already shown that the complete eradication of lionfish in the West-Atlantic and Caribbean region, including the Cayman Islands, is considered impossible (Albins and Hixons, 2011; Morris and Whitfield 2009; Whitfield et al. 2007). The negative ecological effects of the lionfish on the marine ecosystem are agreed upon in the scientific community. Moreover, there is also a high public awareness of the lionfish as an environmental problem among local stakeholders and residents. The socio-economic dimension of the lionfish problem in the Caribbean, however, remains largely unknown. This lacuna of information is a major handicap for decision makers and practitioners in the region in their effort to manage the lionfish invasion.

This study made an attempt at providing an insight into the potential impacts of lionfish proliferation in the Cayman Islands on the tourism industry with specific attention for determining the perception of the lionfish problem by visitors to the Cayman Islands and measure the willingness to pay (WTP) of these tourists for managing this invasive species. The survey among 326 visitors shows that on average 60% of the respondents are in principle willing to pay (WTP) an environmental fee, managed by a nature organization, which would contribute to management of the lionfish problem. Depending on the valuation method chosen and taking into account the distinct characteristics of stay-over and cruise tourists, the total potential annual contribution of visitors for lionfish management in the Cayman Islands is determined at a minimum of USD8 million and a maximum of USD 26.3 million. From these findings we conclude that the support among visitors to manage the lionfish problem is substantial. Therefore, we recommend involving visitors more actively in response strategies.

Overall, we suspect that lionfish management is still relatively unknown to most respondents, thereby depressing potential WTP manifestation. The survey shows that 80% of the respondents never tasted lionfish before and 65% is uninformed about lionfish management efforts in the Cayman Islands. Therefore, communication activities could increase the support by tourists for lionfish management. Overall, one can also conclude that lionfish hunting is an accepted practice in the eyes of tourists whom are informed.

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Annex A Research priorities from workshop, Anguilla 2013

UKOT government representatives identified five research priorities during the workshop in Anguilla February 2013; the Cayman workshop addressed three of these. They are:

- Investigating the impact of feeding by lionfish; it is well known that these species are carnivorous with a voracious appetite, feeding on juvenile reef fish. It is recognized that this may potentially have a strong impact on the population of reef fish, leading to a change in coral reef health (through the predation of herbivorous fish), and to a decline in recruitment of commercially important finfish species. By thoroughly assessing the quantity and quality of fish consumed by lionfish species in the Caribbean, an insight into the potential impacts of the species on coral reef health and fisheries industries.
- Investigating specific means of lionfish removal; the location of these populations at depths beyond cost-effective SCUBA and snorkel measures requires the development of specific traps effective at attracting lionfish with minimal impact to other reef fish populations.
- Identifying hot spots through population surveys; this will enable the prioritizing of efforts and resources in control measures. The challenges lay in that lionfish populations in several of the OTs are believed to be at depth greater than 30m; in order to evaluate population abundance and densities, specialized SCUBA equipment and/or adequate traps will be needed.

Annex B Questionnaire

TO BE FILLED BY THE INTERVIEWER:		Weather: (circle one(s) that apply)	
Interviewer name:		<i>Sunny, overcast, rainy</i>	
Date (m/d/y):	Time:	Location:	
Questionnaire #		Diver: Yes / No	Cruise / Stay over

SURVEY ABOUT THE IMPACT OF LIONFISH ON THE TOURISM SECTOR

0 Introduction

Good morning/afternoon/evening, my name is _____. I am working for the government of the Cayman Islands. We are researching how tourists value the environment on the Cayman Islands. For this we would like to ask a few questions about your motivation to visit the Cayman Islands and your activities while being here. Would you like to participate? It will only take about **15 minutes** and it is completely confidential. Note that there are no wrong answers to the questions - we only want your honest opinion.

0.1 Are you 18 years or older?

1. Yes	CONTINUE QUESTIONNAIRE	
2. No	THANK PERSON AND TERMINATE INTERVIEW	

0.2 Where do you live?

1. Here on the Cayman Islands: THANK AND TERMINATE •	
2. USA: specify state: _____	
3. Canada: specify province/territory: _____	
4. UK and Ireland, specify _____	
5. Continental Europe: specify country _____	
6. Central and South America, specify country _____	
7. Africa and the Middle East, specify country _____	
8. Asia, specify country _____	
9. Australia and Oceania, specify country _____	
10. Other, specify country _____	

0.3 What is the **purpose** of your visit?

1. Leisure	
2. Former residents/ visiting friends or family	
3. Combination of leisure with either business or visiting friends/family (only if you spend one day or more on leisure activities)	
4. Business æTHANK AND TERMINATE •	

You meet our selection criteria. We will now start the survey.**Part 1: Visiting the Cayman Islands**

1.1 Did you arrive on the Cayman Islands by cruise ship or airplane?

1. Cruise		2. Airplane		3. Other	
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1.2 How many **nights** are you staying on the Cayman Islands? nights

1.3 If this is not your first visit to the Cayman Islands, was your first visit by cruise ship?

1. Yes		2. No	
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1.4 Which islands of the Cayman Islands have you visited during this trip?

1. Grand Cayman		2. Cayman Brac		3. Little Cayman	
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1.5 When was your first visit to the Caribbean region? Please specify year

1. Please specify year	2. This is my first visit	
------------------------	-------	---------------------------	--

Part 2: Your experience on the Cayman Islands2.1 If you are a diver, how many dives did you roughly make in you lifetime? 2.2 Please indicate how much you enjoyed the following water-based activities on a scale from 1 to 5 (*1 = not enjoyable; 5 = very enjoyable*).

	Did not do this	<div style="display: flex; align-items: center; justify-content: space-between;"> Not enjoyable ↔ Very enjoyable </div>				
1. Diving		1	2	3	4	5
2. Snorkelling / snorkel trip		1	2	3	4	5
3. Submarine ride / glass bottom boat		1	2	3	4	5
4. Beach visit / swimming		1	2	3	4	5
5. Lionfish hunting		1	2	3	4	5
6. Deep-sea fishing		1	2	3	4	5
7. Reef fishing		1	2	3	4	5
8. Other water-based activities (Kayaking, surfing, jetski, boat trips etc.)		1	2	3	4	5
9. Visited turtle farm		1	2	3	4	5
10. Visited dolphinarium		1	2	3	4	5
11. Other, specify:		1	2	3	4	5

- 2.3** Indicate how many dives you did during your stay on the Cayman Islands and in which area? Also, please rate the quality of the marine environment in that area on a scale from 1 to 5 (1 = poor; 5 = excellent)

Dives		Quality				
1. Grand Cayman total:	# _____ dives	Poor \longleftrightarrow Excellent				
• Northside	# _____ dives	1	2	3	4	5
• Westside	# _____ dives	1	2	3	4	5
• Southside	# _____ dives	1	2	3	4	5
• East End	# _____ dives	1	2	3	4	5
• Kittiwake	# _____ dives	1	2	3	4	5
2. Little Cayman total:	# _____ dives	Poor \longleftrightarrow Excellent				
• Bloody Bay	# _____ dives	1	2	3	4	5
• Elsewhere on Northside	# _____ dives	1	2	3	4	5
• Southside	# _____ dives	1	2	3	4	5
2. Cayman Brac total:	# _____ dives	Poor \longleftrightarrow Excellent				
• Northside	# _____ dives	1	2	3	4	5
• Southside	# _____ dives	1	2	3	4	5
• Capt. Keith Tibbetts	# _____ dives	1	2	3	4	5

[IF RESPONDENT DID NOT SNORKEL: CONTINUE WITH PART 3]

- 2.4** Indicate how many snorkel trips you made during your stay on the Cayman Islands and in which area? Also, please rate the quality of the marine environment in that area on a scale from 1 to 5 (1 = poor; 5 = excellent)

Snorkel trips		Quality				
1. Grand Cayman total:	# _____ trips	Poor \longleftrightarrow Excellent				
• North Sound	# _____ trips	1	2	3	4	5
• Northside	# _____ trips	1	2	3	4	5
• Westside	# _____ trips	1	2	3	4	5
• Southside	# _____ trips	1	2	3	4	5
• East End	# _____ trips	1	2	3	4	5
• Stingray City / Sandbar	# _____ trips	1	2	3	4	5
2. Little Cayman total:	# _____ trips	Poor \longleftrightarrow Excellent				
• Bloody Bay	# _____ trips	1	2	3	4	5
• Elsewhere on Northside	# _____ trips	1	2	3	4	5
• Southside	# _____ trips	1	2	3	4	5
2. Cayman Brac total:	# _____ trips	Poor \longleftrightarrow Excellent				
• Northside	# _____ trips	1	2	3	4	5

Part 3: Environmental Awareness & choice questions

3.1 To what extent do you consider yourself **environmentally aware**?

1. Not at all		4. More than average	
2. Less than average		5. Very	
3. Average		6. Extremely	

THE MARINE ENVIRONMENT IN THE CARIBBEAN EXPERIENCES PRESSURE CAUSED BY A NON-NATIVE SPECIES: THE LIONFISH. THE LIONFISH COMES FROM THE INDO-PACIFIC OCEAN, BUT IS INCREASINGLY ABUNDANT IN THE CARIBBEAN REGION. THERE ARE STRONG INDICATIONS THAT THE IMPACT ON THE REEF FISH STOCKS IS LARGE. THIS GOES FOR THE CAYMAN ISLANDS AS WELL. SOLUTIONS COULD CONSIST OF TARGETING LIONFISH WITH VARIOUS FISHING TECHNIQUES, E.G. SPEARFISHING. THE SPECIES IS EDIBLE.

3.2 Are you in principle **willing to pay** a contribution to manage the lionfish problem on the Cayman Islands? Please keep in mind that a payment reduces your budget for other expenditures.

1. Yes [next question]		2. No [Go to question 3.5]	
------------------------	--	----------------------------	--

3.3 What is the maximum amount you are willing to pay for lionfish management on the Cayman Islands in US\$ per day of your stay? US\$ per day

3.4 Would you have a preference for one of the following **organizations** to manage the collection and allocation of the lionfish management fund?

1. The Government of the Cayman Islands		4. Other non-profit organization (e.g. WWF)	
2. The Government of the Cayman Islands æDepartment of Environment		5. Other, specify:	
3. Cayman Islands Tourism Association		6. Don't know / no preference	

3.5 Are there any reasons why you **would not be willing to pay** to manage the lionfish invasion on the Cayman Islands (check one)?

1. No need for management of nature		6. The health of the marine environment does not interest me	
2. Conservation is the responsibility of the Cayman Islands		7. I am not responsible for the problem	
3. I cannot afford it		8. Other: ...	
4. This program would not be effective		9. Don't know/ prefer not to answer	

[SHOW THE EXAMPLE CHOICE CARD HERE, AND **READ THE FOLLOWING TEXT OUT LOUD**]

The following questions ask you to make a choice between three scenarios for the future state of lionfish management on the Cayman Islands. The scenarios are described in terms of the following aspects:

1. Lionfish hunting refers to two situations: A situation in which spearfishing for lionfish is allowed for tourists and a situation in which it is not.
2. Lionfish as food refers to the availability of lionfish in restaurants on the Cayman Islands.
3. Reef fish diversity / lionfish abundance refers to the diversity of different reef fish and the abundance of lionfish on the reefs around the Cayman Islands. The more lionfish, the less abundant other fish species will be.
4. Coral quality refers to the health of the benthic part of the reef (e.g. corals, sponges etc.). This takes into account coral cover, coral diversity etc. It is assumed that the abundance of lionfish has a negative impact on the coral quality.
5. The lionfish management fee is a daily payment that all tourists would have to pay and would be earmarked for the management of the lionfish invasion on the Cayman Islands. Note that this fee is part of your holiday: money spent on the fee reduces your budget for other things!.

[**CHECKLIST**, EXPLAIN THE FOLLOWING TO THE RESPONDENT:]

- There are **seven choice cards** in which the respondent is asked to choose between three different scenarios.
- Explain the different scenarios on the example card: **Option A**, **Option B** and **The Expected Scenario Without Lionfish Management**. Option A and B change in each choice card.
- There is no “best scenario”. Every choice consists of a **tradeoff** between different attributes.
- There are **no wrong answers** as we are only interested in the respondent’s opinion!
- The lionfish management fee will be part of the respondent’s holiday **expenses** and can only be spent once.
- The **attribute levels are not interchangeable** between different scenarios.

[NOTE: FOR THE FIRST CHOICE CARD TRY NOT TO HELP THE RESPONDENT TOO MUCH, UNLESS HE REALLY DOESN’T UNDERSTAND. JUST BRIEFLY POINT OUT THE DIFFERENCES BETWEEN THE OPTIONS IF NECESSARY BUT TRY TO GIVE A BALANCED PRESENTATION. DO NOT LET YOUR VALUES AND PREFERENCES INFLUENCE THE RESPONDENT’S CHOICE!! AFTER ALL CHOICES ARE MADE, ASK THE RESPONDENT THE FOLLOW UP QUESTIONS. IF THE RESPONDENT REFUSES TO MAKE A CHOICE, TRY TO FIND OUT WHY]

Record the respondent's **answers to each choice question** in the table below.

3.6 FILL CHOICE SET NUMBER HERE # -----	1. Option A	2. Option B	3. Option C	4. Refused
3.7 Choice card 1				
3.8 Choice card 2				
3.9 Choice card 3				
3.10 Choice card 4				
3.11 Choice card 5				
3.12 Choice card 6				
3.13 Choice card 7				

3.12 Indicate on a scale of 1 to 10 how **certain** you are that you are going to **pay** the lionfish management fee in reality (1 means "not certain at all" and 10 "fully certain").

Uncertain					↔					Certain				
1	2	3	4	5	6	7	8	9	10					

3.13 How did you make your **choices**? Did you:

1. Consider all aspects simultaneously		4. Use your intuition	
2. Consider a few aspects		5. Make a random choice	
3. Only consider one aspect		6. Don't know	

3.14 How important were the different attributes in **determining your choices** in the choice experiment?

	Not important		↔	Very important	
	1	2	3	4	5
1. Lionfish hunting					
2. Lionfish as food					
3. Reef fish diversity / lionfish abundance					
4. Coral quality					
5. Lionfish management fee					

[ONLY ASK 3.15 IF RESPONDENT CHOSE THE 'WITHOUT LIONFISH MANAGEMENT' OPTION IN MORE THAN 4 CARDS OR REFUSED TO CHOOSE]

3.15 If you chose 'Without management' in each card or refused to choose, explain **why**:

1. The costs were too high	
2. I am against additional contribution , no matter what it is used for	
3. I think that the money will not be used as specified	
4. I am not responsible for the damage to the marine environment	
5. The lionfish does not pose a serious threat to the marine environment of The Cayman Islands	
6. The issues are more complex than these questions suggest	
7. I couldn't understand the questions	
8. It was too hard to make choices	
9. Other , specify	

PART 4: Threats to the marine environment on the Cayman Islands

4.1 Do you think that there are important **threats to the marine environment** of the Cayman Islands other than lionfish?

--

4.2 Please indicate the extent to which you agree with the following **statements on a scale from 1 to 5** (*1 = completely disagree; 5 = completely agree*).

	<div style="display: flex; align-items: center; justify-content: space-between;"> Fully disagree ← → Fully agree </div>					Don't know
	1	2	3	4	5	
1. I enjoy seeing lionfish when I am in the water						
2. Lionfish are delicious						
3. Lionfish pose a risk to the safety of people						
4. The environmental fee that is currently paid by all travellers should be higher						
5. Hunting/killing lionfish is a horrible practice						
6. The current efforts to manage lionfish on the Cayman Islands are sufficient						
7. I have experience with lionfish hunting						

4.3 Will you **return** to the Cayman Islands for another vacation?

1. Yes, definitely		5. No, definitely not	
2. Yes, most probably		6. Not sure / Don't know	
4. No, probably not			

4.4 If there would be a **reason not to return** to the Cayman Islands, what would the main reason be?

1. Coral reefs are becoming more degraded		6. Did not feel safe on the island(s)	
2. The natural environment is not beautiful enough		7. I rarely return to a vacation destination	
3. Not enough to do		8. There is no reason why I would not return to the Cayman Islands	
4. There is too much development		9. Other, specify:	
5. The islands are too expensive			

Part 5: Personal and household information

Finally, I would like to ask you some questions about your expenditures and your personal situation. Please note that this information is strictly used for scientific purposes only.

5.1 Before I ask you about your spending amounts, how many people did your expenditures cover?

1. # _____ Adults	2. # _____ Children
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5.2 If you booked a **travel package**, what was **included** in the package?

1. Airfare/cruise		6. Car	
2. Accommodation		7. Other local transportation	
3. Breakfast		8. Diving/Snorkelling	
4. Lunch		9. Other activities (tours, etc.)	
5. Dinner		10. Other, specify	

5.3 How much did you approximately pay in total for this **package** (*Fill for most convenient unit: per person or per group indicated in question 5.1*)?

- 5.4** Please indicate the expenditures (**excluding package costs**) on the following items. The amounts should be either given as expenditures per person **or** per group (as specified in 5.2) during your stay on The Cayman Islands (*a **rough estimation** is sufficient and choose your preferred column for each item*).

	US\$ per person		US\$ per group	
	a. per day	b. per stay	c. per day	d. per stay
1. Airfare				
2. Accommodation				
3. Transportation				
4. Diving				
5. Snorkelling				
6. Fishing				
7. Other water-based activities				
8. Land-based tours				
9. Food and beverages (in restaurants)				
10. Shopping				
11. Donations				
12. Other, specify				

- 5.5** What is your **gender**?

1. Female		2. Male	
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- 5.6** What is your **age**?

1. 18 - 25		6. 46 - 50	
2. 26 - 30		7. 51 - 55	
3. 31 - 35		8. 56 - 60	
4. 36 - 40		9. 61 - 65	
5. 41 - 45		10. 66 years and older	

- 5.7** How many **children** do you have? Children

- 5.8** What is the highest level of **education** you have completed?

1. None		5. College / Bachelors	
2. Primary school		6. University / Masters degree / other post-graduate	

5.9 Which **employment** category applies to you?

1. Student		4. Unemployed / seeking work	
2. Employed		5. Retired	
3. Self-employed / Entrepreneur		6. Not in the work force	

5.10 What is your annual total **Household Income before taxes in US\$?**

1. \$0 to \$50.000		5. \$200.000 to \$300.000	
2. \$50.000 to \$100.000		6. Over \$300.000	
3. \$100.000 to \$150.000		7. Prefer not to answer	
4. \$150.000 to \$200.000			

Thank you very much for participating in our survey! If you have any comments, please write them below.

If you are interested to **learn more about the results** of this study, please write your e-mail address below and we will mail you a summary. E-mail:

